COURSE CATALOG

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY BANGALORE

Course Code	Name of the Course	Type of Course
CS/DB 220;CS 220;CS/DS 702	Distributed Computing	ELECTIVE COURSE
DB 210;DS/SE 603;DS 603;CS 605	Data Modeling	ELECTIVE COURSE
DB 270;CS/DS 704;AI 704	Multi-Agent Systems	ELECTIVE COURSE
ES/NC 260;NCE 603;NC 603/ESD 608	Digital Signal Processing	ELECTIVE COURSE
ESD 601;VL 601	Testing & Design For Testability	ELECTIVE COURSE
ESD 814	Device Drivers	ELECTIVE COURSE
ESD 816	Modern Operating Systems	ELECTIVE COURSE
ESD 817	Digital Control Systems	ELECTIVE COURSE
ESD 818;VL 818	Virtual Machines	ELECTIVE COURSE
ESD 853;VL 853	Advanced ARM Architectures	ELECTIVE COURSE
ESD 854;ESD 855;VL 855	Device Driver Development	ELECTIVE COURSE
ESD703/NC802	Principles of Intelligent systems	ELECTIVE COURSE
NCE 601;NC 601	Wireless Access Networks	ELECTIVE COURSE
SE 220	Design Patterns and Software Architecture	ELECTIVE COURSE
CS 101;CS 511	Algorithms	ELECTIVE COURSE
CS 230/NC 285	Cryptography & Network Security	ELECTIVE COURSE
CS 280;CS 604	Artificial Intelligence	ELECTIVE COURSE
DB 250;DS 604	Web Information Retrieval	ELECTIVE COURSE
HSS 102	The City	ELECTIVE COURSE
NC 210;NCE 701;NC 701	Mobile Computing with IMS Architecture	ELECTIVE COURSE
NC 231;NCE 602;NC 827	Wireless Communication	ELECTIVE COURSE
DS 707	Data Analytics	ELECTIVE COURSE
BS 102;BS 102A;SM 101	Chemistry	CORE COURSE
BS 103	Introductory Bio-sciences	CORE COURSE
BS 104;SM 103	Mathematics - 1	CORE COURSE
CC 102	Computer Architecture and Organization	CORE COURSE
CC 106	Digital Communications	CORE COURSE
CC 108;CC 108A	IT Infrastructure	CORE COURSE
CS 202 / CC 101	Design and Analysis of Algorithms	CORE COURSE
CS/ES 250;EG 201;Eg 211 / CC 102	Computer Architecture	CORE COURSE
CS/SE 270	Design and Analysis of Safety-Critical Systems	ELECTIVE COURSE
ES 101	Basic Electronics, Digital Logic & Circuits	CORE COURSE
ES 105;EC 304	Signal Processing	CORE COURSE
ESS 111	Programming in C	CORE COURSE
ESS 112	Programming in Python	CORE COURSE
GEN 297B	Introduction to literature	#N/A
HSS 101;HS 101	Economics	CORE COURSE
OT 104	Introduction to Profession	#N/A
SM 102 / BS 105	Mathematics - 2	CORE COURSE
SM 202 / BS 109	Mathematics - 4	CORE COURSE
SM 203 /BS 107	Physics - 1	CORE COURSE
SM 202	Maths-4	CORE COURSE
CS/DS 601	Theory of Computation	ELECTIVE COURSE

Course Code	Name of the Course	Type of Course
CS/DS 706;GEN 511;AI 511	Machine Learning	ELECTIVE COURSE
CS/SE 703;CS 703	Automated Formal Verification	ELECTIVE COURSE
GEN 501	Mathematics for IT	ELECTIVE COURSE
HSS 104A;DT 104	Technology and Society	ELECTIVE COURSE
NCE 851;NC 851;NC/CS 851	Mathematical Analysis of Networks	ELECTIVE COURSE
SE 701	Design Patterns and Enterprise System Development	ELECTIVE COURSE
CS 110;CS 510;CS 510 /ESD 504;CC 109;EG 301	Operating Systems	CORE COURSE
CS 225;CS 606 / CS 304	Computer Graphics	ELECTIVE COURSE
CS 551;CS 302	Introduction to Automata Theory & Computability	CORE COURSE
CS 603	Cryptography	ELECTIVE COURSE
CS 814	Competitive Programming	ELECTIVE COURSE
CS 855;CS/DS 855;CS/DS 732	Data Visualization	ELECTIVE COURSE
CS 856;CS 714	Advanced Computer Graphics	ELECTIVE COURSE
CS/DS 823	Introduction to Text Processing and Information Retrieval	ELECTIVE COURSE
CS/NC 857	Secure Computation	ELECTIVE COURSE
CS/NCE 854;CS/NC 854;CS/NC/ESD 854;NC/ESD 854;SP 854;SP 864;NC 854	Digital Image Processing	ELECTIVE COURSE
CS/SE 201;CS/DS 602;CS 602	Advanced Algorithms	ELECTIVE COURSE
CS/SE 851	Compiler Design	ELECTIVE COURSE
DS 608;AI 608	Network Science for the web	ELECTIVE COURSE
DS 815	Cloud Computing and Big Data in Practice	ELECTIVE COURSE
DS/NC 863;DS/NC/ESD 863	Machine Perception	ELECTIVE COURSE
DS/NCE 855	Designing Gaming Simulations	ELECTIVE COURSE
EC 202	Electronic Devices and Circuits	CORE COURSE
ESD 501	Mathematics for Electronic Systems Design	ELECTIVE COURSE
ESD 502	Introduction to CMOS Fabrication and Analog CMOS VLSI Design	ELECTIVE COURSE
ESD 503	Analysis and design of CMOS Digital IC	ELECTIVE COURSE
ESD 505	Principles of Embedded Systems	ELECTIVE COURSE
ESD 701	Functional Verification of SOC Designs	ELECTIVE COURSE
ESD 705	Model Based Hardware-Software Co-Synthesis of Embedded Systems	ELECTIVE COURSE
ESD 813;VL 813	Real Time Operating Systems	ELECTIVE COURSE
GEN 602;SM 602	Introduction to Nonlinear Dynamical Systems	ELECTIVE COURSE
HSS 103;HS 102	History of Ideas	CORE COURSE
NC 812/ESD 812;NC 812	Internet of Things	ELECTIVE COURSE
NC 852	Network Security	ELECTIVE COURSE
SE 230;SE 602;CS 731	Software Testing	ELECTIVE COURSE
SE 852;SE 802	Usability Engineering	ELECTIVE COURSE
SE 853	Requirement Engineering	ELECTIVE COURSE

Course Code	Name of the Course	Type of Course
VL 602;ESD 602	High Level Synthesis and Optimization of Digital Circuits	ELECTIVE COURSE
VL 701	Functional Verification of SOCs	ELECTIVE COURSE
CC 103;EG 101	Computer Networks	CORE COURSE
CC 104;CS 501;EG 102	Data Structures and Algorithms	CORE COURSE
CC 110;CS 820;CS 306	Programming Languages	CORE COURSE
CC 111;CS 303	Software Engineering	CORE COURSE
CC 112;GEN 502;CS 201	Discrete Mathematics	CORE COURSE
CS 210;CS 701	Advanced Operating Systems	ELECTIVE COURSE
CS 709	Geometric Modelling	ELECTIVE COURSE
CS 891	Automata Theory and Computability	ELECTIVE COURSE
CS/DS 862	Algorithms for Masssive Data	ELECTIVE COURSE
CS/DS 864	Machine Learning - I	ELECTIVE COURSE
CS/DS 866	Machine Learning II	ELECTIVE COURSE
CS/NC 716;CS 716	Computing on Private Data	ELECTIVE COURSE
CS/NC 813;CS/NC 616;CS 616	Foundations of Cryptography	ELECTIVE COURSE
CS/SE 610	Advanced Computer Architecture	ELECTIVE COURSE
DB 280;DS 703;AI 703	Geographic Information Systems	ELECTIVE COURSE
DS 501;CC 105;CS 301	Database Systems	CORE COURSE
DS/NC 615;DT 212/DS/NC 615;DT 212	Techno-Economics of Networks	ELECTIVE COURSE
DT 102	Digital Components of a Connected Society	CORE COURSE
DT 103	Interface Design for Diverse Populations	CORE COURSE
DT 105	Quantitative Methods	CORE COURSE
DT 113	Qualitative Research Methods	CORE COURSE
DT 201	Engineering and Management of Large Digital Systems	CORE COURSE
DT 202/ ITS 602	The Digital and its Discontents	ELECTIVE COURSE
DT 213;ITS 711	Social Media Communication	ELECTIVE COURSE
DT 301	Information Management	CORE COURSE
DT 304	Digital Product Development	ELECTIVE COURSE
EC 302	Microprocessors and Microcontrollers	CORE COURSE
EC 303	Principles of Communication Systems	CORE COURSE
EC 305	Control theory	CORE COURSE
EC 306	Digital Communication	CORE COURSE
ES 102;ESS 101	Programming I	CORE COURSE
ES 103;ESS 201	Programming II	CORE COURSE
ES 104;ESS 103	Signals and Systems	CORE COURSE
ESD 607/NCE 801;ESD 607/NC 801	Inter device communication	ELECTIVE COURSE
ESD 801;VL 801	Analysis and Design of VLSI Sub-systems	ELECTIVE COURSE
ESS 102	Digital Design	CORE COURSE
GEN 503	Probability and Statistics	ELECTIVE COURSE
GEN 504	Linear Algebra	ELECTIVE COURSE
GEN 505	IT Project and Product Management	ELECTIVE COURSE

Course Code	Name of the Course	Type of Course
GEN 601	Introduction to Scientific Computing	ELECTIVE COURSE
GEN 701	Scientific Computing II	ELECTIVE COURSE
HSS 104B	E-Governance Application Design	ELECTIVE COURSE
HSS 105	Ethics	ELECTIVE COURSE
ITD 101	IT in Domains (Health Care and Robotics)	CORE COURSE
ITS 210;ITS 601;DT 211/ ITS 601	Dynamics of the Information Technology Industry	ELECTIVE COURSE
ITS 603;DT 203/ ITS 603	Information and Communication Technology Policy and Regulation	CORE COURSE
ITS 703	E-Governace Application Design	ELECTIVE COURSE
NC 101;NCE 501;NC 501	Networking and Communication	ELECTIVE COURSE
NC 864	Software Defined Network and Network Function Virtualization	ELECTIVE COURSE
OT 101;GEN 102	Physical Education 1	CORE COURSE
OT 102;GEN 103	Physical Education 2	CORE COURSE
OT 103;ENGLISH;GEN 101	English	CORE COURSE
SE 510	Software Engineering Practices	ELECTIVE COURSE
SM 201, BS 106;BS 106A;BS 106B	Mathematics - 3	CORE COURSE
SM 204 / BS 108	Physics-2	CORE COURSE
CS 868	Compilers	ELECTIVE COURSE
CS 869	Information Technology Product Management	ELECTIVE COURSE
CS/DS 815	Topological Data Analysis	ELECTIVE COURSE
CS/DS 816;CS/DS 715;CS 717	Computational Geometry	ELECTIVE COURSE
CS/DS 867	Seminar in Large Scale Applications of Algorithms	ELECTIVE COURSE
CS/NC 865;CS/NC/ESD 865	Advanced Digital Image Processing	ELECTIVE COURSE
CS/NC 866;NC 866	Advanced Cyber Security	ELECTIVE COURSE
CS/NCE 852;CS/NC 852;NC 853	Network Security	ELECTIVE COURSE
DS/NC 816	Signal and Text Analytics	ELECTIVE COURSE
DS/NC 821;DS/NC 824;DS/SP 823	Automatic Speech Recognition	ELECTIVE COURSE
DS/NC 866	Advanced Machine Perception	ELECTIVE COURSE
DT 303	Advanced Qualitative Research Methods	ELECTIVE COURSE
DT 305	From Territorial Place to Cyberspace: The Political Economy of Location	ELECTIVE COURSE
GEN 705	Information Technology Project and Product Management	ELECTIVE COURSE
ITS 712	Smart Cities: Urban Labelling and Beyond.	ELECTIVE COURSE
CS 816	Software Production Engineering	ELECTIVE COURSE
CS 819	Software Models and Architectural Principles	ELECTIVE COURSE
CS 861;CS/DS 818	Block Chain and Cryptocurrencies	ELECTIVE COURSE
CS/DS 612	Machine Learning-1	ELECTIVE COURSE
CS/DS 812	Foundations of Big Data Algorithms	ELECTIVE COURSE
CS/DS 817;AI 817	Optimization, Learning and Cognition	ELECTIVE COURSE
CS/DS 820	Optimization, Learning and Cognition-2	ELECTIVE COURSE
CS/DS 856	Neural Networks and Reinforcement Learning	ELECTIVE COURSE
CS/DS 870	Seminar Course on Algorithms Compilers	ELECTIVE COURSE

Course Code	Name of the Course	Type of Course
CS/NC 824	Cyber Security Fundamentals with tools and techniques for defense	ELECTIVE COURSE
DS 822	Data Management for AI	ELECTIVE COURSE
DS/NC 822	Speech Processing	ELECTIVE COURSE
DS/NC 831	Image Analysis	ELECTIVE COURSE
DS/NC 871;DS/SP 826;AI 826	Deep Learning for Automatic Speech Recognition	ELECTIVE COURSE
DT 385	Cyberspace, Globalization, and Location	ELECTIVE COURSE
EC 301;ECE 509	Analog Circuits and Systems	ELECTIVE COURSE
EC 502;VL 502	Analog CMOS VLSI Design	ELECTIVE COURSE
GEN 512;AI 512	Mathematics for Machine Learning	ELECTIVE COURSE
GEN 611	Maths for ML	ELECTIVE COURSE
SM 101P	Computational Chemistry	CORE COURSE
DT 108	Human Computer Interaction	CORE COURSE
DT 205	Technology in Development	CORE COURSE
CS 512	Discrete Mathematics and Computability	ELECTIVE COURSE
CS 513	Software Systems	ELECTIVE COURSE
NC 861	Advanced Computer Networks	ELECTIVE COURSE
CS 825	Graph Theory	ELECTIVE COURSE
CS 826	Fully Homomorphic Encryption and Applications	ELECTIVE COURSE
CS 835	Algorithmic Thinking	ELECTIVE COURSE
CS 853	Approximation Algorithms	ELECTIVE COURSE
CS 872	Computational Sustainability	ELECTIVE COURSE
CS 873	Cryptographic Engineering	ELECTIVE COURSE
CS/DS 829;CS/SP 829;DS/SP 829;AI 829	Natural Language Processing	ELECTIVE COURSE
CS/DS 832	Advanced Data Visualization	ELECTIVE COURSE
DS/NC 826;SP 826;AI 836;DS/SP 836	Advanced Visual Recognition	ELECTIVE COURSE
DS/SP 828	Probabilistic Graphical Models	ELECTIVE COURSE
DT 107	Application Development for a Connected Society	CORE COURSE
DT 109	Research Methods	CORE COURSE
DT 110	Enterprise Software Development	ELECTIVE COURSE
DT 204	Social Complexity and Systems Thinking	CORE COURSE
DT 306	Privacy in the Digital Age	ELECTIVE COURSE
DT 307	The Web and the Mind	ELECTIVE COURSE
EC 503;VL 503	Digital CMOS VLSI Design	ELECTIVE COURSE
EC 504;VL 504	System design with FPGA	ELECTIVE COURSE
EC 506;VL 506	System Software	ELECTIVE COURSE
GEN 806	Distributed Systems and Control	ELECTIVE COURSE
GEN 807	Robotics and Control	ELECTIVE COURSE
GEN 811	Introduction to Robotics	ELECTIVE COURSE
HSS 106/DT 215	Digital Sociology	ELECTIVE COURSE
HSS 107/DT216	News Literacies in the Digital Society.	ELECTIVE COURSE
SP 825;AI 825	Visual Recognition	ELECTIVE COURSE
DT 309	Digital Platforms: Technology & Business Components	ELECTIVE COURSE

Course Code	Name of the Course	Type of Course
CS 821	Privacy-Preserving Machine Learning	ELECTIVE COURSE
CS 870	Program Analysis for Software Engineering	ELECTIVE COURSE
CS/DS 720;AI 720	Artificial General Intelligence	ELECTIVE COURSE
DS 821	Spatial Computing	ELECTIVE COURSE
DS/SP 856;AI 856	Reinforcement Learning	ELECTIVE COURSE
GEN 810	Interdisciplinary Robotics	ELECTIVE COURSE
GEN 812	Quantum Computing and Quantum Information	ELECTIVE COURSE
VL 820	Physical design of ASICs	ELECTIVE COURSE
DT 308	Quantitative Data Analysis and Public Policy	CORE COURSE

BS 106B/SM-201 MATH-III
TERM I

Course Code / Course Name	BS-106B/SM-201 MATH-III	
Course Instructor Name(s)	Prof. Manisha Kulkarni	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

SM-103, SM-201

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	yes	Develops Analytical thinking
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	yes	Learn to write proofs by using proper argument, Communicate Mathematical modelling of physics problems in proper language

Course Context and Overview

In day to day life, physical, biological, or economic systems are described by means of differential equations. Our ability to predict the way in which these systems evolve or behave is determined by our ability to model these systems and find solutions of the equations explicitly or approximately. This course is a basic course which gives introduction to differential equations and topics includes mainly a variety of second order differential equations and how to find their solutions, power series solutions, Laplace transforms, Fourier series and integrals.

At the end of the course I expect students to know the following:

- What is ODE, what is meaning of a solution, what initial value problems are, and what constitutes a solution.
- Should able to classify ODEs.
- Should able to say if solutions are linearly dependent or linearly independent.
- Should be able to solve homogeneous and non-homogeneous equations, learn to solve differential equations by using power series method near ordinary point.
- Learn Frobenius method to solve differential equations near regular singular points.
- Learn trigonometric Fourier series.
- Introduction to Laplace and Fourier transformations.
-

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand Picard's theorem for existence of solutions for 2^{nd} order linear differential equations	PO1	Ap	C, P	6	2

CO2	Solve homogeneous and nonhomogeneous linear differential equations of second order by using method of variation of parameters and method of undetermined coefficients	PO1	Ap	C, P	6	2
CO3	Solve Euler-Cauchy homogeneous and nonhomogeneous equations	PO1	Ap	C, P	6	2
CO4	Solve 2nd order linear differential equation using Power series method	PO1	Ap	C, P	5	2
CO5	Solve Legendre's equations	PO1	Ap	C, P	5	2
CO6	Solve Bessel's equations by using Frobenius method	PO1	Ap	C, P	5	2
CO7	Understand Fourier trigonometric series, Fourier transform and Laplace Transform	PO1	U	C, P	6	2
CO8	Understand the concept of Groups, Rings, Fields mainly Finite Fields.	PO1	U	C, P	6	1
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Topic 1. Second Order Linear differential equations, fundamental system of solutions and general solution of homogeneous equation, use of known solution to find another, Existence and uniqueness of solution of IVP,

Topic 2: Wronskian, general solution of nonhomogeneous equations, Euler-Cauchy Equation, extensions of the results to higher order linear equations.

Topic 3: Method of variation of parameters and method of undetermined coefficients.

Topic 4. Power Series Method - application to Legendre Equations, Legendre Polynomials.

Topic 5: Frobenius Method, Bessel equations, Properties of Bessel functions.

Topic 6: Sturm comparison Theorem, Sturm Liouvile BVP, Orthogonal functions.

Topic 7: Fourier Series and Integrals.

Topic 8. Basic Introduction to Laplace and Fourier Transforms (with less stress on theoretical aspects)

Topic-9: Introduction to Groups, Rings, Fields mainly Finite Fields

Instruction Schedule

Lecture 1, 2, 3 and 4: Second Order Linear differential equations, fundamental system of solutions and general solution of homogeneous equation, use of known solution to find another, Existence and uniqueness of solution of IVP,

Lecture 5, 6 and 7: Wronskian, general solution of nonhomogeneous equations, Euler-Cauchy Equation, extensions of the results to higher order linear equations.

Lecture 8, 9 and 10: Method of variation of parameters and method of undetermined coefficients and examples.

Lecture 11, 12, 13 14 and 15: Power Series Method - application to Legendre Equations, Legendre Polynomials, Rodrigues Formula, Orthogonality of Legendre's polynomials.

Lecture 16, 17 and 18: Frobenius Method, Bessel equations, Properties of Bessel Functions, Relations among Bessel's functions, Gamma function and it's properties.

Lecture 19, 20, 21and 22: Sturm comparison Theorem, Sturm Liouvile BVP, Orthogonal functions.

Lecture 23, 24: Fourier Series and Integrals.

Lectures 25 and 26: Laplace and Fourier Transforms and examples.

Lecture 27 and 28 Group, ring and Fields mainly Finite Fields

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Advanced Engineering Mathematics, by Erwin Kreyszig, 8th edition, Wiley,
- . Proper web notes (NPTEL notes are available)
- . Differential Equations with Applications and Historical Notes, by George F. Simmons.
- . Introduction to Ordinary Differential Equations, by Shepley L. Ross, 4th edition, Wiley, 1989.
- . Elements of Partial Differential Equations, by Ian Sneddon.
- . An Elementary Course in Partial Differential Equations, by Amaranath.
- Algebra by Artin

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Final grade will be based on weights given below:

20%: Quizzes
40%: Mid-Term Exam
40%: End-Term Exam

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Quiz-1	CO1,CO2
2	Mid-term-Exam	CO1,CO2, CO3, CO4
3	Quiz-2	CO7, CO8
4	Quiz-3	CO6, CO7
5	End-term Exam	CO5, CO7, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course

- Manual evaluation of descriptive questions
- Automatic evaluation of MCQ questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	Physics 2	
Course Instructor Name(s)	Shiva Kumar Malapaka & B. A. Ashok	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:0	**Total Credits = 3**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*None*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Problem solving skills, Logical reasoning

Course Context and Overview

Physics 2 is a core course studied by iMTech students of ECE and CSE batches in their 4^{th} Semester.

This course contains mainly three topics (i) Electromagnetics (ii) Quantum Mechanics and (iii) Statistical Mechanics. In this half the sememster is dedicated to Electromagnetics and rest of the semster for the other two topics.

The main purpose of this course is to introduce the students to advanced topics in Physics after their initiation to high level physics through Physics -1 in the 3^{rd} Semester.

The topics taught in Electromagnetism use the concepts of Vector calculus that the students would have already learned earlier. The emphasis is on taking the student from their known knowledge of Electricity and Magnetism; that they would have studied in 12^{th} class; to a higher plane where they realize that these aspects infact are two sides of the same coin. Maxwell's equations which not only bridge the two phenomenon but also bring in the aspects of Radiation are taught and the idea of Electromagnetic waves is introduced towards the end of this part of the course.

With these basics in Electromagetism, students (specially from ECE stream) can appreciate topics taught in subjects like Communications, Antennas and Radar theory.

The Quantum Mechanics part of the course is designed to first set the context for the need for such a subject using the ideas in Black body radiation, then go through the various branches that developed simultaneously in this subject namely photo electric effect and compton effect, Heisenberg's uncertainty principle, wave particle duality and atomic models. These topics form what we classify in this course as Old Quantum Mechanics.

New Quantum Mechanics starts with Schrodinger's Wave equation and then various solutions to the same are introduced including that of Hydrogen atom and quantum numbers and their significance discussed. Then we move to introduce postulates of Quantum mechanics, Operators, Dirac notaion, Operator algebra and end this part of the course with a basic introduction to Quantum Computing (that include superposition principle, quantum entanglement and cursory introduction to quantum gates and logic, quantum teleporting, quantum communcations and quantum cryptography) .

The aim of these topics is to enthuse students to take up a quantum computing courses or motivate them to pursue research in this emerging area.

Classical statistical mechanics starts with ideas from themodynamics like entropy and move towards defining various types of ensembles and their properties. Then we derive the Maxwell-Boltzmann distribution funciton from first principles and also explain its practical application in the context of understanding properties of ideal gas and lasers.

Quantum statistical mechanics mainly deals with use of quantisation ideas in statistical mechanics. Here we first introduce the idea of distinguishability and then derive from first principles Bose-Einstein and Fermi Dirac distributions. Their applications to various fields of Physics e.g. specific heat of solids, lasers and Free electron theory and semi conductor phyiscs are discussed at the end of this unit.

One cannot imagine today's life without electronic devices and these devices have their origins in the Free electron model and the semi conductor physics that developed based on the same. The statistical mechanics (both classical as well as quantum) are mainly aimed and introducing the students to how seemingly complex theories (or derivations) in Physics have complete day to day applications.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)
CO1	Understand vector calculus and integral theorems (Gauss divergence, Stokes and Green's)	PO1,	U	F,C, P	2
CO2	Determine the electric field due to a charge distribution in dielectric medium using Coulomb's law, Gauss Law, method of images and multipole expansion.	PO1	Ap	F,C, P	6
CO3	Determine the magnetic field in an infinite wire, quadrilateral loop and toroids using Biot-Savart's law and Ampere's Law.	PO1,	Ap	F,C, P	4
CO4	Understand the effect of Magnetisation in materials and its applications.	PO1	U	F,C. P	2
CO5	Determine Induced magnetic fields and dynamics between currents and fields.	PO1	Ap	F,C, P	4
CO6	Understand electromagnetism interms of Maxwell's Equations.	PO1	U	F, C,P	2

CO7	Understanding the mechanisms behind Photoelectric Effect, Compton's Effect, Heisenberg's Uncertainty Principle, Wave-Particle Duality and atomic models.	PO1	U	F,C, P	4
CO8	Understand Schrodinger's Equations and its application to special cases (particle in a box, hydrogen atom and simple harmonic oscillator).	PO1	U	F,C, P	6
CO9	Understand the principles of quantum computing	PO1	U	F, C	3
CO10	Understand the concepts of Phase space, ensembles, distinguishability, classical distributions and their applications	PO1	U	F,C, P	6
CO11	Understand Quantum Statistical Mechanics, distributions and Applications	PO1	U	F,C, P	6
	Total Number of Hours				**45**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Review : Co-ordinate systems, Vector Calculus, Gauss, Green and Stokes theorems.

Electrostatics: flux of an electric field, Gauss's law, applications, electric potential energy, the divergence of E, Dirac delta function, conductors, capacitance & combinations of capacitors, energy density, dielectrics, dipole, dipole moment, polarization, electric field calculations of various charge configurations, Method of Images, multipole expansion etc..

Magnetostatics : Lorentz force, cyclotron frequency, magnetic force & current-carrying wires, continuity equation, Biot-Savart law & applications, Ampere's law, magnetic dipole moment, magnetic materials, diamagnets, paramagnets & ferromagnets, magnetization & magnetic susceptibility, hysteresis etc..

Electrodynamics : Faraday's law of electromagnetic induction, Lenz's law, Maxwell's equations, boundary conditions, electromagnetic waves, wave equation, energy density, potential formulation of electrodynamics -- gauge transformations, , polarization.

Old Quantum Mechanics: Black body Radiation, Need for QM, the photoelectric effect, wave-particle duality, the Compton effect; de Broglie waves, phase & group velocities; wave-function & probability; a brief discussion on interference & diffraction, Heisenberg's uncertainty principle; Thomson & Rutherford's models of the atom; atomic spectra; Bohr's model of the atom & its explanation of spectral lines; Bohr- Sommerfeld quantization

New Quantum Mechanics : Schroedinger's equation (steady-state & time-dependent) solution for simple problems: particle in a box, tunneling through a potential barrier, simple harmonic oscillator, hydrogen atom, Quantum numbers and their interpretations, fundamental postulates of Quantum mechanics, expectation values, operators, commutator relations, Dirac Notation, Superposition principle, Entanglement, Introduction to Quantum Computing

Classical Statistical mechanics: Phase space, macrostates & microstates, entropy; distinguishable & indistinguishable particles; the most probable distribution; Maxwell-Boltzmann distribution. Application of Maxwell-Boltzmann distribution: properties of ideal gas, lasers.

Quantum Statistical mechanics: Fermi-Dirac & Bose-Einstein distributions
Applications of Quantum Statistical Distributions: Specific heat of solids, Dulong-Petit law, Einstein model; lasers (comes in Unit 6 too), free electron theories, metals; solids & crystals; origin of band structure, electrical & thermal properties of solids; semiconductors.

Instruction Schedule

Pre Mid sem: CO1 to CO6
Post Mid sem: CO7 to CO11
Weekly 2 classes of 1.5 hours each.

Learning Resources

Text books : 1) Classical Electrodynamics , J. D. Jackson 2) Introduction to Electrodynamics David J Griffiths 3) Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill. 4) Mathews & Venkatesan, A textbook of quantum mechanics 5) F. Reif, Statistical Physics (Berkeley physics course vol.5), McGraw Hill (1967) 6) C. Kittel, Solid State Physics (any of the several editions). 7) Mani & Mehta, Introduction to modern physics, Affiliated East-West Press. 8) The Feynman Lectures in Physics, Narosa (2008)

Online Resources: 1) https://arxiv.org/pdf/quant-ph/9809016.pdf (some part of this resrouce) 2) https://www.damtp.cam.ac.uk/user/tong/statphys/sp.pdf

Assessment Plan

Pre mid term Quizzes : 3 - 10 marks each – 30 marks
Midterm : 20 marks

Post mid term Quizzes: 2 - 10 marks each - 20 marks
Marks for attending classes – 10 marks (if this parameter is not mandatory then these marks go into either one quiz or the End sem)
End sem : 20 marks
Total : 100 marks
Relative Grading :
Relative grades are set based on the highest mark obtained by any student in the class and the lowest pass mark that instructor decides. In this band of marks, usually all the grades starting from A to D are spread in equidistant mark bands. Students who get lower than the set pass marks are given F grade.

Assignments / Projects

Not Applicable

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

The quizzes and mid sem and end sem exams usually comprise of questions (both MCQs, Descriptive questions and problems) based on the material discussed in the class. The answer scripts are evaluated manually even when the exam happens using pen& paper or an exam pad.
The answers to the question papers are usually provided just immediately after the exam is over for students's reference.
The students get an opportunity to view the evaluations done where possible either in person or online in a stipulated time period. Once this review process is over, the marks and grades are freezed and are not changed.

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	BS 102 Chemistry	
Course Instructor Name(s)	Brijesh Kumar Mishra	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	2	Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	Not related to employability
Focus on skill development	Yes	The lab work in this course helps students to learn specific skills.
Focus on entrepreneurship	No	Although no direct focus, the course empowers students to realize systems for different applications with limited knowledge.
Provides value added / life skills (language, writing, communication, etc.)	Yes	The component in the course allows students to work in team and present progress and technical report.

Course Context and Overview

The goal of this course is to learn fundamental aspects of Chemistry which helps students to understand and realize the importance of materials and other chemical methods which are useful in advanced courses of electronics, and artificial intelligent systems.

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Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Analyze and Interpret wave functions using Schrodinger equations	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO2	Analyse chemical kinetics and steady state approximation.	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO3	Identify and analyse transition elements, semiconducting nature and superconducting properties	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO4	Design appropriate reaction mechanism.	PSO1, PO3	U, Ap, An, C	C, P, FDP, PC, D	8	0
CO5	Perform and understand synthesis of organic molecules	PSO1, PO5,	U, Ap, An	C, P, PC	8	0

CO6	Analyse metallurgical principles, extraction process, and refining of metals	PSO1, PO5	U, Ap, An	C, P, PC	8	0

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Schrodinger equation; interpretation of wave function; hydrogen atom. Structure and bonding; atomic and molecular orbitals; VSEPR; energy levels in molecules and solids. Trends in the Periodic table.

Chemical kinetics; steady state approximation; collision theory. Catalysis, chemical potential; fugacities, activities; equilibrium constants and free energy; relationship between G and emf; standard potentials.

Transition elements and their uses ; catalysis; semiconducting and super conducting materials, zeolites and spinels. Coordination Chemistry; Transition metal ions and complexes; 18-electron rule; simple ligands such as CO, ethylene, triphenylphosphine. Organometallic chemistry; homogeneous catalysis; magnetochemistry; role of metal ions in biological processes.

Metallurgy; basic principles; extraction and refining of metals and applications.

Reaction mechanism; nucleophilic, electrophilic substitutions; free radical addition; additions and substitutions to aromatic systems; addition to compounds containing carbonyl groups. Linear and cyclic conjugation; benzene; aromaticity and properties of conjugated systems.

Structure of organic molecules; conformations of alkanes and cycloalkanes; glucose and fructose; E and Z; Anomeric effect. R and S; molecular chirality; optical and geometrical isomerism; importance of optical activity in drug synthesis and biological activity.

Synthesis of organic molecules; photochemistry of organic and bio molecules; chemistry of life processes; molecular systems of technological and biological importance; biotechnology and biomedical applications.

LABORATORY COMPONENT

Experiments related to general, organic, physical, inorganic and bio- chemistry.

1. Estimation of iron in heamatite ore.
2. Estimation of hardness in water.
3. Estimation of available chlorine in bleaching powder.
4. Redox titration by potentiometry.

5. Dissociation constant of polybasic acid using pH titration.
6. CMC of soap solution by conductivity measurements.
7. Iron-orthophenanthroline by colorimetry.
8. Estimation of glucose by DNS method.
9. Estimation of inorganic phosphate by Fiske-Subbaraw method.
10. Preparation of Aspirin; meta dinitrobenzene.
11. & 12. Functional groups analysis in organic compounds: hydrocarbons, alcohols, aldehydes, ketones, carboxylic acids, amines, amides, phenols, nitro compounds.

Instruction Schedule

[Provide session-wise schedule]

Topic	No. of hours
Schrodinger equation, Bonding structure, energy levels in molecules and solids	6
Chemical kinetics; steady state approximation; collision theory	6
Transition elements and their uses	6
Metallurgy	6
Reaction mechanism	6
Structure of organic molecules	6
Synthesis of organic molecules	6
TOTAL hours	42

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
4. Physical Chemistry, by P. W. Atkins
5. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Midterm exam-30%
Final exam-30%
Assignments and Quizzes-40%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Analyze and Interpret wave functions using Schrodinger equations	CO1
2	Design appropriate reaction mechanism	CO4

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of circuit analysis and design problems

Students are provided the opportunity to view the evaluations done either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions are not accepted

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	BS 103 Introductory Biosciences	
Course Instructor Name(s)	Visiting Faculty	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	2	Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	Not related to employability
Focus on skill development	Yes	The lab work in this course helps students to learn specific skills.
Focus on entrepreneurship	No	Although no direct focus, the course empowers students to realize systems for different applications with limited knowledge.
Provides value added / life skills (language, writing, communication, etc.)	Yes	The component in the course allows students to work in team and present progress and technical report.

Course Context and Overview

Students who successfully complete this course will be able to:
Identify major kingdoms, a few important phyla and their main characteristics.
List the taxonomical features of organisms that are commonly used as research models and discuss the probable relevance of data from such models to various other species.
List the major pathogens affecting lives of humans, and important plants and animals of importance to human needs, directly or indirectly; also explain the important taxonomical characters, as well as brief their life cycles.
Relate the diversity to the evolution concepts.
Explain the interactions within populations and the surrounding abiotic/biotic factors.
Understand the relationship between population dynamics and evolution (genetic drift and related concepts).
Describe the significance of balance of various interactions and recycling of chemical constituents within a system.
Identify major animal and plant physiological systems, their constituents (organs and tissues) and the mechanisms of operation.
Discuss a few important examples of common disorders affecting various systems in humans and plants.
Explain the peculiarities of germ cell production in the context of genetic diversity, and general physiology.
Explain concepts in genetics and developmental biology.
Establish the relationship between reproduction, cell divisions, genetics, development and differentiation.
Describe the basic principles of inheritance and their discovery; explain genetic linkage and its applications.
List the major human genetic disorders and explain their characters.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Analyze taxonomy and biodiversity	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO2	Analyze ecology	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO3	Identify and analyse plant and animal physiology	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO4	Design and understand appropriate genetics and evolution	PSO1, PO3	U, Ap, An, C	C, P, FDP, PC, D	8	0
CO5	Understand reproduction and developmental biology	PSO1, PO5,	U, Ap, An	C, P, PC	8	0
CO6	Analyse computational biology	PSO1, PO5	U, Ap, An	C, P, PC	8	0

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics

Unit # Topic

I Taxonomy and Biodiversity:

Broad basis of classification of major kingdoms: protista, plants, animals; reference to NCBI sources; research models from different major taxa; taxonomy and brief life cycles of examples (major ones only) pests in plants, animals and humans.

II Ecology:

Introduction to ecosystem concepts; brief description of abiotic and biotic factors influencing dynamics of ecosystem; population ecology; urban ecosystems and impact of modern human lifestyles on various ecosystems.

III Plant and Animal Physiology:

Basics of concepts in cellular vs. general physiology; an overview of plant physiology: plant tissues and functions, water balance, solute transport, translocation (phloem), plant growth, respiration and photosynthesis; human physiology: digestive system, circulation, excretion, muscle structure and functions, and neural tissues and functions; examples of common disorders affecting different systems in humans and plants.

IV Genetics and Evolution:

Mandelian laws of inheritance, examples of multiple alleles governing one phenotype; overview of cytogenetics and genetic linkage; brief overview of molecular genetics; types of mutations and their role in evolution; major human genetic disorders; Darwin's theory of evolution, origin of life (current theory), natural selection and concept of speciation, brief history of species, phylogeny, cladistics systematics, molecular basis of evlolution.

V Reproduction and Developmental Biology

Significance of meiosis in sexual reproduction, differences between male and female gamete generation, fertilization, embryogenesis, early development (– plants and humans), role of hormones in germ cell production and early development and puberty; brief discussion on diversity in these processes across other important species, including plants.

LABORATORY COMPONENT

(10 sessions of 3 hours or 15 sessions of 2 hours each).

1. Microscopy:

a) Introduction (Self prepared PPT – from Leeuwenhoeks Simple Microscope to High Voltage Electron Microscope/SEM, etc.) followed by the usage of simple, monocular, binocular, oil immersion microscopes.

b) Mounting of algae, fungal hyphae, spores, macerated plant tissue,

c) Stem /root sections – TS, VS, free hand/paraffin slides, animal histology slides.

d) Significance of staining, preservation, permanent slides, cytological preparations.

2. Biodiversity:

a) Plantae: Bryophyta, Pteridophyta, Gymnospermae and Angiospermae.

b) Animalia: Protozoa tro Mamalia

c) Microbes as models in research (E.Coli, Petite Yeast): Observation of Lactobacilli.

d) Plant pathogens: Rust disease, Smut, Mildews.

e) Angiosperm taxonomy: Concept of the “Art & Science” of observation, identification and classification of plants (Michelia, Rosa, Datura, Orchid).

3. Experiments in plant physiology:

a) Photosynthesis – pigments – spectroscopic analysis, Emerson effect.

b) Biological oxidation – respiratory quotient, fermentation.

c) Enzymes: catalase activity,

d) Preliminary analysis to identify natural products from plant source (raw drugs).

e) Extraction of DNA.

4. Experiments in animal physiology:

a) Carbohydrate metabolism – reducing sugars – test for sugars in urine, blood.

b) Proteins, lipids.

c) Sodium intake / loss using aquatic models, muscle twitch,

d) Virtual dissection – virtual tour of the human body.

5. Genetics:

a) Analysis of visual traits - tongue folding, rolling, dimple cheek, : : :

b) PTC test, blood group – Rh Factor.

c) Brain teasers – genetic problems.

6. Reproductive biology:

a) Observation of incubated chick material for embryogeny.

b) Slides on Meiosis.

c) Observation of plant pollen, seed – embryo.

7. Ecology:

a) Field visit to study varied ecosystems – Hydrosere – Xerosere.

b) Ecological adaptations in plants – arid plants, salt tolerance, aquatic adaptations, Haustoria.

c) Quadrat study.

8. Applied ecology

a) Water depletion, water shed development, pollution, surface and ground water status.

b) Air quality, pollutants.

c) Solid waste management.

d) Urban Environmental Problems – social, cultural & economic. (Assignment suggested).

9. Computational biology:

a) Introduction to bioinformatics.

b) Assignments /field report writing & analysis /Herbaria /Plastnation technique.

c) Tour report /taxonomic indexing /use of Web media in systematics.

10. Round up:

a) Ideas to share & care for a "better world".

b) Group discussion on environmental issues.

c) Resolutions, feedback.

Instruction Schedule

[Provide session-wise schedule]

Topic	No. of hours
Taxonomy and Biodiversity:	6
Ecology	6
Experiments in plant physiology	6
Experiments in animal physiology	6
Genetics	6
Reproductive biology	6
Ecology, Applied ecology, Computational biology	6
TOTAL hours	42

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. "Typologies and Taxonomies: An Introduction to Classification Techniques (Quantitative Applications in the Social Sciences)," by K. D. Bailey, Sage Publications, 1994.
2. "Evolution," by M.W. Strickberger, Jones and Barlett publishers Inc., London, 1996.
3. "Organizing Knowledge: Taxonomies, Knowledge and Organizational Effectiveness," by P. Lambem, Chandos Publishers, 2007.
4. "Ecology, Concepts and Applications", by M. C. Molles, McGraw-Hill Higher Education, 2nd edition, 2002.
5. "Ecology: from Individuals to Ecosystems," by M. Begon, C. R. Townsend and J. L. Harper, Blackwell Publishing, 4th edition, 2005.
6. "Plant Physiology," by L. Taiz and E. Zeiger, Palgrave Academic Publisher, 4th edition, 2006.
7. "Principles of Anatomy and Physiology," by G. J. Tortora and B. H. Derrickson, Wiley Higher Education, 11th edition, 2006.
8. "Endocrinology: An Integrated Approach," by S. S. Nussey, and S. A. Whitehead, London:Taylor & Francis, 2001.
9. "Genes IX," by B. Lewin, Jones & Bartlett Publishers, Inc., 9th edition, 2008.
10. "An Introduction to Genetic Analysis," by A. J. F. Griffiths, J. H. Miller, D. T. Suzuki, R. C. Lewontin, and W. M. Gelbart, W. H. Freeman & Co., 8th edition, 2000.
11. "Developmental Biology," by S. F. Gilbert, Sunderland (MA): Sinauer Associates, Inc., 2000.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Midterm exam-30%
Final exam-30%
Assignments and Quizzes-40%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Analyze taxonomy, diversity, and ecology,	CO1
2	Design and understand appropriate genetics and evolution	CO4

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of circuit analysis and design problems

Students are provided the opportunity to view the evaluations done either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions are not accepted

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	CS 201 Discrete Mathematics
Course Instructor Name(s)	ASHISH CHOUDHURY

Credits (L:T:P)
(Lecture : Tutorial : Practical)

Hours	Component
	Lecture (1hr = 1 credit)
	Tutorial (1hr = 1 credit)
	Practical (2hrs = 1 credit)
L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme
(Choose by placing X against appropriate box)

X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
	Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:		Branch:	
X	iMTech	X	CSE
	M.Tech		ECE
	M.Sc.		Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
X	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	Not applicable

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The course enables the students to abstract computing problems, solve the problems, apply formal proof techniques and explain their reasoning clearly.
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

Discrete Mathematics is one of the fundamental subjects in computer science and it constitutes a core course for any undergraduate and postgraduate degree program in the computer science. Discrete mathematics is the study of mathematical structures that are discrete in the sense that they assume only distinct, separate values, rather than in a range of values. It deals with the mathematical objects that are widely used in all the fields of computer science, including but not limited to programming languages, data structures and algorithms, cryptography, operating systems, compilers, computer networks, artificial intelligence, image processing, computer vision, natural language processing and machine learning. The subject enables the students to formulate problems precisely, solve the problems, apply formal proof techniques and explain their reasoning clearly.

This course is offered every year during the Aug-Nov semester and it serves as a pre-requisite for the following elective courses:

- Cryptographic Engineering
- Foundations of Cryptography
- Graph Theory

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand propositional and predicate logic, rules of inferences, logical identities, satisfiability/unsatisfiability and tautology	PO1, PSO1, PSO4	U	C	3	2
CO2	Understand proof mechanisms including direct methods, indirect methods, resolution-refutation and induction	PO1, PSO1, PSO4	U	C, P	6	2
CO3	Compute the number of relations (reflexive, symmetric, asymmetric, antisymmetric, partial orderings) and functions (injective, surjective, bijective)	PO1, PSO2, PSO4	Ap	C, P	9	5
CO4	Determine whether a given infinite set is countable or uncountable using Cantor's diagonalization technique	PO1, PSO2, PSO4	Ap	C, P	6	3
CO5	Understand elementary counting techniques including sum-rule, product-rule, permutations, combinations and pigeon-hole principle	PO1, PSO2, PSO4	U	C	3	2
CO6	Solve the recurrence relations for advanced counting problems including Catalan numbers and Stirling numbers	PO1, PSO2, PSO4	Ap	C, P	6	4
CO7	Understand the basic properties of graphs including degree-sequence, vertex-connectivity, edge-connectivity, vertex-chromatic and edge-chromatic number	PO1, PSO2, PSO4	U	C	3	2
CO8	Determine whether a given graph is Eulerian/Hamiltonian	PO1, PSO4	Ap	C, P	3	1
				Total	**39**	**21**

Concept Map of the Course (Optional)

Course Content

- Logic: Proposition and Predicate Logic, Introduction to proof techniques
- Set theory, relations and functions
- Cardinality theory, countable and uncountable sets, Cantor's diagonalization, uncomputable functions.
- Combinatorics Part I: permutations, combinations, sum rule, product rule, pigeon-hole principle, Ramsey numbers.
- Combinatorics Part II: Combinatorial proofs, Catalan numbers, counting using recursion, principal of inclusion-exclusion
- Graph theory: basic definitions, Euler's theorem, bipartite graphs and matching, Hall's marriage theorem, vertex-connectivity, edge-connectivity, Euler graphs and Hamiltonian graphs, various characterizations, vertex and edge coloring

Instruction Schedule

IU	CO/Competencies
IU1	Translate a given set of statements into predicates and derive valid logical conclusions
IU2	Prove whether a given theorem is correct using proof mechanisms including direct proofs, indirect proofs and proofs by induction
IU3	Determine whether a given relation is an equivalence relation, partial ordering or complete ordering
IU4	Calculate the number of injective, surjective and bijective functions
IU5	Differentiate between a countable and uncountable set
IU6	Apply Cantor's diagonalization argument on a given set to check if it is countable or uncountable
IU7	Calculate the number of ways of solving a given task using product rule, sum rule, and pigeon-hole principle
IU8	Prove combinatorial identities using combinatorial proof methods
IU9	Calculate the number of ways of solving a given task by formulating a recurrence equation and deriving its closed-form formula
IU10	Show the equivalence between the number of ways of solving a given task and Catalan numbers
IU11	Calculate the vertex-connectivity, edge-connectivity, vertex-chromatic and edge-chromatic number of a given graph
IU12	Determine the degree-sequence of a given graph

IU stands for instruction unit

Learning Resources

1. Discrete Mathematics and Its Applications, Kenneth Rosen, 7th edition **(main textbook)**
2. Discrete and Combinatorial Mathematics, Ralph Grimaldi, 5th edition
3. Elements of Discrete Mathematics, C. L. Liu, 4th edition
4. Discrete Mathematics, Norman Biggs, 2nd edition

Assessment Plan

- 2 Mid-term exams, best of the two considered: 40%
- 2 End-term exams, best of the two considered: 60%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project/exams	CO Mapping
1	Mid-term exam 1	CO1 – CO4
2	Mid-term exam 2:	CO5 – CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not applicable

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	CS 202/Design and Analysis of Algorithms
Course Instructor Name(s)	Pradeesha Ashok and Meenakshi D'Souza

Credits (L:T:P) **(Lecture : Tutorial : Practical)**	Select <u>one</u> from the following: (Place X appropriately)

Hours	**Component**
3	Lecture (1hr = 1 credit)
1	Tutorial (1hr = 1 credit)
0	Practical (2hrs = 1 credit)
L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)

(Choose by placing X against appropriate box)		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)

(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): (*Place X appropriately. More than one is okay)* *Programme:* *Branch: Computer Science*

X	iMTech
	M.Tech
	M.Sc.

	<table><tr><td>X</td><td>CSE</td></tr><tr><td></td><td>ECE</td></tr><tr><td></td><td>Digital Society</td></tr></table>
Course Category	Select **<u>one</u>** from the following: *(Place X appropriately)* <table><tr><td></td><td>Basic Sciences</td></tr><tr><td>X</td><td>CSE Core</td></tr><tr><td></td><td>ECE Core</td></tr><tr><td></td><td>CSE Branch Elective</td></tr><tr><td></td><td>ECE Branch Elective</td></tr><tr><td></td><td>Engineering Science and Skills</td></tr><tr><td></td><td>HSS/M</td></tr><tr><td></td><td>General</td></tr></table>

Course Pre-Requisites (where applicable, specify exact course names)
Algorithms and Data Structures, Discrete Mathematics

Additional Focus Areas

Course teaches design strategies for designing algorithms to solve real-life computing problems.

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview
As one of the core courses in the iM. Tech. course, Design and Analysis of Algorithms is meant to provide a thorough exposure to many fundamental algorithms in Computer Science. This course is a follow-up of the course on Data Structures and will cover most of the fundamentals of design and analysis of algorithms that are used in classical Computer Science and various applications. The course will also discuss intractable problems by using complexity classes NP and NP-complete problems. The course will act as a foundation for several other courses including competitive programming, advanced courses in algorithms including parametric algorithms, approximation algorithms. The course will also help students with hackathons involving programming to solve computing problems. Design principles and algorithms taught in this course will help students in interviews of jobs and internships.
Concept Map of the Course (Optional)
Course Outcomes and Competencies *Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the fundamentals of the design of algorithms for computing problems and analyzing them in terms of time and memory they consume.	PO1, PSO4	U	C	5	2
CO2	Solve problems by applying the divide-and conquer algorithm design technique, the associated optimal substructure property and proofs based on this property.	PO1, PSO4	Ap	C	4	2
CO3	Solve problems by applying the design technique of dynamic programming and how it improves on divide-and-conquer technique.	PO1, PSO4	Ap	C	7	2
CO4	Solve problems by applying the greedy strategy of design, the associated data structures to be used.	PO1, PSO4	Ap	C	7	2
CO5	Understand classical problems in Computing including sorting, geometric algorithms, algorithms manipulating numbers and strings.	PO1, PSO4	Ap	C	6	5
CO6	Understand elementary graph algorithms, minimum spanning trees, shortest paths and flows in networks.	PO1, PSO4	Ap	C	10	3

CO7	Explain the notion of complexity (time and space).	PO1, PSO4	U	C,P	1	0
CO8	Solve problems on classes P, NP and NP-completeness using the notions of polynomial-time reductions.	PO1, PSO4	U	C,P	5	2
	Total				**45**	**15**

** PO/PSO - Programme Outcome / Programme Specific Outcomes*

** CL - Cognitive Level*

** KC - Knowledge Category*

Course Content (List of Topics)

This course will involve the following topics:

Introduction to algorithms, examples illustrating their role in computing, notations used to represent their time and space complexity.

Divide and conquer techniques, recurrences, solving recurrences.

Dynamic programming

Greedy algorithms

Graph algorithms: minimum spanning trees, single-source shortest paths, all-pairs shortest paths, maximum flow.

Number-theoretic algorithms

String matching algorithms

Complexity classes P, NP and NP-completeness

Instruction Schedule

Provide session-wise schedule

As per timetable. The first half of the semester will be taught by Prof. Pradeesha Ashok and the second half of the semester will be taught by Prof. Meenakshi D’Souza.

Learning Resources

Mention textbooks, reference books and other learning resources required as part of the course

- Jon Kleinberg and Éva Tardos, Algorithm Design, Pearson Education,2006.
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Prentice-Hall, 3rd edition, 2009.
- Any other good book on Algorithm Design.

Assessment Plan

List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)

Two class tests - 2 x 20% = 40%

Mid-term exam - 25%

Final exam - 25%

Project - 10%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

Two quizzes, one theory project and one implementation project.

S. No.	Focus of Assignment / Project	CO Mapping
1	Quizzes	CO2, CO3 and CO4.
2	Theory project	CO2, CO3
3	Implementation project	CO2, CO3

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed
The course uses one or more of the following evaluation procedures as part of the course: · Automatic evaluation of MCQ quizzes on Moodle or other online platforms · Manual evaluation of essay type / descriptive questions Students will be provided the opportunity to view the evaluations done where possible either in person or online.
Late Assignment Submission Policy *State any penalty policy for late submission*
NA
Make-up Exam/Submission Policy *State if any specific policy derived from institute policy is applicable. Otherwise leave it as given*
[As per institute policy]
Citation Policy for Papers
NA

Academic Dishonesty/Plagiarism *State if any specific policy derived from institute policy is applicable. Otherwise leave it as given*
[As per institute policy]
Accommodation of Divyangs *State any special action taken to accommodate Divyangs*
[As per institute policy]

Course Syllabus

Course Code / Course Name	CS 307 Database Systems	
Course Instructor Name(s)	Prof. Uttam Kumar	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3hrs	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
X	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The students taking DBMS course can be employed to industries focusing on database and software development.
Focus on skill development	Yes	The students develop necessary skills to work with real time small and large databases.
Focus on entrepreneurship	Yes	The students can work on real time projects focusing on development and maintenance of temporal database and graphical user interface for small, medium and large enterprises through entrepreneurship/self-employability and start-ups.
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

Ability to deal with data plays a critical role virtually in all disciplines of Information Technology. The core course titled “Database Systems” is the first level course that builds the foundations needed for dealing with persistent data. Building upon the foundations laid in the introductory programming course, this course covers all essential topics in database management in a fast-track mode. The foundations laid in this course will serve as required pre-requisite to several elective courses in the areas of Data Science and Software Engineering (e.g., Data Modeling, GIS, Data Analytics, OOAD, and so on).

Goal of the course:

- To introduce the fundamental concepts for designing, using and implementing database systems and database applications.
- To explore the fundamentals of database design.
- To learn database system implementation techniques.

At the end of the course, the students should have knowledge and competencies in the following areas:

- Understand the principles of conceptual modeling
- Design databases
- Principles of database programming
- Knowledge of DBMS components
- Other data management technologies (e.g., data exchange, in-memory, etc.)

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand the introductory concepts of database models, systems, architectures, terminology and languages.	PO1, PSO2	U	F, C	5	0
CO2	Understand the entity–relationship modelling and database design.	PO1, PSO2	U	F, C, P	3	0
CO3	Draw/prepare/create UML diagrams as per the principles of conceptual DB design.	PO1, PSO2	Ap	C, P	3	2
CO4	Perform data definition and data manipulation operations using SQL.	PO1, PSO2	Ap	C, P	5	6
CO5	Understand normalisation, relational design theory, functional dependencies, and normal forms.	PO1, PSO2	U	C, P	7	0
CO6	Implement data file organisation on disk using the concepts of file structure, indexing of database and physical database design.	PO1, PSO2	Ap	C, P	10	12
CO7	Understand the strategies for query processing and query optimization.	PO1, PSO4	U	C	5	0
CO8	Understand transaction processing concepts, concurrency control, and database recovery from failures.	PO1, PSO2	U	C	5	0
CO9	Implement DB applications using JDBC programming.	PO1, PSO2	Ap	P	0	6
CO10	Implement DB application using Hibernate framework.	PO1, PSO2	Ap	P	0	4

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Information systems: Basic concepts (models, schema, data, information, knowledge), elements of information systems, overview of database systems.

2. Conceptual modeling: Introduction to conceptual modeling, entity relationship models, UML class diagrams.

3. Relational databases: Relational data model, database design concepts, DB design via OR mapping, relational algebra, SQL tutorial, functional dependencies, overview of normal forms (till BCNF).

4. DBMS: Components of a DBMS, storage structures – primary, clustering, secondary, multi-level, query processing – overview, query transformation, query evaluation, transaction processing – overview, ACID properties, concurrency control – schedules, serializability, deadlocks.

5. Other topics (4 hours): Data warehouse and analytics.

Instruction Schedule

[Provide session-wise schedule]

Session 1 – Introduction to Databases: database and database users, database system concepts and architectures.

Session 2 – Conceptual Data Modeling and Database Design: data modeling using the entity-relationship (ER) model.

Session 3 – The Relational Data Model and SQL: the relational data model and relational database constraints, basic SQL, queries, triggers, views and schema modification.

Session 4 – Database Design Theory and Normalization: Basics of functional dependencies and normalization for relational databases, relational database design algorithms.

Session 5 – File structures, hashing, indexing, and physical database design: disk storage, basic file structures, hashing, and modern storage architectures. Indexing structure for files and physical database design.

Session 6 – Query Processing and Optimization: Strategies for query processing, query optimization.

Session 7 – Transaction Processing, Concurrency Control, and Recovery: introduction to transaction processing, concurrency control techniques, database recovery techniques.

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Class slides.
2. Fundamentals of Database Systems; R. Elmasri and S. Navathe; Addison-Wesley, 2000.
3. A First Course in Database System, Jeffrey D. Ullman and Jennifer Widom, Pearson Education.
4. An Introduction to Database Systems; Bipin Desai; Galgotia Publications (West Publishing), 1991.

5. Modern Database Management (Fourth Edition); F. McFadden, J. Hoffer; Benjamin/Cummings (Narosa), 1994.
6. An Introduction to Database Systems (Seventh Edition); C. J. Date; Addison-Wesley, 2000.
7. Principles of Database Systems (Second Edition); J.D. Ullman; Galgotia Publishing, 1994.
8. Database Processing: Fundamentals, Design, Implementation (Fifth Edition); D. M. Kroenke; Prentice-Hall, 1994.
9. Database Systems Concepts, Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGrawHill.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- 15%: Assignment-1
- 35%: Mid-term Exam
- 15%: Assignment-2
- 35%: End-term Exam

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	To understand the introductory concepts and basic terminologies used in the database.	
2.	To understand and have a working knowledge of normalization and various normal forms with hands-on example.	

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

All deadlines are due at on the date and time indicated in LMS. The penalties for late submission are as follows:

- > 4 and < 24 hours late submission: 25% penalty
- > 24 and < 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy.

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable.

Academic Dishonesty/Plagiarism

As per institute policy.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy.

Course Syllabus

Course Code / Course Name	CS 303 / Software Engineering	
Course Instructor Name(s)	Prof. B. Thangaraju	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	2	Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
x	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* *NONE*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	This course will help the students to prepare for their future careers as software engineers.
Focus on skill development	Yes	Developing skills on Software Engineering is very much required for the development of any software project.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

Software engineering is an engineered discipline focused on production of software products, delivered on time and within a set budget as per client requirements. This course is intended to provide foundational knowledge in the area of Software Engineering and help them to understand critical concepts encountered while dealing with complex software projects. The course will cover both process and technical aspects of software engineering and will form the basis for further specialized courses (ex: Software Production Engineering) in this area. This course will help the students can prepare for their future careers as software engineers. Lab sessions ensure that students will get hands-on experiences on the entire software development life cycle and workflow of the software process.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand software engineering principle and existing software process models.	PO1, PSO1	U	F, C	4	0
CO2	Implement Agile methods of software development with Scrum framework.	PO1, PO3 PSO1	Ap	P	4	4
CO3	Develop software requirement specification (SRS) documents for a given project using software requirement engineering principles.	PO1, PS01	Ap	P	4	4
CO4	Implement function oriented software design and data flow diagrams for a given specification.	PO1, PO3, PSO1	Ap	P	3	2
CO5	Design UML diagrams including use case, class, sequence and activity diagrams.	PO1, PO3, PSO1	Ap	P	6	6
CO6	Implement software project management including project scheduling, software size metrics and cost estimation methods.	PO1, PO11, PSO1	Ap	P	7	6
CO7	Prepare software documentation following coding standards.	PO1, PSO1	Ap	P	2	2
CO8	Understand user Interface design and software aging.	PO1, PSO1	U	F, C	2	0
CO9	Understand software risk management including types of risk, risk analysis, risk monitoring and risk exposure.	PO1, PSO1	U	F, C	4	0
CO10	Perform software testing including types of testing, cyclomatic complexity, creation of test cases and test suites.	PO1, PO3, PSO1, PSO3	Ap	C,P	9	6
	TOTAL				**45**	**30**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. This course will cover the following topics:
2. Introduction to software Engineering
3. Software Development Life Cycle
4. Agile methods for development
5. Requirements and Requirement Engineering
6. Software Requirements: Analysis and Specification
7. Function-Oriented Software Design
8. Understanding Unified Modelling Language
9. Software Project Management
10. Coding Standards and Documentation
11. User Interface (UI) Design
12. Risk Management
13. Software Testing
14. Software Aging

Instruction Schedule

[Provide session-wise schedule]

Week	Topics
1	**Introduction to software Engineering** ● Introduction to A Typical Software Project ● Program Vs Software Product ● Factors Contributing to Software Crisis ● The rise and fall of Netscape
2	**Software Development Life Cycle** ● Software Process Models ● Linear Sequential Model

	• Linear sequential model • Prototyping model • Rapid application development model • Evolutionary software process models: • – Incremental model • – Spiral model • – Concurrent development model • Component based development • Model based development
2	**Agile methods for development** • Characteristics of agile processes • Agile methods: Goals • Some existing agile methods • Extreme Programming (XP) • Scrum • Crystal methodologies • Feature driven development • Rational Unified Process (RUP) • Adaptive software development
3	**Requirements and Requirement Engineering** • Reasons for project failure • Reasons for project success • Introduction to requirements • Defining requirements engineering • Requirements and quality • Requirements and lifecycle • Requirements tracing • Requirements and modeling • Requirements and testing • A GENERIC PROCESS for Requirements Engineering • Generic process • Input requirements and derived requirements • Acceptance criteria and qualification strategy • Generic process information model • Information model - using UML
4	**Software Requirements: Analysis and Specification** • Functional and Non-Functional Requirements • Requirements Analysis and Specification • Requirements Gathering

	- Analysis of the Gathered Requirements - Inconsistent Requirement - Incomplete Requirement - Software Requirements Specification - SRS Document - Properties of a Good SRS Document - Non-Functional Requirements - Organization of the SRS Document - Examples of Bad SRS Documents - Representation of complex processing logic
5	**Function-Oriented Software Design** - Structured Analysis/Structured Design - Data Flow Diagrams - Structured Design - Basic Building Blocks of Structure Chart
6-7	**Understanding Unified Modelling Language** - Roots of UML - Evolution of UML - Main UML specification documents - Structure and Behavior - Main diagrams - Use case diagram - Class diagram - Sequence diagram - Activity diagram
8-9	**Software Project Management** - Time-scale Charts - PERT vs. Time-scale chart - Earned Value Management - Project Scope and Risk - Project Approaches to Remember - Responsibility of project managers - Organization of SPMP Document - Estimation - Project planning - Software Cost Components - Software Pricing Factors - Four Common (subjective) estimation models - Top-down and bottom-up estimation

	• Criteria for a Good Estimation Model • Software Cost Estimation • Factors affecting Productivity • Software Size Metrics • Function Point Analysis • Estimation using COCOMO
10	**Coding Standards and Documentation** • Important design considerations • Coding Phase • Coding Standards • Code inspection and code walk throughs • Coding Standards and Guidelines • Representative Coding Standards • Software Documentation • Internal / External Documentation • Textual Documents
10	**User Interface (UI) Design** • The Success of Products • Characteristics of Good UIs • Principles of User Interface Design • Mode-Based versus Modeless Interface • GUI Vs Text-Based User Interface • Types of User Interfaces • Advantages and Disadvantages of User Interface Styles
11	**Risk Management** • Reactive vs. Proactive Risk Strategies • Risk Management Process • Risk Identification • Risk Types • Risk Analysis • Risk Planning • Risk Monitoring • Risk Exposure
12-14	**Software Testing** • Verification versus Validation • Unit testing • Integration testing • System Testing

	• Big Bang Integration Testing • Bottom-up Integration Testing • Top-down Integration Testing • Mixed Integration Testing • Phased vs. Incremental Integration Testing • Alpha Testing • Beta Testing • Acceptance Testing • Overview of Testing Activities • Test cases and Test suites • Design of Test Cases • Black Box Testing Techniques • Coverage-Based Testing Versus Fault-Based Testing • White Box Testing Techniques • Path Coverage based Testing • Control Flow Graph • McCabe's Cyclomatic Metric • Cyclomatic complexity • Derivation of Test Cases • Stress Testing • Volume Testing • Configuration Testing • Compatibility Testing • Recovery Testing • Maintenance Testing • Documentation tests • Usability tests • Environmental test • Regression Testing • Test Summary Report
15	**Software Aging** • The Causes of Software Aging • The Cost of Software Failure • Reducing the Cost of SW Aging • Design for Success • Design for Change • Keeping Records (Documentation) • Why is Software Aging Inevitable? • Software Geriatrics • Planning Ahead

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Software Engineering - A Practitioner's Approach by Roger S. Pressman and Bruce R. Maxim, Eighth edition, McGraw-Hill Education, 2015.

2. Schaum's Outlines, Problems of Software Engineering by David Gustafson, McGRAW-HILL, 2002.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Software Engineering Exam (3 credit)	**Marks (%)**
Pre Mid Term Exam -Quiz1	10
Mid Term Exam	30
Pre End Term Exam -Quiz2	10
End Term Exam	40
Attendance	10
Total	100

Software Engineering Lab Evaluation (1 credit)	**Marks (%)**
Lab Assignments Submission	100

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Lab Assignments	CO3 to CO8 & CO12

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Manual evaluation of Lab Assignments

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

A penalty of 10% of the Lab assignment will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	CS 306 Programming Languages	
Course Instructor Name(s)	Sujit Kumar Chakrabarti	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 3	**Total Credits =**
Grading Scheme *(Choose by placing X against appropriate box)*		4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
X	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
X	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*Programming in Python, Programming in C, Programming II, Data Structures and Algorithms*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	
Focus on skill development	Yes	Broader and deeper knowledge about programming languages, their design and implementation
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

This course aims to teach the following three main things:

1. Survey of programming paradigms. This section gives a broad overview of the PL landscape and develops the vocabulary to do critical comparison between programming languages based on the 'fundamental' features. We spend some time on reviewing ideas in imperative, object-oriented and logic programming.

2. Declarative programming. We learn two declarative programming paradigms: functional programming using OCaml and logic programming using Prolog.

3. Design and implementation of programming languages. We introduce concepts useful for the specification, design and implementation of programming languages. We discuss syntax and semantics. We will implement language processors (interpreters and type checkers) of several programming languages starting with very basic features (e.g. expressions) and approaching fairly sophisticated ones (e.g. higher order functions, type inferencing etc.).

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Critically analyse programming languages in terms of programming paradigm and typing		An	F	5	
CO2	Write multi-module (medium to large sizedprograms in OCaml using functional programming paradigm		Ap	P	10	
CO3	Write moderate sized programs in Prolog using logic programming paradigm and explain their working in technical terms		Ap	P	5	
CO4	Explain each stage in the language processing/compiling pipeline in detail with examples.		Un	C	1	

CO5	Specify, design and implement lexical analysers using regular expressions and finite state automata and Lex family of tools		Cr	C	4	
CO6	Specify, design and implement syntax analysers using context free grammars and Yacc family of tools.		Cr	C	10	
CO7	Present formal operational semantics of programming languages using rules of inference and interpreters		An	C	5	
CO8						
CO9						
CO10						

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

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Course Syllabus

Course Code / Course Name	CS 511 Algorithms
Course Instructor Name(s)	Dr. Muralidhara V N

Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
X	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select <u>**one**</u> from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
Programming in C/C++, Java and Python.
Basic Data Structures like Arrays, stacks, queues, linked lists, trees, binary trees and travels methods, binary heaps, hashing and graph representation.

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Most of the interviews during placements will have questions on Algorithms.
Focus on skill development	Yes	Programming
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Problem Solving Skills

Course Context and Overview

Data Structures and Algorithms are often considered as the foundation of computer science. With advancements in the computer science field, more and more data is generated, this course provides basic tools and techniques to design efficient algorithms to process this data.

This course will covered some of the advanced data structures like Fibonacci Heaps, Treaps, AVL and red black trees. It covers the algorithms design techniques like Divide and Conquer, Greedy algorithms and Dynamic Programming. It also covers Graph algorithms including shortest path problem and Minimum Spanning tree and Network flows.

The students also learn to use the concepts learnt in the course , to solve computing problems in any programming language of their choice .

Course Outcomes and Competencies

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Determine the efficiency of algorithms.	PO4	Ap	C,P	6	2
CO2	Understand the characteristics of data structures including Binomial and Fibonacci Heaps, Balanced Binary Search trees, Union-Find.	PO4	U	C,P	9	2
CO3	Choose appropriate Algorithmic design paradigm including Divide and conquer, Dynamic Programming, greedy algorithms.	PO4	E	C,P	9	3
CO4	Understand the graph traversal algorithms DFS and BFS, algorithms for Shortest path problem and minimum spanning trees and Network Flows.	PO4	U	C,P	9	2
CO5	Choose appropriate data structures to design efficient algorithms to solve computing problems.	PO4	E	C,P	6	3
CO6	Design and implement efficient algorithms in any programming language.	PO4	C	C,P	6	3
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

- Algorithmic analysis : Revive of Asymptotic notations for algorithms, recurrence tree methods, complexity classes
- Abstract Data Structures: Binomial and Fibonacci Heaps, Balanced Binary Search Trees, AVL Trees and Red Black Trees and their applications
- Algorithmic paradigms: Divide and conquer, Dynamic Programming, greedy algorithms including metroid's:
- Graph Algorithms: Graph traversals: DFS and BFS, shortest path problem and the spanning tree problems. Network Flow and applications.
- Randomized Algorithms: Las Vegas and Monte Carlo paradigms, some example randomized algorithms.

Instruction Schedule

- Algorithmic analysis : Revive of Asymptotic notations for algorithms, recurrence tree methods, complexity classes (3 weeks)
- Abstract Data Structures: Binomial and Fibonacci Heaps, Balanced Binary Search Trees, AVL Trees and Red Black Trees and their applications (3 weeks)
- Algorithmic paradigms: Divide and conquer, Dynamic Programming, greedy algorithms including metroid's: (4 weeks)
- Graph Algorithms: Graph traversals: DFS and BFS, shortest path problem and the spanning tree problems. Network Flow and applications. (4 Weeks)
- Randomized Algorithms: Las Vegas and Monte Carlo paradigms, some example randomized algorithms. (1 week)

Learning Resources

Introduction to Algorithms by Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, MIT Press, 3rd Edition 2009.

Assessment Plan

Theory :
Mid Term - 20%
End Term- 20%
Test 1- 10 %
Test 2 - 10%
MCQ 1- 10 %
MCQ 2- 10 %
Programming Test 1 -10%
Programming Test 2 -10%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Designing Efficient algorithms.	CO1,CO5,CO6
2	Applications of Binary Trees, Heaps and BBST	CO1,CO2,CO5,CO6
3	Applications Dynamic Programming and Greedy Algorithms	CO1,CO3,CO5,CO6
4	Applications of Graph Algorithms	CO1,CO4,CO5,CO6

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

No Penalty for one week late, 100% penalty after that.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	DT 102/ Digital Components of a Connected Society		
Course Instructor Name(s)	T K Srikanth		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	4	Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 4:0:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	X	Course provides an understanding of the components and their significance in a digital web-based application or service. Students would, for instance, be prepared for jobs that involve requirements definition or authoring request-for-proposals.
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	X	Students write reports and make presentations as part of their assignments.

Course Context and Overview

[*Provide introduction to the course*]

This course is intended to provide students with an understanding of the fundamentals of digital technologies and the key building blocks of digital solutions. The course will discuss how computers work, basics of data representation, structure and working of large communication networks, the internet, cloud, and web applications, and examples of how these combine and scale to enable complex digital solutions and services. We will also discuss the evolution and impact of selected technologies, as well as issues such as privacy and security related to these solutions.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Determine the hardware specifications of a computer for a given scenario	PO4	U	F, C, C&S	6	
CO2	Understand how the performance of computing systems are evolving	PO4, PO5	U	F, C, PC	8	
CO3	Understand the role of the Operating System in a computing system	PO4, PO5	U	F, C, C&S	16	
CO4	Understand the basic performance parameters of present digital communication networks	PO4,, PO5	U	F, C, C&S	3	
CO5	Understand the role of the main protocols of the 4-layer internet architecture	PO4,, PO5	U	F, C, PC	9	

CO6	Understand how security and privacy requirements of internet communications is taken care of	PO4,, PO5	U	F, C	4	
CO7	Understand the functionality and performance requirements of the key architectural components, including web servers, databases, client programs, of typical internet-based digital platforms and services	PO4, PO5	U	F, C, P, C&S	8	
CO8	Determine the performance of a web service for its usability and accessibility	PO2, PO4, PO5	Ap	F, C, C&S	6	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1: Computers and computing

- Key enablers of the digital world: Universal digital representation, universal digital processor, universal digital communication, and universal digital data.

- Computing machines and Computer Architecture: The von Neumann architecture. Evolution of processors and Moore's Law. Hardware abstractions. Memory hierarchy, cache, and operations. Performance improvements through parallelism, levels of parallelism.

Module 2: Operating Systems, Virtualization and Languages

- Abstractions provided by the OS. Virtualization of CPU's and other resources. Processes and virtual processors. Concurrency, synchronization and semaphores. Scheduling schemes, fairness and mutual exclusion with performance. Virtual memory. Reliable storage. Overview of programming languages and programming paradigms.

Module 3: Communication - The Internet

- Performance characteristics of networks - bandwidth, latency, jitter, quality. Typical bandwidth and latency for a range of technologies. Types and scale of networks.
- Top-down view of the internet. Principle of layering and the 4-layer internet architecture. The end-to-end principle and building up reliability in end-to-end communication. Network delays, flow control and congestion control.
- Application layer protocols. Stateless protocols and client-server architecture over TCP.

Module 4: Internet and Security

- Evolution of security in the internet from a "group of mutually trusting users". Types of attacks.
- Requirements of secure communication. Message integrity and endpoint authentication.

- Cryptography. Common encryption mechanisms, symmetric keys, public key cryptography, hash functions. Message Authentication codes and digital signatures. SSL and HTTPS.
- Tracking on the internet, privacy and protection of information.

Module 5: Internet-based Applications and Services
- Cloud and “X-as-a-service”.
- Architecture of internet-based digital platforms and services.
- Scale, security and performance.
- Usability and Accessibility of applications and services

Instruction Schedule

[Provide session-wise schedule]

Week	Topics	CO
1	Intro: Universal digital representation, universal digital processor, universal digital communication, and universal digital data Number representation: evolution of number systems across civilizations. Decimal and binary systems Computing: Turing Test and Church hypothesis	C01
2	Computing machines and Computer Architecture: The von Neumann architecture. Evolution of processors and Moore’s Law. Memory - role and hierarchy and operations	C02
3	Parallelism as a means of speed up Pipelining and other hardware techniques	C02
4	OS overview. Abstractions, virtualization.	C03
5	CPU Scheduling	C03
6	Concurrency and shared resources	C03
7	Languages and compilers	C03
10	Networks - general characteristics Internet - 4 layer architecture	C04, C05

11	Internet Protocols - general principles Application Layer	C05
12	TCP/IP End-to-end principle, Flow control, congestion Packets and packet switching, IP layer, Little's law	C05
13	Security, Cryptography- usage in the internet Privacy issues - data and internet Personal Identifiable Information, locational privacy	C06
14	Usability, Accessibility	C08
15	Architecture and components of large internet-based systems	C07

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Books and online resources:

1. Kernighan, Brian, D is for Digital. Kindle edition
2. John L. Hennessy, David A. Patterson, Computer Architecture - A Quantitative Approach. (Selected sections and Appendices A to K)
3. Operating Systems: Three Easy Pieces, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau. www.ostep.org
4. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach (selected sections)

Wikipedia pages are in general a good source of overview information, and, in many cases, provide sufficient detail for purposes of this course!

Papers and other reading material will be added during the course and will be listed in LMS.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

The course includes assignments that are intended to help explore different aspects of the design and usage of these digital components. Typically, these involve analysing sub-systems of a larger modern digital application, with a presentation and/or report as the deliverables. In addition, there will be a number of reading assignments as preparation for discussions in class. Some assignments are individual activities and others are done in teams. A mid-term and final exam are part of the assessment.

Regular attendance and participation in class discussions is expected, and will influence the grades.

Grading: The weightage of the assignments and exams, as a percentage of the final grade are:
Assignments: 3 x 15% each = 45%
Mid-term exam: 25%
Final exam: 25%
Class participation: 5%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Detailing specifications of a desktop/laptop for an identified set of use-cases	C01, C02, C03
2	Studying aspects of performance, security and privacy, or usability and accessibility of a web application	CO5, CO6, CO8
3	High-level logical design of an internet-based application	CO4, CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	**Interface Design for Diverse Populations**	
Course Instructor Name(s)	Muralidhar Koteshwar	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
		Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits =**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
	M.Tech
X	M.Sc.

Branch:

	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		Equips students to design technology interfaces for diverse set of users
Focus on skill development		Teaches students to map user needs
Focus on entrepreneurship		Expose students to design principles and thinking needed to covert ideas into inclusive technologies
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

This course deals with User Interface design specifically in the context of ICT applications. ICT applications that are rolled out online have a unique challenge of being accessible to wide cross sections of the population involving diversity in language, literacy levels, technology availability and cultural preferences. The course would focus on generic principles of UI design (learnability, visibility, error prevention, efficiency, and graphic design), key technologies that are in vogue and policy aspects relating accessibility. All this will be discussed in relation to the human capabilities (including perception, motor skills, color vision, attention, and human error) that motivate the need for effective UI design.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand role of effective UI in the success of an ICT program	PO1, PO5	Un	C	6	
CO2	Understand tradeoffs in UI design – heavy vs thin UI, functional vs aesthetic, design thinking vs ease of implementation, accessibility vs comprehensiveness, text based vs text free, etc.	PO4, PO5	Un	F,C	9	2

CO3	Understand what constitutes good UI design – color schemes, choice of appropriate themes, visual branding, principles of navigation, etc.	PO3, PO5	Un	F,C	9	2
CO4	Apply methods to validate the effectiveness of a UI, experiment design, field studies, metrics to evaluate UI, etc	PO1, PO3, PO5	Ap	F, C	6	2
CO5	Evaluate different technology options available to a UI designer and supporting tools	PO1,PO4	An	F, C	3	
CO6	Adopt and integrate tool kits for implementations across multiple interface options	PO4, PO5	An	F,C	6	2
CO7	Analyse policy issues relating to accessibility and possible technology solutions	PO3, PO5	An	F,C	4	
CO8	Create low-fidelity prototypes that can be demonstrated quickly	PO4	Ap		2	7
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

- Introduction to the course
- Principles of UX Design
- Principles of Usability
- Usability Testing
- Accessibility Testing
- Data collection methods to understand the 'audience' towards a better UI design
- Methods to validate the effectiveness of a UI, experiment design, field studies, metrics to evaluate UI, etc.
- Data Visualization
- Prototype Building

Instruction Schedule

[Provide session-wise schedule]

Module 1: Introduction, Principles of Design
Week 1: Introduction to the course
Week 1 and Week 2: Principles of UX Design
Week 3: Principles of Usability

Module 2: Usability and Accessibility Testing

Week 5- Week 6: Usability Testing
Week 7-Week 8: Accessibility Testing

Module 3: Experiment design, field studies, metrics to evaluate UI

Week 9- Week 12: Data collection methods to understand the 'audience' towards a better UI design and Methods to validate the effectiveness of a UI, etc.
Week 13: Data Visualization

Module 4: Prototyping
Week 14- Week 15: Student Presentations

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Mullet, Kevin, and Darrell Sano. Designing Visual Interfaces: Communication Oriented Techniques. Prentice Hall, 1994. ISBN: 9780133033892.
- Baecker, Ronald M., Jonathan Grudin, et al. Readings in Human-Computer Interaction: Toward the Year 2000. 2nd ed. Morgan Kaufmann, 1995. ISBN: 9781558602465. [Preview with Google Books]
- Raskin, Jef. The Humane Interface: New Directions for Designing Interactive Systems. Addison-Wesley Professional, 2000. ISBN: 9780201379372. [Preview with Google Books]
- Jhonson, Jeff. GUI Bloopers: Don'ts and Do's for Software Developers and Web Designers (Interactive Technologies). Morgan Kaufmann, 2000. ISBN: 9781558605824. [Preview with Google Books]
- Card, Stuart K., Thomas P. Moran, and Allen Newell, eds. The Psychology of Human-Computer Interaction. Lawrence Erlbaum, 1983. ISBN: 9780898592436. [Preview with Google Books]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- Mini-assignments --- 20%
- Quizzes – 15%
- Case Study – 20%

- Project – 45%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Mini-assignments	CO2, 4, 6,
2.	Quizzes	CO 1,2, 3, 5, 7
3	Case Study	CO 4, 5, 6, 7, 8
4	Project	CO 2, 4, 5, 6, 7,8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Students will not be allowed to submit their essays or other assignments later than the deadline other than for valid medical or other emergencies.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Students may follow any recognized citation standard such as APA, or Chicago, as long as they do so consistently.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This course has a zero-tolerance policy towards plagiarism. Every time you plagiarize (even if you argue that it is merely quoting someone without citing them), and starting from the first such instance, you will receive a zero for that assignment. Please clear any citation queries you may have ahead of time.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

All readings and grading comments are made available in a digital format that is accessible for visually challenged students. Other accommodations will be as per institute policy.

Course Syllabus

Course Code / Course Name	DT105 Quantitative Methods	
Course Instructor Name(s)	Mandar Kulkarni	
Credits (LT:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:0	**Total Credits = 3**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
	M.Tech
X	M.Sc.

Branch:

	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
X	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	Yes	Familiarity with sampling methods and statistical techniques useful in quantitatively analyzing data and drawing inferences.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

The course will provide students an overview of their statistical foundations. It will equip students with methods pertaining to collecting and describing quantitative data including sampling methods and measures of location (central tendency), dispersion and distribution. The course will also train students in using appropriate analytical methods including linear regression models and inferential procedures as part of analyzing quantitative data. In addition to learning about these descriptive and inferential statistical methods and models of quantitative research conceptually, the students will be given computer-based exercises to perform quantitative analysis.

Course Outcomes and Competencies

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)
CO1	Understand methods of quantitative research and processes pertaining to data analysis to be able to conduct research in an organized manner.	**PO1**	**U**	**C**	**9**
CO2	Understand quantitative techniques and the theories underpinning them to be able to perform data collection, description, analysis and interpretation.	**PO1**	**U**	**C**	**9**
CO3	Understand basic and intermediate level statistical methods and their application.	**PO1**	**U**	**C**	**9**
CO4	Apply various quantitative methods using MS-Excel and other computer-based statistical software.	**PO1**	**Ap**	**P**	**9**
CO5	Design and execute research projects involving data collection (either primary and/or secondary) and analysis using appropriate quantitative techniques	**PO1, PO2**	**C**	**P,M**	**9**
Total Number of Hours					**45**

Course Content

1. **Introduction:** Course overview. Fundamentals of quantitative research methodology. Introduction to the key issues of research process including the significance of social research, data collection, processing and analysis, methodology, and the key principles of scientific investigation.

2. **Probability Theory:** Introduction to Sample Space and Events. Probability Law — Interpretation of probability, Axioms of probability, Conditional probability, Random variables, Prior/Posterior probability.

3. **Statistical and Distribution Theory:** Discrete random variables —Basic concepts, Probability Mass Functions. Continuous random variables — Basic concepts, Probability Density Functions. Introduction to Cumulative Distribution Functions. The Binomial distribution, the Poisson distribution, Conditional distributions, the Normal distribution and related distributions.

4. **Sampling and Sampling Distributions:** Introduction to Sampling and Sampling distributions, Basic Experimental designs including experimental validity and types of variables, Sample size and Standard error.

5. **Inferential Statistics:** Understanding statistical significance. Key types of statistical inference — Point estimation, Hypothesis testing, and Set estimation. Discussion of Known/Unknown variances. One-sample/two-sample tests — t-Tests, Analysis of variance and covariance.

6. **Basic Statistical Analysis:** Quantification of population attributes including descriptive statistics and Graphical representation. Univariate Analysis — Marginals, Measures of central tendency and variability, and Grouping and recoding data. Bivariate Analysis — Cross-Tabulation and Chi-square, Measures of Association (Correlation). The Plug-in estimates.

7. **Multivariate Analysis:** Simple Linear Regression including regression line, method of least squares, regression model and diagnostics. Limited Dependent Variable Models — Logit and Probit models.

8. **Limit Theorems:** Introduction to the Weak Law of Large Numbers, Convergence in Probability, The Central Limit Theorem, The Strong Law of Large Numbers.

Instruction Schedule

Week 1: Introduction
Week 2-3: Probability Theory
Week 4-5: Statistical and Distribution Theory
Week 6-7: Sampling and Sampling Distributions
Week 8-9: Inferential Statistics
Week 10-12: Basic Statistical Analysis
Week 13-14: Multivariate Analysis,
Week 15: Limit Theorems

Learning Resources

- Levin, R. I., and Rubin, D. S. (1995). Statistics for Management, Sixth Edition. New Delhi, India: Prentice-Hall of India Private Limited. ISBN: 81-203-0893-X.
- Trosset, M. W. (2009). An Introduction to Statistical Inference and Its Application with R. Chapman and Hall/CRC. ISBN-13: 978-1584889472; ISBN-10: 1584889470.
- Vanderstoep, S. W., and Johnston, D. D. (2009). Research Methods for Everyday Life: Blending Qualitative and Quantitative Approaches. San Francisco, CA: Jossey-Bass, A Wiley Imprint. ISBN: 978-0-470-34353-1.
- Gray, P. S., Williamson, J. B., Karp, D. A., and Dalphin, J. R. (2007). The Research Imagination: An Introduction to Qualitative and Quantitative Methods. Cambridge, UK: Cambridge University Press. ISBN-13: 978-0-521-70555-4; ISBN-10: 0-521-70555-X.
- Bertsekas, D. P., and Tsitsiklis, J. N. (2002). Introduction to Probability. Massachusetts, USA: Athena Scientific. ISBN: 1-886529-40-X.

Assessment Plan

The proposed weightage for various components is as follows:

- Assignments: 20%
- Quizzes: 10%
- Project: 30%
- Mid-term and End-term exams: 40%

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
1	Group Project	CO3, CO4, CO5

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Late submission will generally not be entertained unless with prior approval of the Course Instructor.

Make-up Exam/Submission Policy

As per Institute policy

Citation Policy for Papers (if applicable)

As per APA Citation Format (see https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/reference_list_electronic_sources.html for more details)

Academic Dishonesty/Plagiarism

As per Institute policy

Accommodation of Persons with Disabilities

As per Institute policy

Course Syllabus

Course Code / Course Name	DT 107/ Application Development for a Connected Society	
Course Instructor Name(s)	Jaya Sreevalsan Nair (jnair@iiitb.ac.in)	
Credits (L:T:P) **(Lecture: Tutorial: Practical)**	**Hours**	**Component**
	2	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 2:0:0	**Total Credits = 2**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
	M.Sc.
	CSE
	ECE
x	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
X	Engineering Science and Skills
	HSS/M
	General

Course Prerequisites	*(Where applicable, state exact course code/name)* None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Students learn to develop websites and web applications as assignments, which are important for industrial opportunities
Focus on skill development	Yes	Students use MySQL and phpMyAdmin workbenches, XAMPP development tool, and WordPress CMS tool in assignments, which builds skills in using these tools
Focus on entrepreneurship	No	-
Provides value-added / life skills (language, writing, communication, etc.)	Yes	Students conduct research and write essays on the state-of-the-art in web applications used for public use; present the websites and web applications they create; publish some of their creations online.

Course Context and Overview

[*Provide an introduction to the course*]

This course introduces students to the theory and practice of tools for a connected society. This entails developing web applications using Javascript, Java, HTML/CSS/PHP. The course guides students through the design and development of internet-based applications using common architecture elements and design patterns, and popular open-source frameworks and libraries. The course also discusses relevant aspects of design thinking and human-computer interaction (HCI) required for tool development.

The outcome of this course is to extend the knowledge and practice of creating web applications, and optionally, mobile applications, in students. The course is delivered as per the requirements of a graduate-level course. Hence, while there are introductory lectures for new topics, the course is predominantly student-driven to build or improve their experience in creating web applications. The skills include design, programming, and presentation skills, where the latter includes an oral presentation, writing, and demonstration by the students. Given the varied background of students from technology as well as social sciences, this course encourages students to learn to use tools and/or program based on their programming competency. The goal of this course is to inform the students to identify and use tools appropriate for specific skill levels and application requirements.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Design websites for public use with a given set of specifications using HTML and CSS templates.	PO1, PO4	Ap	C, P, C&S, PC	8	0
CO2	Analyze existing web applications for public use in terms of usability and identify good features and pitfalls, which are to be incorporated when developing one's own applications	PO1, PO3, PO5	Ap	C, P, C&S, PC	8	0
CO3	Design web applications for public use with a given set of specifications by integrating tools/frameworks (MySQL and phpMyAdmin workbenches), content management system (WordPress), and HTML forms.	PO1, PO2, PO3, PO4	C	C, P, C&S, PC	12	0
CO4	Understand the role and impact of web applications in society in specific domains including healthcare, education, mobility.	PO2, PO3	U	C, C&S, PC	2	0
				Total	30	0

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1: Introduction - Web application architecture and design, the internals of a complex web application, societal applications	Module 2: Web Engineering - Levels of web engineering and skills, server-client architecture
Module 3: User Study - Web application architecture and design, the internals of a complex web application, societal applications	Module 4: Application Design - Requirement engineering, planning, tool integration, demonstration, presentation, evaluation
Module 5: Programming -	Module 6: Practical Knowledge -

HTML, CSS, PHP, MySQL, introduction to frontend and backend development, data visualization using Javascript/Python, multimedia embeddings	Website design, website deployment, content management systems

Instruction Schedule

[Provide session-wise schedule]

S. No.	Topic	Hours	CO
1.	Introduction - web application architecture design	3	CO1
2.	Web Engineering	3	CO1
3.	User Study - user requirements, function and form, a critique of existing applications for the public use, usability	8	CO2, CO4
4.	Application design - requirement engineering, planning, tool integration, demonstration, presentation, evaluation	6	CO2, CO3
5.	Programming - Introduction to frontend and backend development, HTML, CSS, PHP, MySQL, data visualization using Javascript and Python, multimedia embeddings, website design	7	CO1, CO3
6.	Content management system	2	CO3
7.	Website deployment	1	CO3
	Total	30	

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Lecture notes and reading materials provided in class.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

For each module:

- Mid-tem exam as design document for course project -- 10%
- Class presentations (2 for assignments, 2 for course project) -- 20%
- Technical reports (2 essays) -- 20%
- Homework assignments (4 assignments) -- 20%

- Course project -- 30%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Homework-assignment-1: Website development	CO1
2.	Homework-assignment-2: Critique an existing societal web application	CO2
3.	Homework-assignment-3: Data visualization module added to Homework-assignment-1	CO1, CO3
4.	Homework-assignment-4: Add HTML forms and database integration to Homework-assignment-1 or build a small web application using WordPress	CO3
5.	An essay or a technical report on the impact and use cases of existing applications in a specific domain, including education, healthcare, mobility.	CO4
6.	An essay or a technical report on the advancement of technology in web applications	CO4
7.	Course project on designing, implementing, and optionally deploying a societal web application	CO3

The assignment description with all logistics will be provided to the students on LMS. "*Start early and finish on time*" is the guiding principle for all assignments in this course.

All assignments and the course project shall be submitted on LMS.

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Homework-assignment-1, 3, and 4 are graded based on a working implementation of a website or web application. Bonus points are awarded for integrating tools or learning new programming constructs.
- Homework-assignment-2 is graded based on the choice of an existing societal web application and different criteria used for critiquing the same.
- Essays are graded based on the research conducted for their content, content itself, style of technical writing including in-place citations and bibliography, use of images, and grammar.
- Mid-term assessment is for the course project design document which contains problem statement, solution design, initial research on tools used for integration, usability design, Gantt chart for implementation in the second half of the semester.
- Course project assessment involves working implementation, tools evaluation, usability testing, and grading of written documents, namely software documentation, and user manual. Deployment gets bonus points.
- Class presentations are graded based on the quality of presentation and demonstration of websites and web applications by walking through all features, design choices, and usability.

Late Assignment Submission Policy

State any penalty policy for late submission
Late submissions allowed only with the instructor’s permission for lapses owing to medical and personal emergencies.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention “Not applicable” if section is not applicable to the course]

As per institute policy

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This course has zero-tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute’s policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor. All material that will be used for the assessment of the student’s performance shall be original work.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

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Course Syllabus

Course Code / Course Name	Human Computer Interaction	
Course Instructor Name(s)	Linus Kendall	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	36	Lecture (1hr = 1 credit)
	9	Tutorial (1hr = 1 credit)
	30	Practical (2hrs = 1 credit)
	L:T:P = 2:1:1	**Total Credits = 60**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*
Course Category	Select **one** from the following: *(Place X appropriately)*
Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Programme / Branch:

	iMTech
	M.Tech
	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category:

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Interaction Design is taught in the course which is commonly desired skills by employers
Focus on skill development	Yes	The course teaches skills of evaluating and designing technology
Focus on entrepreneurship	Yes	The course teaches how to identify opportunities for and consequently design innovative technologies, in a similar way to how start-ups create technology
Provides value added / life skills (language, writing, communication, etc.)	Yes	Presentation skills and communication of design research

Course Context and Overview

The course is intended as a basic introduction to human computer interaction (HCI) for students with interdisciplinary backgrounds. It teaches the basic concerns, practices and methods of HCI, placing them in relation to other parts of their curriculum. It should provide students with understanding of a variety of methods, practices and principles in HCI. It should equip them to participate or even run a design project. The intended learning outcomes are:

Human Computer Interaction (HCI) is a wide-ranging, interdisciplinary field drawing on a wide variety of other fields such as computer science, design, media studies, cognitive science, sociology and psychology. Having initially been concerned with how computing systems could be designed to be efficient and easy to use, the field now engages with a wide range of issues. These include, for example, ways in which interactive systems and their design can create enjoyment and pleasure or be part of social and political change. As computing has become ubiquitous, so has HCI and its practices. Therefore, HCI practitioners increasingly find themselves at the forefront of studying broader concerns about interactions between humans and technology, then applying these understandings by translating them into design.

Design is central to HCI and accordingly in this course the design process is in focus. It is through design – methods and approaches to creating new forms of technology – that HCI can transform, for example, social concerns or personal needs into new technologies and associated practices. During the course, students will broadly be following the structure of a design project. Throughout the design project's different phases, students will engage with a wide variety of theory and methods of HCI. The focus will lie on screen based interfaces – but students will also consider other interaction modalities such as wearables or voice based interfaces. The primary design approach students will take focuses on human centered and participatory approaches. Increasingly, these approaches have been recognized as crucial for technology interventions to be able to serve the needs of its users.

This course provides a foundation relevant to any student who will take part in technology design or implementation. While design is often thought of as part of specialized practice of consultancies or internal design teams, in this course students will consider how design is part of any project that involves digital technologies. The methods and approaches taught can be used regardless of whether as part of a formal design process, or informally used in a technology implementation project.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)	Practical(Hrs)
CO1	Apply appropriate methods to study a specific user group or usage situation	PO1	Applying		6		6
CO2	Formulate and communicate design opportunities, constraints and requirements from such a study	PO2,PO3, PO4	Applying		3	1.5	6
CO3	Design and critically evaluate different solutions to a design problem, drawing on HCI theory and practice, experience of the problem domain and user studies	PO1,PO3, PO4	Applying		1.5	2	6
CO4	Manifest designs through appropriate use of low and high-fidelity prototypes	PO4	Applying		4.5	2	6
CO5	Evaluate prototypes and designs	PO3,PO4,PO5	Evaluating		3	2	6
CO6	Discuss the theoretical underpinnings of human computer interaction and their relevance to a given design task		Creating		3		
CO7	Identify broadly applicable design principles to a given design task in relevant domains	PO3,PO4	Applying		4.5		
CO8	Locate design activities in relation to other parts of software development and implementation practice		Understanding		3		
CO9	Appreciate how socioeconomic concerns can be translated into practice through HCI via choice of method as well as designs	PO3,PO4,PO5	Evaluating		3	1.5	

CO10	Appreciate how HCI and design itself is a political act, and engages with the broader political economy	PO5	Evaluating		1.5		
	Total				36	9	30

***Legend:** <u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

1. What is usability, interaction design and user research.
2. User research methods.
3. Analysis and presentation of user research findings.
4. Interaction paradigms, interaction styles, user interface types
5. Prototyping
6. Evaluation of user interfaces and prototypes.
7. Visual design & design toolkits
8. Sociotechnical system design.
9. Accessibility.
10. The organisational context of design.
11. Participatory design.
12. The political role of design.

Instruction Schedule

1. Introduction to the course, welcome
2. Structure of the course + Intro to Evaluation
3. Introduction to human centered design, user studies and user research methods. Difference between design research and design practice. Introduction to the project, forming project groups.
4. Methods for studying users and their context
5. Contextual Inquiry
6. Methods III
7. Analysing HCI data – Coding, Themes, Affinity diagramming
8. Analysing HCI data – Scenarios, personas, storyboards
9. Affinity diagramming workshop
10. From user research to design concepts, workshops and ideation
11. Inspirations Cards workshop
12. Theories of HCI – Cognitive & Psychological aspects, Behavioural & Social aspects
13. Interface types and interaction paradigms, what kind of interfaces are we designing, modalities, affordances

14. Modalities 1: Desktop software, interaction styles
15. Modalities 2: Websites, information architecture, card sort
16. Modalities 3: Smartphone apps, touch screen interfaces, wire frames
17. What's prototyping? What's evaluation? Why do we prototype?
18. Prototyping – Types of prototypes, high and low fidelity prototypes.
19. Design principles and heuristics, what is "good" design?
20. Evaluation methods – Think aloud, cognitive walk-throughs
21. Evaluation methods – Heuristic evaluation, Experimental evaluation, A+B testing
22. Visual Design & Design toolkits, Design software. Information Design
23. Accessibility
24. Social context of design – theories of social systems, activity design
25. Design, designers and designing in an organisational context
26. Advanced approaches to design – Participatory, Critical Design, Living Labs
27. Design as Inclusion / Exclusion / Design as as politics

Learning Resources

The primary textbook for the course will be the Encyclopedia of Human Computer Interaction, freely available https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed.

Other material will be articles for reading before each lecture, academic articles and excerpts from textbooks. Additionally, videos and other material will be assigned to lectures as required.

Assessment Plan

- 5% - Class attendance
- 15% - Mid-term written paper and presentation 1000 word hand in plus oral presentation on topic covered in the first half of the course.
- 45% - Group activities and workshops participation in workshops and activities throughout each stage of the design process.
- 35% - Project, presentation and written hand in final project assignment conducted throughout the course, completion of evaluated prototype, write-up and presentation of project. Each person needs to attend at least one of the other group's presentations.

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Midterm presentation & paper on a theoretical subject within HCI	CO6
2	HCI project conducted throughout the course	CO1,CO2,CO3,CO4,CO5,CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Manual evaluation of written design materials
- Manual evaluation of presentations by students

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

As per institute policy

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	DT 109 Research Methods		
Course Instructor Name(s)	Preeti Mudliar and Balaji Parthasarathy		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**		**Component**
	3		Lecture (1hr = 1 credit)
	1		Tutorial (1hr = 1 credit)
			Practical (2hrs = 1 credit)
	L:T:P = 3:1:0		**Total Credits =**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable) *(Choose by placing X in box against not more than two areas from the list)*				
	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	YES	The course teaches students the importance of scientific research and the different methodologies that contribute to the production of research knowledge. It also teaches them different methods of data collection.
Focus on skill development	YES	Students learn a variety of quantitative methodologies such as chi square , ANOVA statistical tests and formulating survey studies and qualitative and ethnographic data collection methods such as field observations to interviews
Focus on entrepreneurship	YES	The course emphasizes primary quantitative and qualitative data collection skills that contribute to various phases of technology development, evaluation, and design.
Provides value added / life skills (language, writing, communication, etc.)	YES	Students learn to read and evaluate scientific research arguments. They also learn to analyze quantitative and qualitative data and write and publish their own research papers.

Course Context and Overview

This course will provide an overview of the philosophical foundations of social science research methods. It will serve as a holistic introduction to modes of explanation and traditions of social inquiry that contribute to conceptual and methodological building blocks in the conduct of research. It will offer students a preliminary footing to appreciate the quantitative and qualitative traditions of research methods by assessing the strengths and limitations of each of the methods, the conditions under which each of the methods is used, the generalizability and purpose of each of the methods, as well as the ethical implications of doing research.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the different philosophies and traditions of research methodologies	PO1, PO2	U	C	3	1
CO2	Learn about the nature and application of qualitative research methods to research	PO1, PO2	U, App	C	1	1
CO3	Learn to conceptualize and formulate research design, sampling, and research questions	PO1, PO2	App, An, Ev, Cr	C	3	1
CO4	Learn and apply ethical principles of conducting research including informed consent and ethical data collection practices	PO1, PO2, PO3	U, App	C,P	3	1
CO5	Learn about qualitative data collection procedures such as field observations,formulating interview questions and conducting in-depth interviews, content analysis, discourse analysis. Learn about quantitative procedures such as sampling methods, confidence interval in statistics, survey methods, experimental design, ANOVA tests	PO1, PO2	U, App	C, P	13	4
CO6	Apply research design and data collection skills by undertaking a research study	PO1, PO2	App, An,	P, M	13	4
CO7	Learn to analyse quantitative and qualitative data and write a mini research paper	PO1, PO2	U, App, An, Ev, C	C, P	6	2
CO8	Understand the publication process in academic research	PO1, PO2	U	C	3	1
Total Hours					45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1: (CO1, CO2, CO3, CO4) Seven lectures and one presentation session

Introduction to research philosophies and methodologies
Formulating research questions
Sampling
Ethics and informed consent

Module 2: (CO5, CO6) Seven lectures and one discussion session
Field observations
Interviews
Online observations and interviewing

Module 3: (CO4, CO5, CO6) Five lectures
Survey methods
Experimental design
Content Analysis and Discourse Analysis

Module 4: (CO6, CO7, CO8) Six lectures and three discussion sessions
Chi square and ANOVA
Data analysis
Writing
Publishing

Instruction Schedule

Module 1: Philosophy of science

- Knowledge and Explanations
- Causality and Inferences

Module 2: Sampling

Module 3: Quantitative traditions

- Social statistics
- Survey methods
- Experimental design

Module 4: Qualitative traditions

- Fieldwork
- Observations
- Interviews

Module 5: Research Design

Module 6: Research Ethics

Module 7: Other Contexts

- Content Analysis
- Discourse Analysis

Module 8: Transcribing and analysing Data
Writing and presenting research

1.

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Readings for the course draw from various papers and books. These resources are made available to the students through the LMS portal. Some of the suggested readings for the course are mentioned below:

1. The following is a list of required references:

2. Geertz, Clifford (1973). The Interpretation of Cultures. New York: Basic Books Inc.
3. Hine, Christine (2005) Virtual Methods: Issues in Social Science Research on the Internet. Oxford; New York: Berg.
4. Jones, Steve (1999) Doing Internet Research: Critical Issues and Methods for Examining the Net. Thousand Oaks, CA: Sage.
5. Markham, Annette and Nancy Baym. (2009) Internet Inquiry: Conversations about Method. Thousand Oaks, CA: Sage.
6. Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook. Thousand Oaks, CA: Sage.
7. Wolcott, H. F. (2002). Sneaky kid and its aftermath: Ethics and intimacy in fieldwork. Walnut Creek, CA: Alta Mira Press.
8. Wolcott, H. F. (1994). Transforming qualitative data: Description, analysis, and interpretation. Thousand Oaks, CA: Sage.
9. Warren, C.A.B. & Karner, Tracy X. (2005). Discovering qualitative methods: Field research, interviews, and analysis. CA: Roxbury Publishing Company.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

1. Class participation: 5%
2. Sampling exercise: 10%
3. Research Design: 15%
4. Survey project: 10%
5. Observation and Interview exercises: 15%
6. Project presentations: 15%
7. Final paper: 30%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Class Participation: Participation in class is determined by engagement with the lectures and readings by asking questions and concerns	CO 1-CO8
2.	Sampling exercise: Draw a sampling plan based on the given scenario and goals	CO3
3.	Research Design: Write a research design for a project that you will work on through the semester	CO1, CO2, CO3
4.	Survey project: Conduct a survey for your research project	CO4, CO5
5.	Observation and Interview exercises: Engage in field observation and conduct interviews in keeping with the research design	CO4, CO5, CO6,
6.	Project presentations: Oral presentations to the class on research findings	CO7, CO8
7.	Final paper: Written research paper presenting findings of the research project	CO7, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Students are required to adhere to deadlines. Extensions are granted for exceptional circumstances when ever warranted.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Citations will be accepted in any recognized style (APA, MLA, Chicago, ACM etc). The Purdue Writing Lab is a handy resource to check your citation and reference format.
https://owl.purdue.edu/owl/purdue_owl.html

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

Plagiarism is a serious misdemeanor in the research community. The class discusses plagiarism and its consequences through the course. Attribution of ideas and scholarship is a critical research practice. There will be zero tolerance for plagiarism and will result in zero grade on the assignment. In addition, regular IIIT-Bangalore policies on plagiarism will be enforced.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

Students requiring special accommodations owing to any special needs will be served to the best of the instructor's abilities and in keeping with institute policy. In the past, students with visual challenges have taken the course and the instructor is familiar with their needs. Students are encouraged to discuss their specific accessibility challenges with the instructor.

Course Syllabus

Course Code / Course Name	DT 113 Qualitative Research Methods	
Course Instructor Name(s)	Preeti Mudliar	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits =**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	YES	The course teaches students the importance of scientific research and the different methodologies that contribute to the production of research knowledge. It also teaches them different methods of data collection.
Focus on skill development	YES	Students learn a variety of qualitative and ethnographic data collection methods ranging from field observations, interviews, authoethnography, and digital data collection methods
Focus on entrepreneurship	YES	The course emphasizes primary qualitative data collection skills that contribute to various phases of technology development, evaluation, and design.
Provides value added / life skills (language, writing, communication, etc.)	YES	Students learn to read and evaluate scientific research arguments. They also learn to analyze qualitative data and write and publish their own research papers.

Course Context and Overview

This course will introduce the students to the major forms of qualitative research methods. The course will train students to analyze the ethical implications, the strengths and limitations of each of the methods, the conditions under which each of the methods is used, as well as the generalizability and purpose of each of the methods. In addition to learning about specific methods such as observations and interview techniques the students will be trained in analyzing and presenting the different forms of data collected through these methods.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the different philosophies and traditions of research methodologies	PO1, PO2	U	C	3	1
CO2	Learn about the nature and application of qualitative research methods to research	PO1, PO2	U, App	C	1	1

CO3	Learn to conceptualize and formulate research design, sampling, and research questions	PO1, PO2	App, An, Ev, Cr	C	3	1
CO4	Learn and apply ethical principles of conducting research including informed consent and ethical data collection practices	PO1, PO2, PO3	U, App	C,P	3	1
CO5	Learn about qualitative data collection procedures such as field observations, photographing the field, formulating interview questions and conducting in-depth interviews, autoethnography, photo elicitation, diary studies, cultural probes, mapping and sketching	PO1, PO2	U, App	C, P	13	4
CO6	Apply research design and data collection skills by undertaking a research study	PO1, PO2	App, An,	P, M	13	4
CO7	Learn to analyse qualitative data and write a qualitative research paper	PO1, PO2	U, App, An, Ev, C	C, P	6	2
CO8	Understand the publication process in academic research	PO1, PO2	U	C	3	1
Total Hours					45	15

***Legend:** <u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1: (CO1, CO2, CO3, CO4) Seven lectures and one presentation session
Introduction to research philosophies and methodologies
Formulating research questions
Sampling
Ethics and informed consent

Module 2: (CO5, CO6) Seven lectures and one discussion session
Field observations
Interviews
Online observations and interviewing

Module 3: (CO4, CO5, CO6) Five lectures
Additional qualitative data collection methods
Researcher positionality and reflexivity

Module 4: (CO6, CO7, CO8) Six lectures and three discussion sessions
Data analysis
Writing
Publishing

Instruction Schedule

Module I

1. Introduction - Why methods matter
2. Research philosophies
3. On the Continuum of Qualitative-Quantitative-Mixed Methods Research
4. Asking Research Questions
5. Sampling
6. Sampling exercises
7. Ethics and Informed Consent

Module II

8. Getting to the Field
9. Field Entree and Staying There
10. Observations
11. Photographing the field
12. Qualitative Interviews - Formulating Questions
13. Conducting Interviews
14. Online Interviewing
15. Mid-semester discussion and review

Module III

16. Subjectivity, Reflexivity, and Representation
17. Qualitative readings of Quantitative Data
18. Autoethnography
19. Getting creative: Activities and participant self-expression-based methods

20. Content Analysis

Module IV

21. Assessing validity and reliability
22. Data Analysis – Transcription and constant comparative analysis
23. Data Analysis – Formulating axes and categories
24. Data Analysis Exercises
25. Writing research papers
26. Research publishing
27. Presentations and discussions

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Readings for the course draw from various papers and books. These resources are made available to the students through the LMS portal. Some of the suggested readings for the course are mentioned below:

1. Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions*. University of Chicago press.
2. Silverman, David. 2017. Chapter 2. “What you can and can’t do with qualitative research” In Doing Qualitative Research. 5th Edition. Sage.
3. Agee, Jane. 2009. "Developing qualitative research questions: a reflective process." *International journal of qualitative studies in education* 22.4. 431-447
4. Corbin, J. and Strauss, A. 2008. Chapter 7. “Theoretical Sampling”. In Basics of Qualitative Research. pp. 143-148. Sage Publications.
5. Silverman, David. 2013. Chapter 4. Ethical Research. In Doing Qualitative Research. Fourth edition. Sage Publications.
6. Burrell, Jenna. 2009. The Field Site as a Network: A Strategy for Locating Ethnographic Research. *Field Methods.*
7. Clifford, James. 1997. Spatial practices: Fieldwork, Travel, and the Disciplining of Anthropology. Anthropological locations: Boundaries and grounds of a field science, 185-222. In Gupta, A., & Ferguson, J. (Eds.) Anthropological locations: Boundaries and grounds of a field science. Univ of California Press.
8. Lofland, John., Snow, David., Anderson, Leon., Lofland, Lyn. 2006. Chapter 3. Getting In (pp. 33-53). In Analyzing Social Settings. A Guide to Qualitative Observation and Analysis. Wadsworth, Cengage Learning.
9. Wolfinger, N. H. 2002. On writing fieldnotes: collection strategies and background expectancies. Qualitative research, 2(1), 85-93.

10. Becker, H. S. 1958. Problems of inference and proof in participant observation. American sociological review, 23(6), 652-660.

11. Pink, Sarah. 2013. Introduction, Chapter 1 and Chapter 2. (pp. 1 - 46). In Doing Visual Ethnography. Sage Publications.

12. Becker, Howard, and Geer, Blanche. 1957. Participant observation and interviewing: A comparison. *Human organization* 16, no. 3 (1957): 28-32.

13. Weiss, Robert S.1995. Chapters 3, 4, and 5. *Learning From Strangers: The Art and Method of Qualitative Interview Studies*. Simon and Schuster.

14. Kvale, Steinar. 2006. Dominance through Interviews and Dialogues. *Qualitative Inquiry* 12, no. 3: 480-500.

15. Chen, Julienne, and Pearlyn Neo. "Texting the waters: An assessment of focus groups conducted via the WhatsApp smartphone messaging application." *Methodological Innovations* 12, no. 3 (2019): 2059799119884276.

16. Bott, Esther. 2010. Favourites and Others: Reflexivity and the Shaping of Subjectivities and Data in Qualitative Research. *Qualitative Research.* 10, no. 2 (2010): 159-173.

17. Erete, Sheena, Aarti Israni, and Tawanna Dillahunt. 2018. An Intersectional Approach to Designing in the Margins. *Interactions* 25, no. 3: 66-69.

18. D'Ignazio, Catherine, and Lauren F. Klein. 2020. Chapter 3. On Rational, Scientific, Objective Viewpoints from Mythical, Imaginary, Impossible Standpoints. Pp. 73-96. *Data feminism*. MIT Press, 2020.

19. Crawford, Kate., Gray, Mary., & Miltner, Kate. 2014. Critiquing Big Data: Politics, ethics, epistemology. International Journal of Communication, 8(10).

20. Ellis, Carolyn, Tony E. Adams, and Arthur P. Bochner. 2011. Autoethnography: an overview. *Historical social research/Historische sozialforschung* : 273-290.

21. Harper, Douglas. 2002. Talking about pictures: A case for photo elicitation. Visual studies, 17(1), 13-26.

22. Krippendorff, Klaus. 1989. Content analysis. In E. Barnouw, G. Gerbner, W. Schramm, T. L. Worth, & L. Gross (Eds.), International encyclopedia of communication (Vol. 1, pp. 403-407). New York, NY: Oxford University Press.

23. Whittemore, Robin, Susan K. Chase, and Carol Lynn Mandle. 2001. Validity in Qualitative Research. *Qualitative Health Research.* 11, no. 4: 522-537.

24. Miles, Huberman, and Saldana. Chapter 11. Drawing and Verifying Conclusions. Pp. 275 – 322.

25. Charmaz, Kathy. 2014. Chapter 5 and 6. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. Sage.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

1. Class participation: 5%
2. Sampling exercise: 10%
3. Research Design: 15%
4. Positionality and reflexivity statement: 10%
5. Observation and Interview exercises: 15%
6. Project presentations: 15%
7. Final paper: 30%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Class Participation: Participation in class is determined by engagement with the lectures and readings by asking questions and concerns	CO 1-CO8
2.	Sampling exercise: Draw a sampling plan based on the given scenario and goals	CO3
3.	Research Design: Write a research design for a project that you will work on through the semester	CO1, CO2, CO3
4.	Positionality and reflexivity statement: Reflect on your positionality as a researcher and how it affects your data collection process	CO4, CO5
5.	Observation and Interview exercises: Engage in field observation and conduct interviews in keeping with the research design	CO4, CO5, CO6,
6.	Project presentations: Oral presentations to the class on research findings	CO7, CO8
7.	Final paper: Written research paper presenting findings of the research project	CO7, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Students are required to adhere to deadlines. Extensions are granted for exceptional circumstances when ever warranted.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Citations will be accepted in any recognized style (APA, MLA, Chicago, ACM etc). The Purdue Writing Lab is a handy resource to check your citation and reference format.
https://owl.purdue.edu/owl/purdue_owl.html

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

Plagiarism is a serious misdemeanor in the research community. The class discusses plagiarism and its consequences through the course. Attribution of ideas and scholarship is a critical research practice. There will be zero tolerance for plagiarism and will result in zero grade on the assignment. In addition, regular IIIT-Bangalore policies on plagiarism will be enforced.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

Students requiring special accommodations owing to any special needs will be served to the best of the instructor's abilities and in keeping with institute policy. In the past, students with visual challenges have taken the course and the instructor is familiar with their needs. Students are encouraged to discuss their specific accessibility challenges with the instructor.

Course Syllabus

Course Code / Course Name	DT201 Engineering and Management of Large Digital Systems		
Course Instructor Name(s)	Amit Prakash		
Credits (LT:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
	M.Tech
X	M.Sc.

Branch:

	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
X	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Trains students to model complex social contexts; useful in drafting RFPs and high-level design documents
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

A recent research study by University of Oxford and McKinsey & Company reveals that 71% of large IT projects face cost overruns and 33% are more than 50% over budget; they are also found to deliver 56% less value than predicted. This is often a result of inconsistencies in managing the design and deployment processes in these projects and it is this that the proposed course will be concerned with. Projects that deploy digital technologies for addressing the needs of large and diverse population groups are often found to exhibit properties of complex systems and this course will introduce the students to different elements of complexity inherent in such systems. It also intends to use conceptual frameworks and practices involved in the engineering and management of IT projects drawn largely from theoretical positions developed in the discipline of systems engineering related largely to requirements specification, system architecture and design processes. Students will also be introduced to different systems thinking methodologies that have been found useful in resolving various aspects of the aforesaid complexity.

Course Outcomes and Competencies

Course Content

I. Background: Revisiting (traditional) software engineering and project management

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand constituents of complexity in social and socio-technical contexts, including heterogeneity, hierarchy, near-decomposability, redundancy, self-adaptation and emergence.	**PO3**	**U**	**C**	**6**	**2**
CO2	Understand the nature of complex social problems, especially wicked problems and messy situations as opposed to tame and benign problems.	**PO3**	**U**	**C**	**6**	**2**
CO3	Understand the significance of diverse perspectives while framing engineering and management challenges and approaches, particularly those related to requirements engineering and project management in large/complex IT projects.	**PO3**	**U**	**C**	**6**	**2**
CO4	Understand fundamentals of systems thinking approaches and their applications.	**PO3**	**U**	**C**	**6**	**2**
CO5	Identify different components of a social/ socio-technical system and their inter-relationships.	**PO3**	**Ap**	**P**	**6**	**2**
CO6	Apply systems thinking concepts, in general, and soft systems methodology, in particular, to model social/socio-technical complexity.	**PO4**	**Ap**	**P**	**6**	**2**
CO7	Draft requirement specifications and high-level system design documents that can lead into RFPs in case of external procurement.	**PO1, PO2, PO4**	**C**	**P,M**	**9**	**3**
Total Number of Hours					**45**	**15**

approaches

II. Complexity, social problems and the nature of inquiry

III. Systems approaches; socio-technical systems

IV. Soft systems methodology

V. Group Project; Drafting of an RFP/high-level design document for a social change process involving digital technologies

Instruction Schedule

Week 1 & 2

- Introduction and Overview of the Course
- Bergman, M., King, J. L., & Lyytinen, K. (2002). Large-scale requirements analysis revisited: the need for understanding the political ecology of requirements engineering. *Requirements Engineering*, *7*(3), 152-171.
- Boehm, B.W. and Ross, R. (1989). Theory-W software project management: principles and examples. *IEEE Transactions on Software Engineering,* 15(7), 902-916.

- Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria. *International journal of project management*, *17*(6), 337-342.

Week 3 & 4

- Koskela, L. J., & Howell, G. (2002). The underlying theory of project management is obsolete. In *Proceedings of the PMI Research Conference* (pp. 293-302). PMI.
- Boehm, B. (2006, May). A view of 20th and 21st century software engineering. In *Proceedings of the 28th International Conference on Software Engineering* (pp. 12-29). ACM.
- Boehm, B. (2006). Some future trends and implications for systems and software engineering processes. *Systems Engineering*, *9*(1), 1-19.

Week 5

- Simon, H. A. (1962). The architecture of complexity, *Proceedings of the American Philosophical Society*, Vol. 106, No. 6. (Dec. 12, 1962), pp. 467-482.
- Tan, J., Wen, H.J. & Awad, N. (2005). Healthcare and services delivery systems as complex adaptive systems. *Communications of the ACM*, Vol. 48 No. 5, pp. 36-44.

Week 6

- Dent, E. B. (1999). Complexity science: A worldview shift. *Emergence*, *1*(4), 5-19.
- Heylighen, F., Cilliers, P., & Gershenson, C. (2006). Complexity and philosophy. *arXiv preprint cs/0604072*.
- Vincent, R. (2012). Insights from complexity theory for the evaluation of development action: Recognizing the two faces of complexity. *IKM Working Paper No. 14*, IKM Emergent Research Programme, European Association of Development Research and Training Institutes (EADI), Germany. www.eadi.org

Week 7 & 8

- Rittel, H. & Webber. M.(1984). Planning problems are wicked problems. *Developments in Design Methodology. New York: John Wiley & Sons*, 135-144.
- Head, B. W. (2008). Wicked problems in public policy. *Public Policy*, Vol. 3 No. 2, pp. 101-118
- Iivari, J., Hirschheim, R., & Klein, H. K. (1998). A paradigmatic analysis contrasting information systems development approaches and methodologies. *Information Systems Research*, *9*(2), 164-193.
- Hirschheim, R., & Klein, H. K. (1989). Four paradigms of information systems development. *Communications of the ACM*, *32*(10), 1199-1216.

Week 9

- Mingers, J., & White, L. (2010). A review of the recent contribution of systems thinking to operational research and management science. *European Journal of Operational Research*, *207*(3), 1147-1161.
- Mumford, E. (2000). A socio-technical approach to systems design. *Requirements Engineering, 5: 125-133*

- Mumford, E. (2006). The story of socio-technical design: reflections on its successes, failures and potential. *Information Systems Journal, 16: 317-342*

Week 10 &11

- Reynolds, M (2011). Bells that still can ring: systems thinking in practice. In: Tait, Andrew and Richardson, Kurt eds. *Moving Forward with Complexity: Proceedings of the 1st International Workshop on Complex Systems Thinking and Real World Applications.* Litchfield Park, AZ: Emergent Publications, 327–349.
- Reynolds, M., & Holwell, S. (2010). Introducing systems approaches. In *Systems approaches to managing change: A practical guide* (pp. 1-23). Springer London.
- Pisano, U. (2012). Resilience and Sustainable Development: Theory of resilience, systems thinking and adaptive governance. *European Sustainable Development Network (ESDN)*, *26*, 50.

Week 12 & 13

- Checkland, P. (1985). Achieving'desirable and feasible'change: an application of soft systems methodology. *Journal of the Operational Research Society*, 821-831.
- Checkland, P., & Poulter, J. (2010). Soft systems methodology. In *Systems approaches to managing change: A practical guide* (pp. 191-242). Springer London.
- Checkland, P. (2000). Soft systems methodology: a thirty year retrospective. *Systems Research and Behavioral Science*, *17*, S11-S58.
- Rose, J., & Haynes, M. (1999). A soft systems approach to the evaluation of complex interventions in the public sector. *Journal of Applied Management Studies*, *8*(2), 1-19.

Week 14 & 15

Project activities; fieldwork; review; drafting of a RFP/high-level design document

Learning Resources

Please see the Instruction Schedule section above

Assessment Plan

Students will be assessed based on their participation in class discussions, submission of written assignments and class presentations and performance in mid-term and end-term assessments. The proposed weightage for various components is as follows:

- Class participation: 10%
- Class presentation: 10%
- Quizzes: 20%
- Group Project (drafting a design specifications/RFP document for a social change using

digital technologies): 35%
- End-term exam: 25%

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
1	Group Project	CO2, CO5, CO6, CO7

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Late submission will generally not be entertained unless with prior approval of the Course Instructor.

Make-up Exam/Submission Policy

As per Institute policy

Citation Policy for Papers (if applicable)

As per APA Citation Format (see https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/reference_list_electronic_sources.html for more details)

Academic Dishonesty/Plagiarism

As per Institute policy

Accommodation of Persons with Disabilities

As per Institute policy

Course Syllabus

Course Code / Course Name	DT204 Social Complexity and Systems Thinking	
Course Instructor Name(s)	Amit Prakash	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Trains students to model complex social contexts; useful in drafting RFPs and high-level design documents
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

Inconsistencies in managing the design and deployment processes in many social projects, especially those that seek to leverage the potential of digital technologies, lead to various issues not only with respect to time and cost overruns but also in terms of their missing critical considerations and viewpoints while setting desired objectives. Projects that deploy digital technologies for addressing the needs of large and diverse population groups are often found to exhibit properties of complex systems and, using their examples, this course introduces the students to different elements of complexity inherent in social and socio-technical systems.

Students will be introduced to different systems thinking methodologies that have been found useful in resolving various aspects of the aforesaid complexity. This will then be used to provide insights into a few relevant methodologies considered useful to model and manage such systems. Conceptual frameworks and practices involved in the engineering and management of IT projects drawn largely from theoretical positions developed in the discipline of systems engineering, related largely to requirements specification, system architecture and design processes are also introduced to students to enable them to work on a high-level design specifications/Request for Proposal (RFP) document for initiatives that seek to bring a desired set of changes in complex social situations using digital technologies.

Course Outcomes and Competencies

	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand constituents of complexity in social and socio-technical contexts, including heterogeneity, hierarchy, near-decomposability, redundancy, self-adaptation and emergence.	**PO3**	**U**	**C**	**6**	**2**
CO2	Understand the nature of complex social problems, especially wicked problems and messy situations as opposed to tame and benign problems.	**PO3**	**U**	**C**	**6**	**2**

CO3	Understand the significance of diverse perspectives while framing engineering and management challenges and approaches, particularly those related to requirements engineering and project management in large/complex IT projects.	**PO3**	**U**	**C**	**6**	**2**
CO4	Understand fundamentals of systems thinking approaches and their applications.	**PO3**	**U**	**C**	**6**	**2**
CO5	Identify different components of a social/ socio-technical system and their inter-relationships.	**PO3**	**Ap**	**P**	**6**	**2**
CO6	Apply systems thinking concepts, in general, and soft systems methodology, in particular, to model social/socio-technical complexity.	**PO4**	**Ap**	**P**	**6**	**2**
CO7	Draft requirement specifications and high-level system design documents that can lead into RFPs in case of external procurement.	**PO1, PO2, PO4**	**C**	**P,M**	**9**	**3**
Total Number of Hours					**45**	**15**

Course Content

I. Background: Revisiting (traditional) software engineering and project management approaches
II. Complexity, social problems and the nature of inquiry
III. Systems approaches; socio-technical systems
IV. Soft systems methodology
V. Group Project; Drafting of an RFP/high-level design document for a social change process involving digital technologies

Instruction Schedule

<u>Week 1 & 2</u>

- Introduction and Overview of the Course
- Bergman, M., King, J. L., & Lyytinen, K. (2002). Large-scale requirements analysis revisited: the need for understanding the political ecology of requirements engineering. *Requirements Engineering*, *7*(3), 152-171.
- Boehm, B.W. and Ross, R. (1989). Theory-W software project management: principles and examples. *IEEE Transactions on Software Engineering,* 15(7), 902-916.
- Atkinson, R. (1999). Project management: cost, time and quality, two best guesses and a phenomenon, it's time to accept other success criteria. *International journal of project management*, *17*(6), 337-342.

<u>Week 3 & 4</u>

- Koskela, L. J., & Howell, G. (2002). The underlying theory of project management is obsolete. In *Proceedings of the PMI Research Conference* (pp. 293-302). PMI.
- PMI (2017). *Agile Practice Guide.* Project Management Institute, Inc. USA.
- Boehm, B. (2006, May). A view of 20th and 21st century software engineering. In *Proceedings of the 28th International Conference on Software Engineering* (pp. 12-29). ACM.

- Boehm, B. (2006). Some future trends and implications for systems and software engineering processes. *Systems Engineering*, *9*(1), 1-19.

Week 5

- Simon, H. A. (1962). The architecture of complexity, *Proceedings of the American Philosophical Society*, Vol. 106, No. 6. (Dec. 12, 1962), pp. 467-482.
- Tan, J., Wen, H.J. & Awad, N. (2005). Healthcare and services delivery systems as complex adaptive systems. *Communications of the ACM*, Vol. 48 No. 5, pp. 36-44.

Week 6

- Dent, E. B. (1999). Complexity science: A worldview shift. *Emergence*, *1*(4), 5-19.
- Heylighen, F., Cilliers, P., & Gershenson, C. (2006). Complexity and philosophy. *arXiv preprint cs/0604072*.
- Vincent, R. (2012). Insights from complexity theory for the evaluation of development action: Recognizing the two faces of complexity. *IKM Working Paper No. 14*, IKM Emergent Research Programme, European Association of Development Research and Training Institutes (EADI), Germany. www.eadi.org

Week 7 & 8

- Rittel, H. & Webber. M.(1984). Planning problems are wicked problems. *Developments in Design Methodology. New York: John Wiley & Sons*, 135-144.
- Head, B. W. (2008). Wicked problems in public policy. *Public Policy*, Vol. 3 No. 2, pp. 101-118
- Iivari, J., Hirschheim, R., & Klein, H. K. (1998). A paradigmatic analysis contrasting information systems development approaches and methodologies. *Information Systems Research*, *9*(2), 164-193.
- Hirschheim, R., & Klein, H. K. (1989). Four paradigms of information systems development. *Communications of the ACM*, *32*(10), 1199-1216.

Week 9

- Mingers, J., & White, L. (2010). A review of the recent contribution of systems thinking to operational research and management science. *European Journal of Operational Research*, *207*(3), 1147-1161.
- Mumford, E. (2000). A socio-technical approach to systems design. *Requirements Engineering, 5: 125-133*
- Mumford, E. (2006). The story of socio-technical design: reflections on its successes, failures and potential. *Information Systems Journal, 16: 317-342*

Week 10 &11

- Reynolds, M (2011). Bells that still can ring: systems thinking in practice. In: Tait, Andrew and Richardson, Kurt eds. *Moving Forward with Complexity: Proceedings of the 1st International Workshop on Complex Systems Thinking and Real World Applications.* Litchfield Park, AZ: Emergent Publications, 327–349.
- Reynolds, M., & Holwell, S. (2010). Introducing systems approaches. In *Systems approaches to managing change: A practical guide* (pp. 1-23). Springer London.

- Pisano, U. (2012). Resilience and Sustainable Development: Theory of resilience, systems thinking and adaptive governance. *European Sustainable Development Network (ESDN)*, *26*, 50.

Week 12 & 13

- Checkland, P. (1985). Achieving'desirable and feasible'change: an application of soft systems methodology. *Journal of the Operational Research Society*, 821-831.
- Checkland, P., & Poulter, J. (2010). Soft systems methodology. In *Systems approaches to managing change: A practical guide* (pp. 191-242). Springer London.
- Checkland, P. (2000). Soft systems methodology: a thirty year retrospective. *Systems Research and Behavioral Science*, *17*, S11-S58.
- Rose, J., & Haynes, M. (1999). A soft systems approach to the evaluation of complex interventions in the public sector. *Journal of Applied Management Studies*, *8*(2), 1-19.

Week 14 & 15

Project activities; fieldwork; review; drafting of a RFP/high-level design document

Learning Resources

Please see the Instruction Schedule section above

Assessment Plan

Students will be assessed based on their participation in class discussions, submission of written assignments and class presentations and performance in mid-term and end-term assessments. The proposed weightage for various components is as follows:

- Class participation: 10%
- Class presentations: 20%
- Assignments (includes mid-term/end-term assessments): 40%
- Group Project (drafting a design specifications/RFP document for a social change using digital technologies): 30%

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
1	Assignment 1	CO1, CO2
2	Assignment 2 (mid-term)	CO1, CO2, CO3
3	Assignment 3 (end-term)	CO4, CO5
4	Group Project	CO2, CO5, CO6, CO7

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Late submission will generally not be entertained unless with prior approval of the Course Instructor.

Make-up Exam/Submission Policy

As per Institute policy

Citation Policy for Papers (if applicable)

As per APA Citation Format (see https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide/reference_list_electronic_sources.html for more details)

Academic Dishonesty/Plagiarism

As per Institute policy

Accommodation of Persons with Disabilities

As per Institute policy

Course Syllabus

Course Code / Course Name	DT 205 Technology in Development	
Course Instructor Name(s)	Janaki Srinivasan	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Teaches students how social divides shape the heterogeneous consequences of a technology initiative, and sensitises them to the importance of factoring this into the design, deployment and use of digital technologies for diverse populations
Focus on skill development	Yes	Teaches critical thinking and analytical skills
Focus on entrepreneurship	Yes	Highlights cases of development-focussed entrepreneurial ventures; teaches how to analyse the challenges and promise of such ventures
Provides value added / life skills (language, writing, communication, etc.)	Yes	Trains students in reading, writing and skills of constructing an evidence-based argument about the working of a technology initiative

Course Context and Overview

This course explores how the digital space shapes a multiplicity of social, economic, political and cultural inequalities in contemporary society. It will focus on two dimensions of such divides in the digital era: first, how classical inequalities and debates about them are reproduced in the digital space and, second, how the digital space might open up opportunities to challenge these divides. We will use the example of development theory and practice to introduce students to such divides and to understand how they have been conceptualized and addressed over time in the context of 'developing' countries. An important goal of the course will be to offer students the opportunity to think more critically about the possibilities and limits of ICT for Development (ICTD) projects.

'Development' has come to stand in for a variety of social, economic and political transformations in the past century, with its meaning and goals being redefined many times in that period. Our first step in this course will be to distinguish between the various senses of 'development' that prevail. We will trace the interplay of these different histories and meanings of development to understand why trajectories of social change have diverged dramatically in different geographies and times. Throughout, our focus will be on the central role accorded to technology in these theories and processes of social change.Subsequent modules will focus more narrowly on the contemporary production, deployment and use of novel digital technologies against the backdrop of this relationship between distinct senses of development. They will draw on examples of digital technology use in the domains of health, education, agriculture, governance and political advocacy in parts of Asia, South America and Africa. Our examples help us understand how the many kinds of development we studied shape digital spaces and, in so doing, open up possibilities for that space to be leveraged both to reinforce and to challenge existing inequalities and divides in different geographies.

In keeping with the larger goals of the Digital Society and other Masters programmes at IIITB, the lectures and assignments of the course are structured so as to encourage students to understand the socio-economic, cultural, and political factors that shape the implications of technology deployment in a development context and for various marginalised populations. They also encourage students to carry out independent secondary research of significant depth on a given geography, sector and ICTD initiative. Throughout, the course provides opportunities to students to apply their understanding of social divides to the reproduction and contestation of social divides in the design, deployment and use of digital technologies.

This course will be a foundation for students planning to take courses on e-governance, AI ethics or Social Media that examine technology use in the context of marginalised communities.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	**PO**	**CL**	**KC**	**Class (Hrs)**	**Tut (Hrs)**
CO1	Understand the types of social and digital divides and their roots in gender, class, caste, race, and region.	PO3	R, U	C	7.5	
CO2	Understand the evolution of development theories and their critiques, including contemporary debates on development metrics and goals,	PO3, PO5	R, U, An	F, C	9	3
CO3	Understand the role of technology in achieving developmental goals	PO3, PO5	R, U, An	F, C	3	
CO4	Understand the vision, ICT infrastructure and ICT policy environment that were developed and deployed in different parts of the globe since the 2000s	PO3	U, Ap, An, E	F, C	4.5	2
CO5	Understand the innovations in ICT that were developed and deployed in different parts of the globe since 2000 in education, healthcare, agriculture, finance, and governance,	PO3	U, Ap, An, E	F, C	7.5	2

CO6	Understand the innovations in ICT that were developed and deployed in different parts of the globe since 2000 in livelihood-related activities,	PO3	U, Ap, An, E	F, C	8.5	2
CO7	Analyze how social divides are reproduced and contested in the design, deployment, and use of digital technologies	PO3, PO4	Ap, E	C	2.5	5
CO8	Conduct secondary research of significant depth on the development trajectory of a given low-income geography, a sector (such as education, agriculture, finance, governance) in that region and an ICTD initiative in that sector and geography	PO1, PO2	Ap, An, C	C, MC	2.5	5
					45	**15**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1 (towards CO1, CO8): **Divides, Digital and Social** (4 lectures, 1 essay discussion session)
• Theories of information society and digital divides
• Introduction to studying divides using the example of development theory and practice

Module 2 (towards CO2, CO3, CO7, CO8): **Theories and critiques of Development** (8 lectures, 1 essay discussion session)
• Overview of the multiple meanings and goals of 'development' and how these have been contested by various actors at different points in history
• Differentiating between 'little d' and 'Big D' development, and how they shape each other
• Classical theories explaining capitalism (little d development) and the role of technology in each
• Outlining the eras of interventional Development since WWII (Big D development) and the role of technology in each: Modernization approach, Dependency Theory, Washington Consensus and the Neo-Liberal Turn, Post-Development Critiques
• Insights from history and a framework to study digital technologies in development:
  o identifying role of state vs. market
  o understanding efficiency vs. equity implications of various development models and metrics
  o learning to see role of structures and agency in how technological initiatives work

Module 3 (towards CO4, CO5, CO6. CO7, CO8): **ICT for D** (9 lectures, 1 essay discussion session)
• The role of devices, points of access and standards in ICTD interventions

• Cases of ICT deployment in education, finance, health, agriculture
• Analysing what is assumed and obscured, role of state and market, of structure and agency in each case

Module 4 (towards CO7, CO7, CO8): **ICTs in 'little d' development** (4 lectures, 1 essay discussion session)
• The commoditization of land, labour and knowledge as part of the capitalist development of ICT industries
• Dissent in the digital era

Module 5 (towards CO1): **Wrap-up** (1 lecture)
• Bring together threads from earlier modules to discuss alternative ways of thinking about the use of ICTs in the current conjecture of d/Development

Instruction Schedule

[Provide session-wise schedule]
Module 1
Session 1 Introduction to class
Session 2 Is the World Flat in the Age of Information?
Session 3 Living in an Information Society
Session 4 Theories of Digital Divides
Session 5 Discussion of Essay Rationale in class
Module 2
Session 6 The Many Definitions of Development
Session 7 Theories of Capitalist development I
Session 8 Theories of Capitalist development II
Session 9 Modernization and Dependency Schools of Development
Session 10 Challenges to the modernization approach (1970s)
Submission of Essay 1
Session 11Structural Adjustment and the Washington Consensus (1980s)
Session 12 Discussion of Essay 2 plan in class
Session 13 Post Development: Participatory and Sustainable Development?
Session 14 Post Development (contd.): Development through Markets?

MID-TERM: Submission of Essay 2

Module 3
Session 15 The Vision for ICTD in the 2000s
Session 16 ICT Infrastructures – Devices, Connectivity, Access and Algorithms
Session 17 ICT Policy Environment – Standards, Regulation and Ethics
Session 18 ICTs in Literacy, Education, and Learning
Session 19 ICTs in Finance
Session 20 Discussion of Essay 3 plan in class
Session 21 ICTs in Agriculture
Session 22 ICTs in Health, Nutrition and Disability
Session 23 ICTs in Governance and Social Protection
Session 24 What is Assumed and What is Obscured in ICTD interventions
Module 4
Session 25 Discussing Essay 3 outline
Session 26 Real Estate in a Virtual World?
Session 27 Digital Labour
Session 28 Knowledge in the Age of Information
Session 29 Digital Counter Movements?
Module 5

Session 30 Beyond Empowerment and Instrumental Use?

END TERM: Submission of Essay 3

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]
There is no single prescribed textbook for this course. Students will rely on lecture notes and assigned readings (excerpted from books or articles, a few of which are mentioned below). These will be made available on the institute LMS.

• Bhatia, A and Bhabha, J. 2017. "India's Aadhaar scheme and the promise of inclusive social protection." *Oxford Development Studies* Vol. 45 (1), pp. 64-79.
• Bonilla, Yarimar, and Jonathan Rosa. 2015. "# Ferguson: Digital protest, hashtag ethnography, and the racial politics of social media in the United States." *American Ethnologist* 42, no. 1: 4-17.
• Chan, Jenny, Ngai Pun, and Mark Selden. 2013. "The politics of global production: Apple, Foxconn and China's new working class." *New Technology, Work and Employment* 28, no. 2: 100-115.
• Easterly, William R. 2002. *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*. Reprint edition. Cambridge, Mass.: The MIT Press.
• Escobar, Arturo. 1995. "Imagining a Post-Development Era." In *Power of Development* edited by J. Crush. London: Routledge.
• Eubanks, Virginia. 2018. "A Child Abuse Prediction Model Fails Poor Families" *WIRED*, January 15.
Evans, Peter. 2010. "Is it labor's turn to globalize? Twenty-first century opportunities and strategic responses." *Global Labour Journal* 1, no. 3.
• Francis, E., Blumenstock, J., & Robinson, J. (2017). "Digital Credit: A Snapshot of the Current Landscape and Open Research Questions." *Working Paper 516*, The Bureau for Research and Economic Analysis of Development.
• Frank, Andre Gunder. 1966 'The Development of Underdevelopment,' *Monthly Review* (18): pp. 17-31.
• Gandhi, Rikin; Rajesh Veeraraghavan; Kentaro Toyama, and Vanaja Ramprasad. 2007. "Digital Green: Participatory video for agricultural extension." In *IEEE Proceedings of Information and Communication Technologies and Development*, 2007: 1-10.
•Jensen, Robert. 2007. "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector." *The Quarterly Journal of Economics* 122 (3): 879–924.
• Jessop, Bob. 2007. Knowledge as a fictitious commodity: Insights and limits of a Polanyian perspective. In *Reading Karl Polanyi for the twenty-first century: Market economy as political project*. Palgrave, Basingstoke, pp. 115-134.
• Morawczynski, O. 2009. "Exploring the usage and impact of ''transformational'' mobile financial services: the case of M-PESA in Kenya." *Journal of Eastern African Studies* 3(3): 509-525
• Upadhya, Carol. 2007. "Employment, Exclusion and 'Merit' in the Indian IT Industry." *Economic and Political Weekly*, pp. 1863-1868.
• Vie, Stephanie. 2014. "In defense of "slacktivism": The Human Rights Campaign Facebook logo as digital activism." *First Monday* 19, no. 4.
• W. W. Rostow, 1960. *The Stages of Economic Growth: A Non-Communist Manifesto.* Cambridge: Cambridge University Press.
• Warschauer, Mark and Morgan Ames. 2010. "Can One Laptop Per Child Save the
• Webster, Frank. 2006. Theories of the Information Society. London; New York: Routledge. inclusive social protection." Oxford Development Studies Vol. 45 (1), pp. 64-79. World's Poor?" *Journal of International Affairs* 64(1)

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]
Assessment criteria:

1. Class participation - 5%
2. Reading responses – 10%
3. Leading class – 10%
4. Essays (3) – 75%
    a. Examining a chosen country's development models – 15%
    b. Examining the development planning and priorities of a specific sector in that country- 25%
    c. Examining an ICT initiative targeted at above sector in chosen country – 35%

The evaluation criteria for each essay will be based on:

- Depth of country research
- Argument and linking to readings/concepts from class
- Clarity and structure in your writing

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
	Class participation: Throughout the semester, in lecture-based and discussion sessions. Your participation grade will be based on the extent to which you engage with the material and in our discussions in class - you will find it very hard to do either if you have not read the material for class.	CO1-CO6
	Leading class: Once or twice in the semester **(**depending on class size) You will be required to make a 15-minute presentation to the class at least once in the semester. Your presentation will be evaluated for its ability to summarize the main arguments of the readings assigned for that session and to raise questions.	CO4, CO5, CO6
	Reading responses: 10 reading responses to be submitted through semester You are required to post your reading responses (150 – 250 words) by midnight the day prior to the session whose readings you are responding to. Individual responses will not be graded (but if you don't submit, that will reflect in your grade). You will be graded overall for your ability to engage with, connect and challenge the concepts introduced in your readings. Module 2: You will respond to the readings assigned for a class session and post responses for all 8 lecture-based sessions in the module. Module 3 and 4: Reading responses for these modules will be Module-level i.e., you will be expected to respond to one question that we pose in each module. You may use readings from any one class from that module to answer that question.	CO3-CO6
	Essays: 3 essays in the semester You will be required to write a sequence of three essays for this course. The essays will build on each other, and you will engage with them through the semester. Closer	CO7, CO8

	to the submission date of the essays, there will be an in-class discussion session where you will be required to discuss your essay plan with your classmates in groups. You will pick a country that the World Bank currently lists as low or low-middle income and that is of interest to you. In your first essay, you will trace the history of development in that country since the early 20th century, paralleling the theories and histories we will discuss in class. For the second essay, you will pick a domain that has been the target of Development activity in that country (eg., governance, health, education) and trace its history, again paralleling class discussions. For your final essay, you will build on your previous essays and once again leverage discussions in class to analyse an ICT-based project currently underway in the country and domain you picked. In each case, you will use your essay to engage with the arguments of a relevant reading from class.	

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided an opportunity to view their graded essays over email or in person. They will also have an opportunity to view other components of their score and enquire about them.

Late Assignment Submission Policy

State any penalty policy for late submission

Students will not be allowed to submit their essays or other assignments later than the deadline other than for valid medical reasons.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Students may follow any recognized citation standard such as APA, or Chicago, as long as they do so consistently.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This class has a zero-tolerance policy towards plagiarism. Every time you plagiarize (even if you argue that it is merely quoting someone without citing them), and starting from the first such instance, you will receive a zero for that assignment. Please clear any citation queries you may have ahead of time

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

All readings and grading comments are made available in a digital format that is accessible for visually challenged students. Other accommodations will be as per institute policy.

Course Syllabus

Course Code / Course Name	DT 301: Information Management		
Course Instructor Name(s)	Prof. Uttam Kumar		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3hrs	Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 4:0:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable) *(Choose by placing X in box against not more than two areas from the list)*				
X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The students taking the Information Management course can be employed in industries focusing on database and report.
Focus on skill development	Yes	The students develop necessary skills to work with real time small and large databases.
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

Information Management is an area of study that deals with different aspects dealing with digital information. The specific topics of relevance to this course are information modeling, information storage and retrieval. After they complete this course, the students should be able to pursue next level courses in the areas of software application development, data analysis, information architecture and so on.

Goal of the course:

- To introduce the fundamental concepts for designing, using and implementing database systems and database applications.
- To explore the fundamentals of database design.
- To learn database systems implementation techniques.

At the end of the course, the students should have knowledge and competencies in the following areas:

- Understand the principles of conceptual modeling.
- Design databases.
- Principles of database programming.
- Knowledge of DBMS components.
- Other data management technologies (e.g., data exchange, in-memory, etc.).

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand the introductory concepts of database models, systems, architectures, terminology and languages.	PO1, PSO2	U	F, C	5	0
CO2	Understand the entity–relationship modelling and database design.	PO1, PSO2	U	F, C, P	3	0
CO3	Draw/prepare/create UML diagrams as per the principles of conceptual DB design.	PO1, PSO2	Ap	C, P	3	2
CO4	Perform data definition and data manipulation operations using SQL.	PO1, PSO2	Ap	C, P	5	6
CO5	Implement information management use cases in spreadsheet software	PO1, PSO2	Ap	P	0	6

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1: Introduction to Information Systems (3 hours)

- What is an information system
- Different types of information systems
- Components of an enterprise information system
- Elements of deployment architecture

Module 2: Data models (3 hours)

- Introduction database systems
- Types of data
- Role of data models in organizing and managing data
- Conceptual modeling using ER and UML

Module 3: Relational database design and implementation (9 hours)

- Relational data model
- Relational database design
- Data processing with SQL
- Case study of relational database design

Module 3: Database Management Systems (3 hours)

- Introduction to computer storage architectures
- Components of a DBMS

Module 5: Information Reporting (3 hours)

- Types of reports
- Report generation using reporting tools
- Data visualization

Module 6: Overview of other information models (3 hours)

- Introduction to XML
- Organizing information in spreadsheets
- Introduction to Big Data

Instruction Schedule

[Provide session-wise schedule]

Date	Topic
Session 1	Information Management
Session 2	Information Life Cycle
Session 3	Intro to database management
Session 4	DB design
Session 5	DB design
Session 6	Exam
Session 7	OR Mapping
Session 8	Introduction to DBMS
Session 9	Introduction to DBMS
Session 10	SQL Hands On
Session 11	Storage technologies and Excel Reporting
Session 12	Use of XML for information management
Session 13	XML Validation

Learning Resources

[Mention textbooks, reference books and other learning resources required as part of the course]

- *Fundamentals of Database Systems*, R. Elmasri, and S. Navathe, Benjamin Cummings.
- Other white papers and reading material to be given as needed

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Final grade will be based on weights given below:

Assignment --- 20%
Mid-Term exam --- 40%
End-sem exam --- 40%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Design conceptual database schema for a given application.	CO3
2.	Write SQL queries for fetching data from relational databases	CO4
3		

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

All deadlines are due on the date and time indicated in LMS. The penalties for late submission are as follows:

- > 4 and < 24 hours late submission: 25% penalty
- > 24 and < 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy.

Citation Policy for Papers (if applicable)

[If the course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable.

Academic Dishonesty/Plagiarism

As per institute policy.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy.

EC 202 Electronic Devices and Circuits

Course Code / Course Name	EC 202 Electronic devices and circuits - Theory		
Course Instructor Name(s)	Madhav Rao, Chetan Parikh		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3:0:0	**Total Credits = 3**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable) *(Choose by placing X in box against not more than two areas from the list)*				
	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The basic circuit and systems knowledge and interfacing is useful for employability.
Focus on skill development	Yes	The troubleshooting and selection of components for designing circuits and systems is a useful skill development.
Focus on entrepreneurship	No	Although no direct focus, the course empowers students to realize systems for different applications with limited knowledge.
Provides value added / life skills (language, writing, communication, etc.)	Yes	The project component in the course allows students to work in team and present progress and technical report.

Course Context and Overview

The goal of this course is to learn to analyze and design analog circuits with diodes and transistors, and design a small analog system, such as a Buck Converter, a low-dropout regulator, analog filter, etc.

Diode characteristics. Diode circuits: Clipper circuits, rectifiers – half wave, full wave, with capacitor. Bipolar junction transistors (BJTs): Characteristics, modes of operation, dc analysis of simple circuits, bias stability. AC analysis of BJT amplifier circuits. BJT amplifier configurations: common-emitter, common-base, common-collector, other. Design of a high-performance amplifier. Frequency response of BJT amplifiers. Stability and compensation of amplifiers.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Analyse simple diode circuits, including clipping circuits and various types of rectifiers.	PSO1, PO3	U, Ap, An	C, P, PC	8	0
CO2	Analyse simple bipolar junction transistor (BJT) circuits under dc and small-signal ac conditions.	PSO1, PO3	U, Ap, An	C, P, PC	10	0
CO3	Identify and analyse basic BJT amplifier configurations: common-emitter, common-base, and common-collector.	PSO1, PO3	U, Ap, An	C, P, PC	7	0

CO4	Design BJT amplifiers to meet a given set of specifications.	PSO1, PO3	U, Ap, An, C	C, P, FDP, PC, D	3	0
CO5	Perform low-frequency and high-frequency analyses of BJT amplifiers, and draw their Bode plots	PSO1, PO5,	U, Ap, An	C, P, PC	5	0
CO6	Analyse the frequency stability of amplifier circuits, and do simple frequency compensation	PSO1, PO5	U, Ap, An	C, P, PC	2	0
CO7	Design a simple analog system, such as a Buck Converter, or an analog filter, etc.	PSO1, PO5, PO3	U, Ap, An	C, P, M, FDP, PC, D	8	0

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Topic	No. of hours
Diode physics and characteristics	4
Diode circuits – clipping circuits, rectifiers	4
Bipolar Junction Transistor (BJT) characteristics and modes of operation	5
BJT dc circuit analysis	5
Bias stability	2
BJT small-signal approximation and small-signal circuit analysis	2
BJT amplifier configurations: CE, CB, CC, others	3
BJT amplifier design	3
Frequency response of BJT amplifiers	5
Stability and compensation of BJT amplifiers	2
Design of a small analog system	8
TOTAL hours	42

Learning Resources
[Mention text books, reference books and other learning resources required as part of the course]

1. A.S. Sedra and K.C. Smith, Microelectronic Circuits, 7th edition, Oxford, 2017.

2. R.C. Jaeger and T.N. Blalock, Microelectronic Circuit Design, 5th edition, McGraw-Hill, 2015.

3. M.H. Rashid, Microelectronic Circuits: Analysis and Design, 2nd edition, Cengage Learning, 2012.

Assessment Plan
[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Midterm exam-30%
Final exam-30%
Assignments and Quizzes-40%

Assignments / Projects
[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Design of a high performance bipolar transistor amplifier	CO4
2	Design of a complete analog system, such as a Buck converter	CO7

Evaluation Procedures
Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:
- Manual evaluation of circuit analysis and design problems

Students are provided the opportunity to view the evaluations done either in person or online.

Late Assignment Submission Policy
State any penalty policy for late submission

Late submissions are not accepted

Make-up Exam/Submission Policy
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	EC302 Microprocessors and Microcontrollers	
Course Instructor Name(s)	Vinod Veera Reddy	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
	2	Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**4**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
X	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
Digital Logic basics, programming basics

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Engineers trained on Embedded systems are sought for. This course provides strong foundation for the same.
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

Microcontrollers and microprocessors are at the heart of all embedded systems that enable building all electronic devices. This course enables the students to familiarize themselves with the functioning of microprocessors and microcontrollers within an embedded system.

In this course, we study all the building blocks that constitute a microcontroller choosing 8051 as the microcontroller for this study. We also learn how instructions provided to the controller translate into action. We then look into more recent ATMEGA328p microcontroller which is in the heart of Arduino boards. The capabilities of this controller are discussed in detail before we discuss ARM architecture. We confine ourselves for ARM Cortex M3 microprocessor within this course.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the architecture and functioning of Intel 8051 microcontroller	PO1, PSO1	U	C, P	10	
	CO1-C1: Understand the core, interrupt handing and instruction set architecture of Intel 8051 microcontroller	PO1, PSO1	U	C, P	5	
	CO1-C2: Understand the ports and peripherals of 8051 microcontroller	PO1, PSO1	U	C, P	5	
CO2	Write assembly language programs to solve simple problems with Intel 8051 microcontroller	PO1, PSO1	Ap	F, C	5	25
CO3	Understand the architecture and functioning of ATMEGA328p microcontroller	PO1, PSO1	U	F, C	15	
	CO3-C1: Understanding the core, interrupt handling and memory of the AMTEGA328p microcontroller	PO1, PSO1	U	F, C	8	
	CO3-C2: Understanding the ports and peripherals of the AMTEGA328p microcontroller	PO1, PSO1	U	F, C	7	

CO4	Design embedded system to address real-life problems using Intel 8051 or ATMEGA328p	PO1, PSO1	Ap	C, P	5	5
CO5	Understand the architecture and functioning of ARM Cortex M microprocessor	PO1, PSO1	U	F, C	10	
	CO5-C1: Understanding the architecture, interrupt and exception handling of ARM Cortex M microprocessor	PO1, PSO1	U	F, C	8	
	CO5-C2: Understanding the input-output interfacing with external peripherals	PO1, PSO1	U	F, C	2	
	Total Hours				45	30

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Prerequisites
2. 8051 microcontroller (8-bit)
    a. Pin description & Architecture
    b. Instruction set architecture and Assembly Instructions
    c. Ports and Peripherals
        i. Serial Communication
        ii. Ports, Timers
    d. Interrupts
3. ATMEGA328p (8-bit)
    a. Pin description & Architecture
    b. Registers & Instruction execution
    c. Interrupt handling, Memory
    d. Ports and Peripherals
4. ARM Cortex M (32-bit)
    a. Cortex M architecture
    b. Exceptions and Interrupt architecture
    c. Input-Output interfacing

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Muhammad Ali Mazidi and Janice Gillispie Mazidi, "The 8051 Microcontroller and Embedded Systems".
2. ATMEGA328p datasheet.
3. Muhammad Tahir and Kashif Javed, "ARM Microprocessor Systems: Cortex-M architecture, Programming, and Interfacing".

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assessment type	Percentage distribution
Assignment 1	10
Quiz 1	10
Mid-semester exam	30
Assignment 2	10
End-semester exam	35
Class participation	5

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Interface an external peripheral with 8051 microcontroller. Program the controller to acquire data and process the same	CO2, CO4
2	Students learn to employ ATMEGA328p and its internal peripherals for the application specified.	CO5, CO6
3	Student presentation as part of class participation on various building blocks of ARM microprocessor	CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

A penalty of 10% of the assignment marks will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	**Principles of Communication Systems- Course and Lab (EC-303 and EC-303P)**		
Course Instructor Name(s)	**Prof. Priyanka Das and Prof. Jyotsna Bapat**		
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**	
	45+30 = 75	Lecture (3hrs = 3 credit)	
		Tutorial (0hr = 0 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:0:1	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data	**X**	Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
X	ECE
	Digital Society

Course Category

Select <u>**one**</u> from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
Signals and Systems (ESS 103)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The conceptual understanding of this course helps the students to get jobs in information technology and communication system design industry
Focus on skill development	Yes	The course content and assignments develop the student skills in applications of analog and digital communication systems
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

- **Course category**: Engineering Science
- Offered in Fall semester
- **Aim of the course**: Communication systems are basic workhorses behind the information age. This course aims to introduce the underlying principles behind the design and analysis of communication systems. The labs will be conducted using Matlab and FM radio experiments will be conducted using Raspberry Pi.
- **Course Overview**: Digital communication is the inevitable design choice in modern systems. Design examples will be taken from the most prevalent communication systems today: cell phones, Wi-Fi, radio and TV broadcasting, satellites, and computer networks. Key components of the communication system designer's toolbox are mathematical modeling and signal processing. Beginning with various basic tools such as Fourier Series/Transform and complex baseband representations of passband signals, the course will cover several important analog communication techniques for Amplitude Modulation, Frequency Modulation, and Phase Modulation. It will also cover superhet receiver and the core concept of phase-locked loop (PLL) and its applications in system design.

  The later part of the course is focused on digital modulation techniques such as ASK, QAM, PSK, and orthogonal modulation. Nyquist criterion for avoiding intersymbol interference will also be dealt with in the course. Thereafter, the course will cover review of probability, random variables, and random processes with the application in noise modelling. These techniques will then be used in analyzing digital communication performance metric such as bit error probability.

  The associated labs are divided into Software based (Matlab) and Hardware based (Raspberry Pi).

- **Courses to which this course is prerequisite**:
    - Digital Communication (EC-306)
    - Wireless Communication (NC-827)

- **The importance of the course to the profession**: Progress in telecommunications over the past two decades has been nothing short of revolutionary, with communications taken for granted in modern society. There is therefore a persistent need for engineers who are well-versed in the principles of communication systems. These principles apply to communication between points in space, as well as communication between points in time (i.e, storage). Digital systems are fast replacing analog systems in both domains. The course also provides a review or introduction to communication systems for practitioners, easing the path to pursue research in modern wireless communication in either industry or academia.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand high-level description of analog and digital communication systems	PO1/PSO2	U	C, F	3	0
CO2	Understand the characteristics of baseband and passband signals, and the systems that shape them through simulations using Matlab	PO1/PSO2	U	C, F	6	4
CO3	Understand amplitude modulation methods including DSB-SC, AM, SSB, VSB, and demodulation methods including coherent demodulation and envelope detection through simulations using Matlab	PO1/PSO2	U	C, F	6	6
CO4	Understand angle modulation and demodulation principles, the functionality of superhet receiver, and phase-locked loop	PO1/PSO2	U	C, F	9	0
C05	Design frequency modulator/demodulator system that resists jamming using Raspberry Pi hardware	PO1/PSO2	Ap	C, P	0	8
CO6	Determine the bandwidth requirements for transmissions through band-limited channels using Nyquist criterion for ISI avoidance	PO1/PSO2	Ap	C	6	0
CO7	Model noise in a communication channel as a Gaussian random process	PO1/PSO2	U	C, F	6	0
CO8	Design optimal detector/matched-filter at communication receiver for minimizing symbol error probability through simulations using Matlab	PO1/PSO2	Ap	C, P	3	6
C09	Compute bit error rate for binary signalling schemes under AWGN with and without carrier phase uncertainty through simulations using Matlab	PO1/PSO2	Ap	C, P	6	6

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Lab (Hrs): Number of hours of Lab session (where applicable)*

Course Competencies:

- Understand basic building block of an analog/digital communication system
- Conduct analysis of baseband signals in time and frequency domain, and use Matlab for signal processing
- Understand complex-baseband representation of passband signals
- Understand the role of modulation index in amplitude demodulation by envelope detection and compute power efficiency
- Determine bandwidth requirements for amplitude modulation methods including DSB-SC, AM, SSB, VSB from frequency spectra
- Understand SSB modulation using the Hilbert transform of the message
- Understand phase and frequency modulation principles and their equivalence
- Compute maximum frequency deviation and modulation index for angle modulation
- Understand limiter-discriminator demodulation operation for FM
- Determine frequency spectra for FM signal and compute bandwidth
- Understanding the impact of modulation index, SNR on FM transmission using Raspberry Pi
- Implement frequency modulator/demodulator system that resists jamming using Raspberry Pi
- Understand the functionality and applications of PLL and analyze steady state phase error
- Demonstrate the role of pulse modulation in ISI avoidance
- Understand Gaussian random variables/vectors/random process and its application in noise modeling
- Establish the basic framework for hypothesis testing to be used in demodulation and symbol detection under AWGN
- Derive the ML and MAP decision rules and understand their physical significance
- Analyze and compare symbol error probability expressions for binary signaling schemes
- Derive union bound of error probability that provide quick insights into power-bandwidth tradeoffs for M-ary signaling schemes
- Show the impact of carrier phase uncertainty in optimal demodulation through Matlab simulations

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Section 1: Introduction and background

- High-level description of analog and digital communication systems
- Review of signals and systems, Fourier Series/Transform, Properties, Autocorrelation, Energy Spectral Density, Parseval's Theorem
- Complex baseband representation of passband signals

Section 2: Analog communcation techniques

- Amplitude modulation/demodulation schemes, including DSB-SC, AM, SSB, VSB
- Angle modulation/demodulation schemes, such as commercial FM, as well as PM
- Superheterodyne receiver working principle and image frequency calculation
- Phase-Locked Loop (PLL)-mathematical model, analysis, and applications

Section 3: Digital modulation

- Power spectral density of a linearly modulated signal
- Nyquist sampling theorem and sinc pulse
- Nyquist criterion for ISI avoidance
- Bandwidth efficiency computation

Section 4: Probability and random process

- Basics concepts of probability and random variables: conditional probability, MAP principle, Baye's theorem
- Gaussian random variables, joint Gaussianity
- Random process and Gaussian random process
- Noise modeling

Section 5: Optimal demodulation

- Hypothesis testing, ML and MAP decision rules
- Signal-space concepts and its application in hypothesis testing
- Geometry of ML decision rule, decision regions
- Correlator/matched filter-based optimal receiver design
- Bit error rate analysis for ML decision rule with binary signaling
- Union bound of error probability for M-ary signaling

Instruction Schedule

[Provide session-wise schedule]

Schedule	Course (EC-303) Topic	Exam
Week 1	Introduction to communication systems	
Week 2	Review of signal and systems, Fourier Transform and Fourier Series	
Week 3	Complex Baseband representation of passband signals	Quiz-1
Week 4	Amplitude modulation/demodulation schemes: DSB-SC, conventional AM	
Week 5	Single-sideband modulation and vestigial-sideband modulation, and demodulations	
Week 6	Frequency and phase modulation/demodulation, Frequency spectra for narrow-band and wide-band FM	Quiz-2
Week 7	Bandwidth requirements for angle modulated signals, Carson's formula, superhet receiver working principle	
Week 8	Phase-Locked Loop (PLL)-mathematical model, analysis, and applications	Mid-term
Week 9	Digital modulation techniques: ASK, PSK, FSK, pulse modulation	
Week 10	Nyquist criterion for ISI avoidance, bandwidth efficiency	
Week 11	Review of probability and random variables	
Week 12	Gaussian random process, noise modeling	Quiz-3
Week 13	Hypothesis testing problem, ML, and MAP decision rules	
Week 14	Optimum demodulation under AWGN, signal-space concept	
Week 15	Bit error rate analysis, union bound with M-ary schemes	End-term

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Text book

- Upamanyu Madhow, "Introduction to Communication Systems", Cambridge University Press

Reference Books

- Taub and Schilling, “Principles of Communication Systems”, McGrawHill
- Simon Haykin, “Communication Systems”, Wiley, 5th Edition
- B.P. Lathi and Z. Ding, “Modern Digital and Analog Communication Systems”, Oxford University Press, 4th Edition

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Course: Quiz (25%), Mid-term (30%), End-term (35%), and Class Participation (10%)
Lab: Weekly assignments: 65%, Project: 30%, Class Participation: 5%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Introduction to Matlab using basic signal processing operations	CO2
2	Design of matched-filter communication receiver using Matlab	CO8
3	Demonstrate the impact of carrier phase uncertainty on reconstructed signal using Matlab	CO9
4	Demonstrate amplitude modulation and envelope detection operations using Matlab	CO3
5	Build FM Transmitter using Raspberry Pi hardware	CO5
6	Understand the impact of modulation index, SNR on FM transmission using Raspberry Pi hardware	CO5
7	Design an FM modulator/demodulator system that resists jamming using Raspberry Pi hardware	CO5

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Student is allowed to submit within 1 day after deadline. Exceptions are made if prior permission is taken.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Appropriate citation of references as per the standard IEEE format is mandatory in assignments and course project.

Academic Dishonesty/Plagiarism

[State if any specific policy derived from institute policy is applicable. Otherwise leave it as given]

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	EC304 Digital Signal Processing		
Course Instructor Name(s)	Dinesh Babu J		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P =	**Total Credits = 3**	
Grading Scheme *(Choose by placing X against appropriate box)*	**x**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
	-	Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

x	iMTech
	M.Tech
	M.Sc.
	CSE
x	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
x	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

ESS 103 - Signals and Systems

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Additional Focus Areas

Focus Area	Yes/ No	Details
Direct focus on employability	Yes	Apply signal processing to real-world problems
Focus on skill development	Yes	Ability to analyse signals and model real world problems
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	Yes	Students write project reports and also work in groups

Course Context and Overview

This course follows up on the Signals and Systems course, which dealt with definition of signals, LTI systems and several transforms such as Fourier, Laplace and z-transforms. In this course, the focus is on Discrete Fourier transform which forms the basis for Fast Fourier Transform, and show the computational reduction in FFT versus DFT [O(N^2) vs O(NlogN)]. We solve numerical problems. Then the need for filters is introduced followed by FIR vs IIR filter design. In particular Window-based FIR filter design (Rectangular vs Hamming vs Kaiser Window) is discussed and problems solved. Finally, Butterworth IIR filter design is discussed. The course also builds the hands-on skills of the students using MATLAB. Students work with real world signals e.g speech and music signals and also filter them followed by extraction of spectral information and even classify them (using some of the principles they learn in the Machine Learning course offered in the same semester).

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)

CO1	Understand Continuous Time and Discrete Time Fourier Transforms/Series - CTFS, CTFT, DTFT, DTFS, DFT of signals	PO1, PSO3	U	F, C	3
CO2	Compute Fast Fourier Transform(FFT) numerically using Decimation-in-Time technique	PO1, PSO3	Ap	C,P	9
CO3	Understand the concepts of Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters	PO1, PSO3	U	F, C	9
CO4	Design FIR filters (rectangular, Hamming and Kaiser Window) as per given filter specifications	PO1, PSO3	Ap	C, P, C&S	6
CO5	Design Butterworth IIR filters as per given filter specifications	PO1, PSO3	Ap	C, P, C&S	6
CO6	Write MATLAB programs to process real world signals, compute spectra and make simple inferences	PO1, PO5, PSO3	Ap	C, P	12
					45

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Topic 1: Applications of Signal Processing
Topic 2: Revision of Fourier Transforms till Discrete Fourier Transform
*Topic 3: Topic 2: DFT to FFT [*O(N^2) vs O(NlogN)]
*Topic 4: FIR Filter Design (*Rectangular vs Hamming vs Kaiser Window)
*Topic 5: IIR Filter Design (*Butterworth IIR filter)
Topic 6: Real world Signals and Signal Processing applications

Instruction Schedule

[Provide session-wise schedule]
W1: Applications of Signal Processing
W2: Revision of Fourier Transforms till Discrete Fourier Transform
*W3,4: Topic 2: DFT to FFT [*O(N^2) vs O(NlogN)]

*W5,6,7: FIR Filter Design (*Rectangular vs Hamming vs Kaiser Window)
W8: Hands on assignment
*W9,10,11: IIR Filter Design (*Butterworth IIR filter)
W12,13,14: Real world Signals and Signal Processing applications

Learning Resources

Orfanidis, Sophocles J. Introduction to signal processing. Prentice-Hall, Inc., 1995.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Application report (10%)	CO6
2	Handwritten notes of Youtube lectures (10%)	CO1
3	Speech and Music signal analysis (25%)	CO6
4	FFT (10%)	CO2
5	FIR (10%)	CO3, CO4
6	IIR (10%)	CO3, CO5
7	Signal analysis using mobile phone sensors (25%)	CO6

Evaluation Procedures

Manual evaluation of essay type / descriptive questions
Answer sheets will be shared after evaluation (offline evaluation), and overall score will be uploaded on LMS and score on sub-rubrics will be shared if students asks for it (online evaluation).

Late Assignment Submission Policy

One or two days delay with permission is fine, after that 20% negative marks will be imposed for a week delay (again with permission). Delayed submission without permission will incur 50% reduction in marks.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	EC 305 Control Systems		
Course Instructor Name(s)	Sachit Rao		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3:0:0	**Total Credits = 3**	
Grading Scheme *(Choose by placing X against appropriate box)*	X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Design controllers for autonomous systems
Focus on skill development	Yes	Ability to model system dynamics and design controllers from first principles
Focus on entrepreneurship	Yes	Ability to choose appropriate firmware when building new systems
Provides value added / life skills (language, writing, communication, etc.)	Yes	Ability to state and prove new concepts

Course Context and Overview

This course introduces the basics of feedback control systems and theory-a topic which finds application in several disciplines of engineering and other sciences. As this is an introductory course, the focus will only be on the class of linear time-invariant systems. Starting with the traditional polynomial based approaches for controller design and analysis for typical engineering systems, the course will move to modern-day techniques such as continuous time and discrete state-space methods.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Identify what parameter is to be controlled in a dynamic system and the resources available to do so.	PO1, PSO3	U	F,C	3	
CO2	Derive a mathematical model of a dynamic system based on first principles between the output variable and the control variable.	PO1, PSO3	Ap	C,P	6	
CO3	Identify the open-loop stability properties, desired transient and steady-state closed-loop specifications to select an appropriate control algorithm.	PO1, PSO3	U	F,C	12	
CO4	Implement and test the selected algorithm and fine-tune its parameters based on the desired specifications.	PO1, PSO3	Ap	C,P	12	
CO5	Learn how to use simulation tools and numerical techniques to simulate closed-loop behavior.	PO1, PSO3	Ap	C,P	12	9

Legend: *<u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

	Topic
1	Open/Closed-loop Systems; Common examples; Transfer function representations
2	Modeling of common mechanical and electrical systems; Linearisation; Block diagrams and reduction; Commonly-used inputs; Analysis of first and second-order systems
3	Steady-state errors; Introduction to PID controllers; Pole-placement; Examples
4	PID controller tuning rules; Design using Root-locus and Bode-plots
5	State-space representations; Properties of Continuous Linear Time-invariant systems; Examples; Review of specific topics in Linear Algebra
6	Controllability and Observability; Pole-placement design; Observers for state estimation; (Kalman Filter)
7	Notions of Stability; Equilibria; Lyapunov Analysis
8	Digital control; Sampling; Extension of controller design topics to the discrete domain

Instruction Schedule

Week	**Topic**
1-2	Introduction; Open/Closed-loop Systems; Common examples; Transfer function representations
3-4	Modeling of common mechanical and electrical systems; Linearisation; Block diagrams and reduction; Commonly-used inputs; Analysis of first and second-order systems
5-6	Steady-state errors; Introduction to PID controllers; Pole-placement; Examples
7-9	PID controller tuning rules; Design using Root-locus and Bode-plots
10-11	State-space representations; Properties of Continuous Linear Time-invariant systems; Examples; Review of specific topics in Linear Algebra
12	Controllability and Observability; Pole-placement design; Observers for state estimation; (Kalman Filter)
13	Notions of Stability; Equilibria; Lyapunov Analysis
14-15	Digital control; Sampling; Extension of controller design topics to the discrete domain

Learning Resources

- Katsuhiko Ogata, "Modern Control Engineering (Fifth Edition)", Prentice-Hall
- Karl Johan Astrom and Richard M. Murray, "Feedback Systems: An Introduction for Scientists and Engineers", electronic version accessible from http://www.cds.caltech.edu/~murray/amwiki
- Charles L. Phillips and H Troy Nagle, "Digital Control System Analysis and Design (Third Edition)", Prentice-Hall
- Other curated material which will be shared on LMS

Assessment Plan

4 in-class quizzes (15%), 2 closed-book exams (80%), Involvement in tutorials (5%).

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Block diagram reduction and derivation of closed-loop systems	CO3, CO4
2	Design and simulation of PID controllers	CO3, CO5
3	Design and simulation of state-feedback controllers and observers	CO3, CO4

Evaluation Procedures

Manual evaluation of essay type / descriptive questions
Answer sheets will be shared after evaluation (offline evaluation), and overall score will be uploaded on LMS and score on sub-rubrics will be shared if students asks for it (online evaluation).

Late Assignment Submission Policy

Delays acceptable with permission and valid reasons. Delayed submission without permission will incur 50% reduction in marks.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

If simulation programs are available online, they should be cited and appropriately commented to exhibit understanding of the program.

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	**Digital Communication Course and Lab (EC-306 and EC-306P)**		
Course Instructor Name(s)	**Prof. Priyanka Das and Prof. Arti Yardi**		
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**	
	45+30 = 75	Lecture (3hrs = 3 credit)	
		Tutorial (0hr = 0 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:0:1	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data	**X**	Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Principles of communication systems (EC-303)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The conceptual understanding of this course helps the students to get jobs in information technology and communication system design industry
Focus on skill development	Yes	The course content and assignments develop the student skills in applications of advanced digital communication systems
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

- **Course category**: Engineering Science
- Offered in Spring semester
- **Aim of the course**: The primary goal of the course is to provide the student an in-depth understanding of the principles, techniques, trade-offs, and fundamental limits in modern digital communication systems. This course introduces the fundamentals of digital signaling, information theory and coding, digital transmission and reception, and the spread-spectrum modulation. The lab assignments should be conducted in Matlab.

- **Course Overview**: This course is a sequel to Principles of Communication Systems (EC-303) course and covers fundamental concepts of modern digital communication systems. The mathematical background necessary to understand communication theory often intimidates the undergraduate students. The purpose of this course is to provide such a lecture style exposition to provide an accessible, yet rigorous, introduction to the subject of digital communication with its practical applications. Beginning with Nyquist sampling theorem, pulse code modulation, and delta modulation, the course will introduce the foundation of information theory, source coding, and source compression algorithms. It will cover several channel coding schemes such as linear block codes, cyclic codes, and convolution code in detail. The later part of the course is focused on optimal receiver design for additive white Gaussian noise (AWGN) channels and their error rate performance considering digital modulation techniques such as Binary Phase Shift Keying (BPSK), Frequency Shift Keying (FSK), Quadrature Amplitude Modulation (QAM), M-ary Phase Shift Keying (MPSK). Spread-spectrum techniques will be dealt with in the course with focus on its anti-jamming property. Finally, the course will treat communication through fading channels, including the characterization of fading channels and the key important parameters: path loss, shadowing, multipath effect, coherence time, coherence bandwidth, and Doppler spread. Link budget analyses for wireline and radio communication systems will also be treated.

- **Courses to which this course is prerequisite**:
    - Wireless Communication (NC-827)

- **The importance of the course to the profession**: The field of digital communication has evolved rapidly in the past few decades, with commercial applications proliferating in wireline communication networks (e.g., digital subscriber loop, cable, fiber optics), wireless communication (e.g., cell phones and wireless local area networks), and storage media (e.g., compact discs, hard drives). After course completion, the students should be well equipped for research or cutting-edge development in communication systems in either industry or academia. Specifically,
    - There are myriads of job opportunities in the manufacturing industry and service establishments such as broadcasting, data communication, entertainment, consulting, research and development including system support.
    - The students might get a chance to work in multimedia service organizations that are engaged in real-time information transfer via video conferencing/internet broadcasting.
    - Scope to work in different sectors such as Defence, DRDO, ISRO, Civil Aviation, Indian Telephone Industries, Development Centers in various states, NPL, A.I.R, Post and Telegraph Department, Railways, Software Engineering/IT, Hardware Manufacturing, VLSI Design, Telecommunication, Power Sector, Television Industry, Research & Development, and Home Appliances.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand signal processing steps to transfer digital data from a source to its destination through a communication channel	PO1/PSO2	U	C, F	2	0
CO2	Understand PCM, DPCM, and DM principles for analog to digital data conversion	PO1/PSO2	U	C, F	3	0
CO3	Apply source encoding/decoding algorithms for digital data transfer through simulations using Matlab	PO1/PSO2	Ap	C, F, P	4	6
CO4	Understand the impact of channel encoding/decoding schemes including linear block codes, cyclic, and convolutional codes on output bit error probability through simulations using Matlab	PO1/PSO2	U	C, F, P	12	6
CO5	Design optimal receiver structure using coherent detection for AWGN channel by employing signal-space concept	PO1/PSO2	Ap	C, F	3	0

CO6	Understand the role of digital modulation techniques including ASK, PSK, FSK, MQAM on symbol error probability through simulations using Matlab	PO1 /PSO2	U	C, F	6	4
CO7	Understand spread spectrum modulation principles including DS-SS and FH-SS and its impact on channel jamming through simulations using Matlab	PO1/PSO2	Ap	C, F	6	6
CO8	Model wireless time-varying channel and its impact on received signal quality through simulations using Matlab	PO1/PSO2	Ap	C, F	9	8

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Lab (Hrs): Number of hours of Lab session (where applicable)*

Course Competencies:

- Understand the detailed signal processing steps for digital data transfer through a channel
- Apply PCM principle to evaluate signal-to-quantization noise ratio
- Understand lossless data compression algorithms including Huffman coding and Lampel-Ziv coding and compute source encoding efficiency
- Demonstrate lossy source compression schemes for digital audio signal transmission via BSC through Matlab simulations
- Understand channel encoding/decoding schemes including linear block codes, cyclic codes, and convolutional codes, and demonstrate their impact on output bit error probability through Matlab simulations
- Understand matched-filter/correlator-based receiver employing coherent detection for ASK, MPSK, MFSK, and MQAM signaling schemes and appreciate the need for carrier and symbol synchronization
- Analyze exact SEP for BFSK, BPSK, QPSK, PAM, and MQAM schemes, and also obtain SEP union bound for MPSK and MFSK schemes to gain insights into the system performance
- Understand power-bandwidth tradeoffs and practical applications for various M-ary signaling schemes
- Understand the role of PN sequence in spectrum spreading including DS-SS and FH-SS principles
- Understand anti-jamming property, processing gain, and CDMA application of spread-spectrum
- Model wireless fading channel and understand its impact on received signal-to-noise ratio
- Compute cell coverage area and outage probability under pathloss and shadowing effect
- Calculate coherence time and coherence bandwidth and classify the type of small-scale fading
- Perform link budget analysis for wireline and wireless channels with practical examples

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Section 1: Introduction and background

- High-level description of digital communication systems
- Digital versus analog performance criteria
- Review of white Gaussian noise
- Power spectral density and bandwidth computation

Section 2: Source coding

- Pulse-code modulation
- Differential pulse-code modulation and delta modulation
- Entropy, source coding theorem
- Lossless data compression algorithms: Huffman coding, Lampel-Ziv coding

Section 3: Channel coding

- Discrete memoryless channel
- Channel capacity
- Channel coding theorem
- Linear block codes
- Cyclic codes
- Convolutional codes and Viterbi decoding algorithm

Section 4: Bandpass modulation and demodulation

- Geometric representation of signals using signal-space concept
- Optimal receivers using coherent detection
- Digital bandpass modulation techniques: ASK, PSK, FSK, QAM
- Symbol and bit error probability analysis
- Bandwidth efficiency

Section 5: Spread-spectrum techniques

- Benefits of spread-spectrum systems
- Direct-sequence spread-spectrum
- Frequency hopping spread-spectrum
- Anti-jamming characteristics of spread-spectrum and CDMA

Section 6: Wireless channel model

- Path loss and lognormal shadowing effect
- Transmit and receive signal models employing ray tracing
- Outage probability and cell coverage area calculation

- Small scale fading, multipath effect, channel coherence bandwidth
- Time varying channel, Doppler effect, channel coherence time
- Link budget analysis

Instruction Schedule

[Provide session-wise schedule]

Schedule	Topic	Exam
Week 1	Introduction to digital communication systems	
Week 2	PCM, DPCM, and DM	
Week 3	Source coding theorem, Lossless data compression algorithms: Huffman coding, Lampel-Ziv coding	Quiz-1
Week 4	Channel capacity and channel coding theorem	
Week 5	Linear block codes	
Week 6	Cyclic codes	Quiz-2
Week 7	Convolution codes and Viterbi Algorithm	
Week 8	Geometric representation of signals in signal-space, Optimal receivers using coherent detection	Mid-term
Week 9	Digital modulation techniques: ASK, PSK, FSK, QAM	
Week 10	Error probability analysis, bandwidth efficiency	
Week 11	Spread-spectrum techniques, Direct-sequence spread-spectrum	Quiz-3
Week 12	Frequency hopping spread-spectrum, anti-jamming	
Week 13	Wireless channel: free-space path loss and simplified path loss models	
Week 14	Lognormal shadowing, outage probability, cell coverage area	
Week 15	Small-scale fading, Doppler effect, link budget analysis	End-term

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Text Books

1. Bernard Sklar and Pabitra Kumar Ray, “Digital Communication”, Pearson Education
2. Simon Haykin, “Digital communication systems”, Wiley Edition

Reference Books

1. John G Proakis and Masoud Salehi, " Digital Communications", McGraw Hill
2. Andrea Goldsmith, "Wireless Communication", Cambridge University Press
3. Upamanyu Madhow, "Fundamentals of Digital Communication", Cambridge University Press

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Course: Quiz (25%), Mid-term (30%), End-term (35%), and Class Participation (10%)
Lab: Weekly assignments: 65%, Project: 30%, Class Participation: 5%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Compress audio signal using FFT, DCT, and LPC-based source compression algorithms through Matlab simulations	CO3
2	Apply combined source and channel coding schemes for digital audio transmission through a BSC channel using Matlab	CO4
3	Understand the role of digital modulation techniques including BPSK, BFSK, MPSK on symbol error probability through simulations using Matlab	CO6
4	Demonstrate DS-SS system and find probability of error under the presence of jamming signal using Matlab	CO7
5	Demonstrate FH-SS system with BPSK modulator and show its impact on jamming resistance using Matlab	CO7
6	Demonstrate the combined effect of path loss and shadowing phenomena on outage probability through Matlab simulations	CO8
7	Demonstrate the impact of empirical path loss and 3GPP path loss models on received signal power through Matlab simulations	CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy
Student is allowed to submit within 1 day after deadline. Exceptions are made if prior permission is taken.

Make-up Exam/Submission Policy
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)
[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Appropriate citation of references as per the standard IEEE format is mandatory in assignments and course project.

Academic Dishonesty/Plagiarism
[State if any specific policy derived from institute policy is applicable. Otherwise leave it as given]

As per institute policy

Accommodation of Divyangs
[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	EG 101/ Computer Networks	
Course Instructor Name(s)	Prof. Amrita Mishra	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3/week	Lecture (1hr = 1 credit)
	1/week	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		**X**	Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The conceptual understanding of this course helps the students to procure jobs in the Information Technology industry
Focus on skill development	Yes	The course content and assignments help develop student's skills with respect to applications of Computer Networks.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

The main aim of this course is to make the students familiarise and understand how the heterogenous networks are interconnected in practice and digital information flows from the source to the destination. Further, this course delves into various protocols involved in successful transmission of packets from one end of the globe to the other end via the internet. Towards this end, various network applications and their underlying protocols are discussed. Basics of socket programming enables students to understand the connection between application layer to transport layer for reliable delivery of data. State-of-the-art congestion and flow control algorithms for flow of information over the internet are also taught. Existing routing algorithms concepts for information flow are covered along with the medium access control protocols. Finally, how information moves step by step across various layers of the internet protocol stack to reach the final destination is summarized.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand digital information flow from source to destination over computer networks	PO1/ PSO2	U	F, C	4	1
CO2	Understand the network protocol stacks in Internet	PO1/PSO2	U	F, C	5	

						1
CO3	Understand the functioning of web browsing, FTP, e-mail and real-time network applications	PO1/PSO2	U	F, C	8	2
CO4	Determine the appropriate routing protocols for efficient routing for given topological conditions and router abilities	PO1/PSO2	Ap	F,C ,P	8	2
CO5	Understand role of flow control and congestion control algorithms to avoid congestion over the Internet.	PO1/PSO2	U	F, C, P	8	2
CO6	Understand IPV4 and IPV6 packet formats and their the differences.	PO1/PSO2	U	F, C, P	4	1
CO7	Determine the appropriate medium access control protocol to avoid collision of packets during transmission in a given medium.	PO1/PSO2	Ap	F,C ,P	8	2

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

- Motivation of networking and communication in IT applications, Topologies and need for different topologies, Circuit switching and packet switching
- Need for Protocols, Networking parlance, Protocol Stack – Basic Overview and Functionalities
- Application layer protocols
- Socket Programming
- Transport Layer protocols: Multiplexing and De-multiplexing of information in a node; TCP protocol: Reliable transmission algorithm, Congestion and flow control algorithms, UDP protocol,
- Network Layer protocols: Routing algorithms - link state and distance vector, IP Addressing, IP mobility,
- Data link layer: Concepts of medium access control protocol, error detection and correction, frame structure

Instruction Schedule

[Provide session-wise schedule]

Week 1 - Introduction, Motivation of networking and communication in IT applications, Topologies and need for different topologies, Circuit switching and packet switching
Week 2- Need for Protocols, Networking parlance, TCP/IP Protocol Stack – Basic Overview and Functionalities -
Week 3 - Application layer protocols: HTTP, FTP, SMTP
Week 4 – Application layer protocols (contd) DNS, Basics of Socket Programming
Week 5 – Transport Layer –Primitives, Multiplexing/Demultiplexing, UDP
Week 6 – Reliable Data Transfer (Selective Repeat, Go-Back-N), TCP – Connection, Segment Structure
Week 7 – Flow control and congestion control algorithms –
Week 8 – Network layer functionalities, Routing Algorithms – Link State (LS) and Distance-Vector (DV) Routing Algorithms
Week 9 – IP Addressing: IPV4 and IPV6 packet formats – comparison
Weeks 10 & 11 – Intra-autonomous system routing: RIP, OSPF, Inter-autonomous system routing: BGP, Mobility at Network Layer
Week 12 – Data Link Layer Functionalities – Forwarding, Flow Control, Error Control, Medium Access Control (MAC) Protocols: Taxonomy, channel partioning, random access, taking turn
Weeks 13 & 14 - Random Access MAC protocols – Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA, Address Resolution Protocol (ARP)
Week 15 - With respect to all the concepts in previous classes, this week stitches all the concepts from application to data link layers to explain -- how digital information packets move from the source to the destination using internet

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Computer Networking: Top-Down Approach, by Kurose and Ross
2. Local Area Network, by G. Keiser
3. Performance Analysis of the IEEE 802.11 Distributed Coordination Function, by G. Bianchi, IEEE Journal of Selected Areas in Communications, Vol. 18, No. 3, March 2000.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- Mid-Term (#1): 30 points
- End-Term (#1): 30 points
- Assignments (#2): 10 points
- Quizzes (#2): 10 points
- Course Project –Research Oriented (#1): 10 points
- Attendance and Classroom participation: 10 points

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Questions related to delay calculation in practical networks; http 2.0, https, QUIC protocols; MIME format for emails; Socket Programming	CO1,CO2,CO3
2	Questions related to IPV4 and IPV6 interoperability; reliable data transfer, flow and congestion control in TCP protocol	CO4, CO5,CO6,CO7
3	Course Project: Research project to perform literature survey of up to two journal papers in related and upcoming areas of computer networking	CO1-CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Dates of release and submission of assignments (with a 2-week window gap) announced on the first day of commencement of lectures. Late submission of assignments shall not be considered for grading except for cases of personal/health emergencies.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Appropriate citation of references (text and figures) as per the standard IEEE format is mandatory in assignments and course projects. Plagiarism of any form is highly discouraged and will incur strong penalties.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

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Course Syllabus

Course Code / Course Name	EG 102/Data Structures and Algorithms		
Course Instructor Name(s)	Dr. Muralidhara V N		
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
	2	Practical (2hrs = 1 credit)	
	L:T:P = 3:1:2	**Total Credits = 5**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select <u>**one**</u> from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
X	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
Programming in C and Python.

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Most of the interviews during placements will have questions on DSA.
Focus on skill development	Yes	Programming
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Problem Solving Skills

Course Context and Overview

Data Structures and Algorithms are often considered as the foundation of computer science. With advancements in the computer science field, more and more data is generated, this course provides basic tools and techniques to design efficient algorithms to process this data.

This is a core course to the iM.Tech second semester students. The aim of the course is to provide students with a grasp of the principles of the many data structures used in modern software.

The students also learn to use the concepts of DSA in any programming language of their choice to solve computing problems.

Course Outcomes and Competencies

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)	Lab (Hrs)
CO1	Determine the efficiency of algorithms.	PO1, PSO4	Ap	C,P	8	3	
CO2	Understand the characteristics of data structures including arrays, linked lists, stacks, queues, trees,	PO1, PSO4	U	C,P	10	3	

	Heaps, Binary Search trees , hashing, graphs .						
CO3	Understand algorithms for sorting and searching.	PO1, PSO4	U	C,P	7	3	
CO4	Understand the graph traversal algorithms DFS and BFS, algorithms for Shortest path problem and minimum spanning trees.	PO1, PSO4	U	C,P	10	3	
CO5	Choose appropriate data structures to design efficient algorithms to solve computing problems.	PO1, PSO4	E	C,P	10	3	
CO6	Design and implement efficient algorithms in any programming language.	PO1, PSO4	C	C,P			30
	Total				45	15	30

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

1. Introduction to algorithms and complexity.
2. Sorting: Merge, quick, radix, selection, bubble sort, insertion sort and heap sort.Lower bound for sorting.
3. Randomized Algorithms: Las Vegas and Monte Carlo paradigms, some example randomized algorithms
4. Arrays, stacks, queues and linked lists .
5. Dictionaries: Skip-lists, hashing, analysis of collision resolution techniques.
6. Binary Trees: Traversals, binary search trees, balanced binary search trees - AVL and Red Black Trees.
7. Priority queues: binary heaps, binomial heaps and Fibonacci heaps.

8. Graphs:Breadth-_first search and connected components, Depth-_first search in directed and undirected graphs. Single course shortest path problem and minimum spanning tree - prim's and kruskal's algorithms.

Instruction Schedule

1. Introduction to algorithms and complexity. (2 weeks)
2. Sorting: Merge, quick, radix, selection, bubble sort, insertion sort and heap sort.Lower bound for sorting. (2 weeks)
3. Randomized Algorithms: Las Vegas and Monte Carlo paradigms, some example randomized algorithms (1 Week)
4. Arrays, stacks, queues and linked lists . (1 week)
5. Dictionaries: Skip-lists, hashing, analysis of collision resolution techniques. (1 week)
6. Binary Trees: Traversals, binary search trees, balanced binary search trees - AVL and Red Black Trees. (3 weeks)
7. Priority queues: binary heaps, binomial heaps and Fibonacci heaps. (2 weeks)
8. Graphs:Breadth-_first search and connected components, Depth-_first search in directed and undirected graphs. Single course shortest path problem and minimum spanning tree - prim's and kruskal's algorithms. (3 week)

Learning Resources

Introduction to Algorithms by Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, MIT Press, 3rd Edition 2009.

Assessment Plan

Theory :
Mid Term - 25%
End Term- 25%
Test 1- 10 %
Test 2 - 10%
MCQ 1- 15 %
MCQ 2- 15 %

Lab

Mid Term - 25%
End Term- 25%

Test 1- 10 %
Test 2 - 10%
Assignments - 30 %

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Applications of Sorting and Searching	CO1,CO3,CO6
2	Applications of Stacks, Queues and Heaps	CO1,CO2,CO5,CO6
3	Applications of Binary Trees and BBST	CO1,CO2,CO5,CO6
4	Applications of Graph Algorithms	CO1,CO4,CO5,CO6

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

No Penalty for one week late, 100% penalty after that.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	EG 301 / Operating Systems		
Course Instructor Name(s)	Prof. B. Thangaraju		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	2	Practical (2hrs = 1 credit)	
	L:T:P = 3:0:1	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
x	CSE Core
x	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* *NONE*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Engineers trained on operating systems are sought for. This course provides strong foundation for the same.
Focus on skill development	Yes	Developing skills on Linux System Programming is very much required for the development of Embedded and Real Time Systems.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

An operating system defines an abstraction of hardware and manages computing resource sharing among the computer's users. This course covers developing key approaches to operating system design and implementation. From basic structure to synchronization, overview of monolithic, micro and hybrid kernel types, implementation of file, processes, memory organization and Network management kernel subsystems will be discussed in detail.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand the importance of operating systems, kernel subsystems, types of kernel used for GPOS, embedded and real time systems.	PO1, PSO1	U	F,C	3	0
CO2	Use the existing file types including regular, directory, link, device and socket, and file systems including ext4 and XFS. .	PO1, PSO1	Ap	F,C ,P	4	2
CO3	Perform I/O management with file related system calls and file locking synchronization mechanism.	PO1, PSO1	Ap	C, P	6	2
CO4	Implement the process management including mode, space, process states, scheduling policy for real time and non real time processes.	PO1, PSO1	Ap	C, P	6	4
CO5	Implement timers, manipulation of system resources limits and implementation of Signaling mechanisms with standard and real time signals.	PO1, PSO1	Ap	F, C, P	5	4

CO6	Develop multithreaded programs by using POSIX threads.	PO3, PSO1	Ap	C, P	3	2
CO7	Understand how the OS manages the physical memory.	PO1, PSO1	U	F, C, P	3	0
CO8	Implement the inter process communication mechanisms including the unnamed pipe and named pipe (FIFO).	PO1, PO3, PSO1	Ap	F, C, P	6	4
CO9	Perform System V IPC mechanisms including Message Queue, Shared Memory and Semaphore.	PO3, PSO1	Ap	C, P	6	8
CO10	Implement socket programming to communicate between two different systems through a concurrent server.	PO3, PSO1	Ap	C, P	3	4
	TOTAL				**45**	30

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

This course will cover the following topics:
1. OS Introduction
2. File Management
3. I/O Handling
4. File Locking
5. Process Management
6. Daemon Process
7. Timers, Resource Limits and Log Messages
8. POSIX Thread Basics
9. Signaling Mechanisms
10. Memory Management
11. Primitive Inter Process Communications
12. System V IPC
13. Socket Programming

Instruction Schedule

[Provide session-wise schedule]

Week	Topics
1	1. OS Introduction a. Features

	b. Layered Approach c. Kernel Functionality d. Different types of Kernel –Monolithic, Micro and Hybrid e. Booting Procedure
2	2. File Management a. File Tree Structure b. File Types c. File System d. Ext4/XFS e. Device Special Files f. procfs g. Buffer Cache
3	3. I/O Handling a. overview b. fd table c. System Calls d. Opening a file e. Duplicating a file descriptor f. Random Access g. File control h. Get file status i. Select system call
4	4. File Locking a. Types of file locking b. flock structure c. Pseudo Code for write lock
5-6	5. Process Management a. mode and space b. Context switch c. Per process objects d. Execution Context e. Process structure f. Process states g. Process scheduling h. Process Creation - fork i. execl family of Library functions
7	6. Daemon Process a. Characteristics b. Example Program
8	7. Timers, Resource Limits and Log Messages a. Time Zone b. Alarm c. Interval Timers d. Set and Get Timers e. Time Stamp Counter f. Hard and Soft Resource Limits g. Set and Get Limits h. syslog
9	8. POSIX Thread Basics a. overview

	b. User Level Thread c. Kernel Level Thread d. Example Program
10	9. Signaling Mechanisms a. Introduction b. Signal Vs Interrupt c. Receiving a signal d. Handling a signal e. signal ( ) system call f. kill ( ) system call g. sigaction ( ) system call
11	10. Memory Management a. Virtual memory b. Paging c. memory mapping d. Demand paging e. mm data structure
12	11. Primitive Inter Process Communications a. pipe b. popen, pread, pwrite c. FIFO d. Process Tracing
13-14	12. System V IPC a. Introduction b. message Queues c. Shared Memory d. Semaphore
15	13. Socket Programming a. Connection Oriented b. Concurrent and Iterative Server

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Operating System Concepts by Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Eighth edition, John Wiley & Sons. Inc, 2009.
2. Linux System Programming by Robert Love, O'Reilly Media, 2013.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

OS Theory Exam (3 credit)	**Marks (%)**
Pre Mid Term Exam -Quiz1	10

Mid Term Exam	30
Pre End Term Exam -Quiz2	10
End Term Exam	40
Attendance	10
Total	100

OS Lab Evaluation (1 credit)	**Marks (%)**
Hands-on List 1	25
Hands-on List 2	25
Mini Project	40
Attendance	10
Total	100

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	**Focus of Assignment / Project**	**CO Mapping**
1	64 Lab exercises on Linux System Programming	CO2 to CO10
2	Project: Design and Development of online banking management system. Use: only system calls, file locking, semaphore, multithreaded and socket programming.	CO3, CO6,CO9 , CO10

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Manual evaluation of programming questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

A penalty of 10% of the Lab assignment/ project marks will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	EG 211/ Computer architecture		
Course Instructor Name(s)	Nanditha Rao		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:CS and ECE*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
X	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* *Digital design*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	
Focus on skill development	Yes	
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

Course overview:

The course gives a basic overview of the architecture of a processor, its interfaces, and how programs are executed on a processor. We explain three different architectures in this course. We start with a simple 21-instruction processor called the Princeton/ IAS architecture and describe its functioning. We then move on to the basic architecture of the 8085 processor and its interfacing, briefly. The third and major component of the course is the MIPS processor design. We explain the instruction set architecture and design the data and control path design for MIPS non-pipelined and pipelined architectures. We discuss pipeline hazards and discuss ways to resolve hazards such as forwarding. We discuss cache memories and how to evaluate performance of caches.

Why is it important?

It is important to understand how a processor works and executes instructions. We start with basic architectures but move on to modern concepts such as pipelining, hazards and caches.

Pipelining is one of the concepts used in most modern processors and it is important to understand the issues associated with pipelining, such as hazards, and discuss ways to resolve hazards. Caches form a key component of all modern processors and it is therefore important to understand them in detail.

This course is a pre-requisite to the advanced architecture course called “Processor Architecture” taught in the 4th year. CSE students can use the knowledge of computer architecture in programming, compiler design, simulation models, GPU programming and so on. ECE students can build upon their architecture fundamentals by studying concepts such as memory design, circuit design, GPU fundamentals and so on.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the architecture of Princeton/IAS computer architecture and its functioning through assembly language programming.	PO1, PSO1	U	C	6	2
CO2	Design the Princeton/IAS processor using C/python.	PO3, PSO1	Ap	C, P		2
CO3	Understand an Instruction cycle, I/O fundamentals (PCI) and interrupts	PO1, PSO1	U	C	6	2
CO4	Understand 8085 architecture, interfacing	PO1, PSO1	U	C,F	6	1
CO5	Write assembly programs in 8085 and write simple programs for 8085-interfacing	PO1, PSO1	Ap	P	3	1
CO6	Design a data and control path for the MIPS instruction set architecture (non-pipelined design)	PO1 PSO1	Ap	C, P	6	2
CO7	Design a data and control path for a MIPS pipelined architecture with and without hazards	PO1 PSO1	Ap	C,P	6	2
CO8	Design direct mapped and set/fully associative cache memories and determine their performance	PO1, PO3, PSO1	Ap	C, P	6	2
CO9	Understand exceptions and loop optimizations/unrolling	PO1, PSO1	U	C, P	3	1
	Total hours				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]
Topic 1: Fundamentals of assembly language, IAS instruction set architecture
Topic 2: Computer function and interconnection
Topic 3: 8085 and interfacing
Topic 4: MIPS
Topic 5: Cache memory

Instruction Schedule

[Provide session-wise schedule]

2 weeks: Topic 1: Fundamentals of assembly language
Chapter-1,2 William Stallings

- Stored program concept, RISC vs CISC
- Harvard vs Von Neumann architecture
- RISC computer: Princeton/IAS computer, instruction set, programming, Instruction encoding
- Stack

Assignment: Implementation

2 weeks: Topic 2: Computer function and interconnection,
I/O, interrupts
Chapter-3 William Stallings

- Instruction cycle, IO fundamentals: handshaking, programmed IO, interrupt driven IO; Interrupt handling mechanism, Buses: protocols, arbitration, direct memory access (DMA), PCI timing

2-3 weeks: Topic 3: 8085 and interfacing

- Example study: 8085 architecture, timing
- 8085 instruction set
- Addressing modes, Basics of assembly level programming
- Interfacing: Programming counters, delays, interrupt controller, memory interfacing

Topic 4: MIPS

- 2 weeks: MIPS instruction set, MIPS assembly programming, Procedure and stacks
- 1 week: data and control path design, ALU design
- 3 weeks: Pipelining, data and control path design, hazards: data, control, structural hazard, Performance evaluation
- Assignment: Implementation
- 1-2 weeks: Exceptions, forwarding,Loop optimisation/unrolling

Topic 5: Memory

- 2 weeks: Memory: Cache memory, memory hierarchies, performance evaluation (AMAT), Read/Write stategies
- Assignment: Implementation

Wrap-up:

- 1 week: Case study of a modern day processor architecture (say x86 or ARM)
- Overview of advanced computer architecture

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- *Computer Organisation and Architecture - by William Stallings*
- *Computer-Organization and Design- MIPS version -5th-Edition Hennessy and Patterson*
- *8085- Ramesh Gaonkar*
- *Tools*
- *GNUSim8085*
- *MARS MIPS Simulator*

Edx: Computation Structures -2

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

	Weightage
Quizes (2-3)	25%
Midterm	20%
Endterm	25%
Assignments/Demo/ Project	25%
Active class/tutorial participation	5%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Design the IAS computer architecture	CO1
2.	Design the MIPS non-pipelined data and control path	CO5
3.	Design a cache memory	CO6

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools
- Demo for assignments/projects

Students will be provided opportunity to view the evaluations done either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission:
10% penalty for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

- **All assignments/codes/reports will be run through a plagiarism check tool**
- **Cheating – 0 marks for the assignments**
- **Repeat offense/Cheating in exam – Zero marks + Grade penalty**

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	ESS 201/ Programming II
Course Instructor Name(s)	T. K. Srikanth (tk.srikanth@iiitb.ac.in) Jaya Sreevalsan Nair (jnair@iiitb.ac.in)

	Hours	Component
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
	2	Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(*Place X appropriately. More than one is okay)*
Programme: *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
X	Engineering Science and Skills
	HSS/M
	General

Course Prerequisites

(Where applicable, state exact course code/name)

ESS111 (C) and ESS112 (Python) [Previously both courses were combined as ESS101]

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Students learn programming in Java and C++, both of which are important for industrial opportunities
Focus on skill development	Yes	Use of Eclipse, VS Code development tools
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

This is a second course on programming that is expected to reinforce the concepts taught in Programming I and the Data Structures courses. This course introduces students to the theory and practice of object-oriented programming (OOP) through Java and C++. Java and C++, along with C and Python, routinely feature in the top 4 programming languages as per IEEE Spectrum language ranking in terms of the widely used languages, and in terms of employability.

Course Contents

- Object-oriented design
- Encapsulation and information-hiding
- Separation of behavior and implementation
- Classes and subclasses
- Inheritance
- Static and dynamic binding
- Polymorphism
- Generics and templates
- Containers and Collections
- Event-handling methods
- Exception handling

This course includes programming laboratory sessions.

The outcome of this course is to extend the knowledge and practice of programming complex problems using OOP. This course builds on the Programming I (ESS111 and

ESS112, previously combined as ESS101) course, where students are introduced to programming.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand Object-oriented programming (OOP) paradigm, objects, and classes in Java and C++	PO1, PSO1	U	C	9	4
CO2	Write simple programs in C++ and Java	PO1, PSO1	Ap	F, C, P	5	4
CO3	Write programs employing concepts of Abstraction, modularity, access control in Java and C++	PO1, PO3, PSO1	Ap	F, C, P	7	4
CO4	Write programs employing concepts of inheritance and polymorphism in Java and C++	PO1, PO3, PSO1	Ap	F, C, P	15	8
CO5	Write programs using Generics in Java and templates in C++	PO1, PO3, PSO1	Ap	F, C, P	6	6
CO6	Write programs in Java and C++ with a focus on memory management	PO1, PO3, PSO1, PSO4	Ap	F, C, P, PC	3	4
				Total	45	30

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1: Java - Intro to OOP	**Module 2: C++ -** - Introduction to C++ classes

- Encapsulation, modularity Objects in Java - reference to objects Java Operators, Primitives, Strings, Arrays Classes in Java - data members and methods - Constructors and Initialization Garbage collection Encapsulation - Package and Access specifiers Abstraction - Association, composition, aggregation Inheritance - Overriding - Overloading - Late binding Polymorphism - upcasting and downcasting - Inheritance vs Composition Abstract classes Interfaces Generics Collections - Iterators - Algorithms Error handling and exceptions	- OOP features - SOLID principles - Constructors, Destructors, Copy constructors, Manipulators, Accessors - C++ classes - Friends - Access control - Memory management - References and this-pointer - Operator overloading - Composition - Type-casting - Inheritance - Polymorphism - Templates - Abstract containers - STL - Function objects - Generic algorithms - Class and function templates - Exception handling

Instruction Schedule

[Provide session-wise schedule]

S.No.	Topic	Hours	CO

Java Module			
1	Introduction to Java and OOP	2	CO1
2	Syntax, Primitives and Operators	2	CO2
3	Classes, Memory Management	3	CO1, CO6
4	Encapsulation and Abstraction	3	CO3
5	Inheritance, Polymorphism,	6	CO4
6	Abstract Classes, Interfaces	3	CO4
7	Generics, Containers, Collections	3	CO5
8	Exception Handling	2	CO1
	Module (Total)	24	
C++ Module			
1.	Introduction to C++ classes		
a.	OOP features, SOLID principles	2	CO1
b.	Constructors, Destructors, Copy constructors, Manipulators, Accessors	2	CO2
2.	C++ classes		
a.	Friends, access control	2	CO3
b.	Memory management, references, this-pointer	2	CO6
c.	Operator overloading	1	CO2
d.	Composition, type-casting	2	CO3
4.	Inheritance	3	CO4
5.	Polymorphism	3	CO4
6.	Templates		
a.	Abstract containers, STL	1	CO5

b.	Function objects, generic algorithms	1	CO5
c.	Class and function templates	1	CO5
7.	Exception handling	1	CO1
	Module (Total)	21	

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Lecture notes and reading materials provided in class.

- Java
  - Java: How to Program, Paul Deitel and Harvey Deitel
  - Thinking in Java, Bruce Eckel.
  - The Java Tutorials: Oracle Java Documentation
- C++
  - C++ annotations, B Stroustrup: https://www.stroustrup.com/books.html

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Both Java and C++ modules have equal weight across all assessment types given below:

- Weekly programming assignments (best 4 out of 5 in each part of the course) -- 20%
- Programming tests (better of 2 in each part of the course) -- 20%
- Final (team) assignment/mini-project -- 10%
- Written examination with theory and programming components (mid-term, end-term) -- 50%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
	Java Module	

1.	Programming assignment in C to motivate structures and classes	C01
2.	Programming assignment in Java to introduce syntax and classes	C01, C02, C03, C06
3.	Programming assignment in Java on base classes and derived classes	C01, C03, C04
4.	Programming assignment in Java on using generics and containers	C05
5.	Programming assignment in Java on object-oriented event-driven programming	C01, C04
6.	Mini-project in Java that requires application of key concepts of the course, and enabling integration across implementations that share common base classes or interfaces.	C03, C04, C05
	C++ Module	
7,	Programming assignment in C as a warm-up	CO1
8.	Programming assignment on introduction to C++ classes	CO2
9.	Programming assignment on composition of C++ classes, along with use of pointers for memory management	CO2, CO6
10.	Programming assignment on inheritance in C++, along with use of STL	CO4, CO6
11.	Programming assignment on polymorphism in C++, along with use of STL	CO4, CO6
12.	A mini-project on a larger problem statement with each student in a 5-member team working on different features to be implemented in a larger C++ codebase, along with integration of code as a team.	CO4, CO5, CO6

- The assignment description with all logistics are provided to the students on LMS. "*Start early and finish on time*" is the guiding principle for all assignments in this course.
- All programming assignments and tests shall be submitted on LMS and Domjudge.

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools
- Manual evaluation of code design as per rubrics

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions allowed only with instructor's permission for lapses owing to medical and personal emergencies.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This course has zero-tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor. All material that will be used for the assessment of the student's performance shall be original work.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	ESS 102 Digital Design
Course Instructor Name(s)	Subhajit Sen

Credits (L:T:P)
(Lecture : Tutorial : Practical)

Hours	Component
3	Lecture (1hr = 1 credit)
1	Tutorial (1hr = 1 credit)
0	Practical (2hrs = 1 credit)
L:T:P = 3:0:0	**Total Credits = 3**

Grading Scheme
(Choose by placing X against appropriate box)

X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
	Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
X	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	
Focus on skill development	Yes	Students learn design using Verilog HDL
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

The goal of the course is three-fold: (1) to understand how numbers are represented in digital computing systems, (2) to understand the fundamentals digital hardware as implemented using CMOS VLSI technology and (3) how to apply the above in the design of combinational and sequential circuits required for computing systems. This course is a foundational course in for almost all subjects related to Computer Science and Engineering and Electronics Engineering.

The course begins with the introduction of the concept of 3-Y's (hierarchy, modularity, regularity) that is required to deal with the enormous complexity of modern digital systems. It then discusses number representations in computing (binary, octal, BCD, hexadecimal) and the 2's complement representation, addition and subtraction. In the second part the course discusses the topic of Noise Margin of logic gates and the static discipline. It then explains semiconductors, operation of diodes and MOSFET transistors leading up to the function of the inverter and NAND/NOR gates.

In the third part the course begins with combinational logic circuits and their representations as truth tables, SOP and POS equation forms. Subsequent topics covered are: Boolean logic axioms and theorems, simplification of logic expressions, Karnaugh map, glitches, delays in logic gates. Sequential circuits are discussed next: states, Moore & Mealy machines (FSM), state representation of FSM, synthesis of FSM, dynamic discipline and static timing in FSM, pipelining in sequential circuits. Subsequently we cover digital sub-systems: fast adders, multipliers, multiplexers, decoders, memory sub-systems, programmable logic. About 2 lectures and 2 labs are conducted in introducing the concept of HDL programming specifically on Verilog. Finally and optionally, the SAP (Simple-As-Possible) computer is introduced to the students.

Two special approaches make this course a unique offering: (a) the use of a very well-written and comprehensive text-book (Digital Design & Comp. Architecture by Harris/Harris) and (b) the use of an online simulation tool **CircuitVerse** that allows the students to understand digital design at the logic gate level and helps them to visualize the functioning of complex combinational and sequential circuits.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the concept of 3Y in Digital Design	PO1, PSO1	U, Ap	C, P	2	0
CO2	Add/subtract binary numbers using the 2's complement representation of binary numbers	PO1, PSO1	U, Ap	C,P	5	1
CO3	Determine the representation of a decimal number in binary number system and vice-versa	PO1, PSO1	Ap	C, P	5	2
CO4	Understand the concept of noise margin in logic gate interfaces	PO1, PSO1	U, Ap	C, P	2	0
CO5	Draw the CMOS circuit for a given Boolean logic function	PO1, PSO1	Ap	C,	5	1
CO6	Draw the Karnaugh map for a 4-variable Boolean logic function and determine a possible minimal logic function in POS(SOP) form	PO1, PSO1	R, U , Ap, Ev	C, P	7	2
CO7	Determine the static & dynamic power of a CMOS logic circuit	PO1, PSO1	U, Ap	C, P	2	1
CO8	Understand the concepts of Moore and Mealy Finite State Machines	PO1	U	C,P	2	1
CO9	Draw the state transition diagram from a description of FSM and use it to design the FSM sequential circuit	PO1	U, Ap, An, Ev, C	C,P	8	3
CO10	Understand constructs of Verilog HDL and apply that to the description of logic circuits	PO1	U,Ap	C,P	4	2

	Total				42	14

Legend: *<u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Topic	No. of hours
Introduction to digital computers and the concept of 3-Y's	2
Number Systems	4
Logic Gates & Truth Table	1
Noise Margins (Static Discipline)	2
Semiconductor Devices (Diode, MOSFET transistor)	2
CMOS Circuits	2
Power Dissipation in CMOS Circuits	2
Boolean Logic Theorems & application	3
Karnaugh Map simplification of Boolean logic functions	4
Glitches in logic circuits	1
Propagation and contamination delay	1
Sequential Circuits: states, state-transition diagrams, next-state tables	5
Dynamic Discipline (setup/hold time, clock-speed maximization, skews)	2
Pipelining	2
Verilog-HDL	2
Digital sub-systems (Fast adders, multipliers, mux/decoders, ALU, memory)	5
Programmable Logic (FPGA)	1
Simple-As-Possible (SAP) Computer	1
TOTAL hours	**42**

Learning Resources

1. David M. Harris, Sarah Harris, Digital Design & Computer Architecture, Elsevier, 2017.

2. Morris Mano, Michael D. Ciletti, Digital Design, 5th edition, Pearson, 2013.

3. Albert Malvino, Jerald Brown, Digital Computer Electronics, 3rd Edition.

Assessment Plan

Midterm exam-20%
Final exam-30%
Assignments and Quizzes-50%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Determine Noise Margin of a TTL-CMOS logic interface	CO1, CO4
2	Logic simplification using Boolean Theorems	CO6
3	Logic simplification using Karnaugh Maps	CO6
4	Maximize the speed of a sequential circuit	CO9
5	Design an ice-cream vending machine	CO6, CO8,CO9

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of design problems in assignments, quizzes and exams
- Manual evaluation of Circuitverse assignments and project.

Students are provided the opportunity to view the evaluations done either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions are accepted with a penalty.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	Signals and systems (ESS 103)		
Course Instructor Name(s)	Neelam Sinha / Vinod reddy		
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 4	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data	X	Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **<u>one</u>** from the following:
(Place X appropriately)

	Basic Sciences
X	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Basic concepts on signals and systems used across domains; solving problems through coding
Focus on skill development	Yes	Building systems to accomplish objectives such as signal de-noising, amplification
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand characteristics of signals (Differences between continuous-time and discrete complex exponentials)	PO1, PSO3	U	C	6	2
CO2	Understand characteristics of continuous-time and discrete systems	PO1, PSO3	U	C	3	1
CO3	Transform signals through folding, reversing, shifting and scaling	PO1, PSO3	Ap	C	3	1
CO4	Determine the output of an LTI system using convolutional integral, summation, and paper-pen -coding	PO1, PSO3, PO5	Ap	P	9	3
CO5	Compute Fourier series/Transform (CTFS, CTFT, DTFS, DTFT, DFT) of a given signal through Paper-pen-coding and plotting Power spectrum	PO1, PSO3, PO5	Ap	C, P	9	3
CO6	Compute sampling period as required by Nyquist criterion and reconstruct signals by sinc interpolation and linear interpolation technique	PO1, PSO3	Ap	C, P	3	1

CO7	Determine Laplace transform of a given differential equation and impulse response	PO1, PSO3	Ap	C, P	5	1.5
CO8	Determine Z-Transform: Paper pen and coding exercise	PO1, PSO3,	Ap	C, P	5	1.5
					45	14

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Dynamic representation of systems, systems attributes, causality, linearity, stability, time-invariance; special signals, complex exponentials, singularity functions (impulse and step functions); Linear Time-Invariant Systems, differential equation representation, convolution integral; discrete form of special functions; discrete convolution and its properties; realization of LTI systems (differential and difference equations). • Fourier analysis of continuous time signals and systems, Fourier series, Fourier Transform and properties, Parsevals theorem, frequency response of LTI systems; sampling theorem. • Fourier analysis of discrete time signals & systems, Discrete-time Fourier series, Discrete-time

Fourier Transform (including DFT) and properties; frequency response of discrete time LTI systems. • Laplace Transform and its inverse, definitions, existence conditions, region of convergence and properties, applications of Laplace Transform for the analysis of continuous time LTI system (stability etc.), significance of poles and zeros. • Z-Transform and its inverse, definitions, existence, region of convergence and properties, applications of Z-Transform for the analysis of discrete time LTI systems, significance of poles and zeros.

Instruction Schedule

[Provide session-wise schedule]

Week1 & 2: Understand difference between Data and signal – represent, classify signals

Week3 : Define a system – Properties, Identify Properties of a given system

Week4 : Transformations of Signals – Folding, Reversing, shifting

Week5,6,7 : Define output of an LTI system; Compute convolutional Integral and summation - paper pen and coding exercise

Week8: Compute Fourier series/Transform of a given signal – Paper pen and coding exercise; Plot Power spectrum

Week9: Mid Sem Exam

Week10-11: Continue with …Compute Fourier series/Transform of a given signal – Paper pen and coding exercise; Plot Power spectrum

Week12: Compute Sampling criterion and compare different Reconstruction Techniques

Week13,14 : Compute Laplace -Transform: Paper pen

Week14,15 : Compute Z-Transform: Paper pen and coding exercise

Week16 : Buffer Time

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Signals and Systems by Oppenheim and Wilsky
Problems on Signals and Systems – Schaum series

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

[Before Mid-sem] Assignment1 15%, Quiz1 10%, Mid sem 10%, Assignment 2 (Programming) 10%, Class Participation 5%

[Post Mid-sem] Assignment3 15%, Quiz2 10%, End sem 10%, Assignment 4 (Programming) 10%, Class Participation 5%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Assignment 1: Paper-pen solving of problems (Before Mid-sem) System properties, LTI system Output using convolution	CO 2, CO 4
2	Assignment 2: Programming assignment (Before Mid-sem) Plot Discrete signals, Check signal periodicity, Compute Discrete Fourier Transform and plot power spectrum	CO 1, CO 5
3	Assignment 3: Paper-pen solving of problems (After Mid-sem) Signal sampling using Nyquist criterion, Signal Reconstruction using Interpolation techniques, Compute Laplace and Z- Transform	CO 6, CO 7
4	Assignment 4: Programming assignment (After Mid-sem) Compare signal reconstruction using sinc and linear reconstruction methods; Compute Z-Transform for a given signal	CO 6, CO 7, CO 8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Late Assignment submissions are NOT considered

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	ESS 112/ Programming in Python	
Course Instructor Name(s)	Sujit Kumar Chakrabarti	
Credits (L:T:P) (Lecture:Tutorial:Practical)	**Hours**	**Component**
	X	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
	X	Practical (2hrs = 1 credit)
	L:T:P =	**Total Credits = 2**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A, A-, B+, B, B-, C+, C, D, F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
X	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	
Focus on skill development	Yes	
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Special focus is given to equip students with life- and professional-skills like communication skills, teamwork, ethical conduct, problem solving skills etc.

Course Context and Overview

This course will introduce Python as a high level programming language useful in solving computing problems.

The Python part of the Programming I lab course will aim to get the students to get off the block as quickly as possible and start building programs for reasonably complex problems using the rich collection of constructs and built-in and other readily available libraries in Python. The focus will be on problem solving using Python as a tool. So the course is structured around a set of problems that are designed to introduce the students to language features in chunks till they are equipped to build a fairly non-trivial piece of code themselves.

The Python programming lab is intended to complement the C programming lab in several ways, e.g. in terms of richness of the programming constructs, use of a feature-rich IDE, and introduction to GUI programming. The idea is to give the students an opportunity to get hands-on experience with building projects that will make learning programming a fun-filled exercise.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Practical (Hrs)
CO1	Use basic constructs to implement simple programs		A	F, C, P	4	4
CO2	Design and implement programs with procedures/functions		A	F, C, P	2	2
CO3	Design and implement Python programs using		A	F, C, P, FDP, CS, PC, DI	3	3

	functional programming principles					
CO4	Design and implement Python programs using object oriented programming principles		A	F, C, P, FDP, CS, PC, DI	3	3
CO5	Explain basic features of programming languages and their implementation in Python		U	F, C	1	0
CO6	Participate in/contribute to group programming projects in Python		C	F, C, P, FDP, CS, PC, DI	1	5
CO7						
CO8						
CO9						
CO10						

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

- Introductory concepts -- working environment, comparison with other programming languages
- Basic syntax -- expressions, types, statements, variables, etc.
- Control constructs - branches and loops
- Inbuilt containers - tuples, lists, sets, maps
- Functions
- Recursion
- Exception handling
- Introduction to program design
- Introduction to functional programming -- lambda expressions, coroutines, decorators, higher order functions
- Introduction to object oriented programming -- Inheritance, polymorphism, duck typing
- GUI programming (optional)

- Project and summary

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

1. Programming Python, 4th Edition -- Mark Lutz
2. Essential Python Reference, xth Edition -- David M. Beazley

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	**HSS 101: Economics**	
Course Instructor Name(s)	V Sridhar	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	45	Lecture (1hr = 1 credit)
	15	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 45:15:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

None

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Provides students an appreciation of the rational economic behavior of individuals, firms and governments.

Course Context and Overview

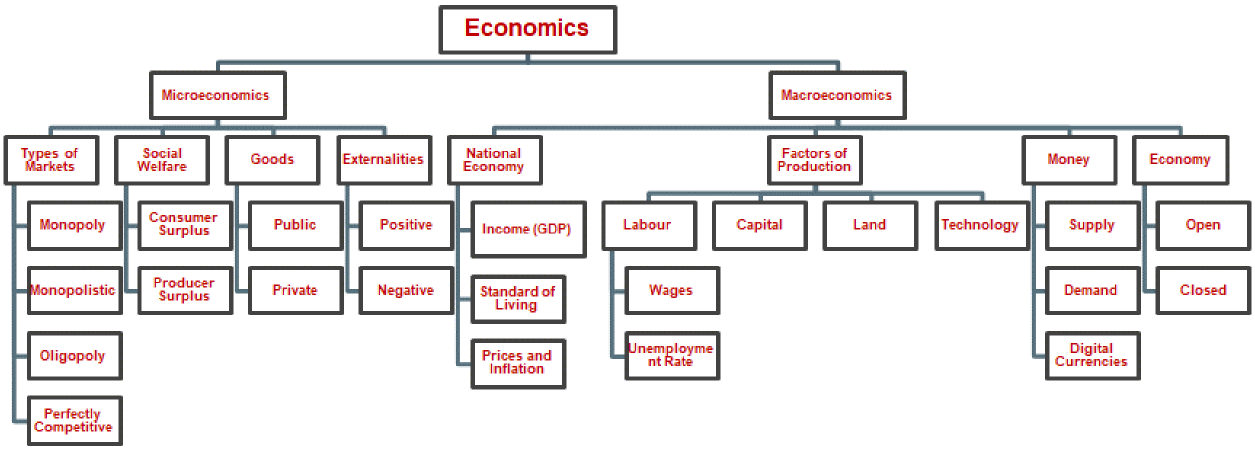
This course provides an introduction to economics – both micro and macro- to engineering and computer science students. The objective of the course is to enable the students to appreciate and understand the concepts of Economics and how they are related to our daily lives. Using a calculus and graphical approach, the course explains the theoretical principles of economics so that the students are able to understand the working of individuals, firms and government in our society. After taking the course, the students will be able to apply the principles learnt in the course to the working of the Information and Communications Technology (ICT) industry.

Course Outcomes and Competencies

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Analyze the functioning of different types of markets including Monopoly, Monopolistic competition, Oligopoly, and Perfect Competition and the corresponding equilibrium conditions in each market.	PO6	An	C,P	9	3
CO2	Analyze market efficiencies, consumer surplus, producer surplus and social welfare in economic markets.	PO7, PO8	An	C,P	6	2
CO3	Analyze theory of public and private goods and its implications on pricing of such goods with applications in the ICT industry	PO6	An	F, C, P	3	1
CO4	Understand theory of labour markets and associated equilibrium wages, employment and unemployment rates with applications in the ICT industry	PO6	Ap	F, C, P	9	3
CO5	Apply macroeconomics principles to estimate the welfare of countries including the determination of GDP, standard of living and unemployment rates.	PO6	An	C, P	6	2
CO6	Understand theories of money including digital currencies and the associated monetary policies on the economies of countries.	PO6	An	F, C, P	6	2
CO7	Analyze factors of production including capital, land, labour and technology and their effect on productivity and standard of living with applications in the ICT industry	PO6	An	F, C, P	6	2
	Total				**45**	**15**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)



Course Content

The **first part** of the HSS 101: Economics course, will cover **Microeconomics** in detail during the pre-midterm and early part of post-midterm session. The course will cover the following topics in depth:

1. How does the market work: supply, demand and equilibrium;
2. Consumer and producer choices: elasticities of supply and demand;
3. Competitive, monopolistic and oligopolistic markets and strategic behavior of firms;
4. Public versus private goods; common resources; externalities
5. Labour markets and wage determination
6. The theory of consumer choice
7. Frontiers in Microeconomics research

The **second part** of the course, will cover **Macroeconomics** during part of the post-midterm session. The course will cover the following topics in depth:

1. Measurement of national economy, GDP calculations;
2. Cost of living comparisons; measurements; price and GDP adjustors;
3. Productivity and growth; productivity models;
4. Money and Inflation
5. Unemployment and its impact on national economy; trade-offs between inflation and unemployment
6. International trade
7. Open economy

Instruction Schedule

Week	Topics
1	**Overview of Microeconomics: [Ch: 1]** Ten principles of economics; how people make decisions; how firms behave; how the economy as a whole works; economist as a scientist and as a policy adviser; illustrations through day-to-day examples. **Supply, Demand and Equilibrium: [Ch: 4]** What is a market? What is competition; Demand curve - relationship between price and quantity demanded; Supply curve - relationship between price and quantity supplied Shifting along the curves and of the curves and their meaning; definition of market equilibrium Determination of market equilibrium; analyzing changes in equilibrium; shifts in supply/demand curves and the corresponding effects on equilibrium
2	**Elasticity and its applications: [Ch:5]** Price elasticity of demand and its determination; variety of demand curves; total revenue and the price elasticity of demand; other demand elasticities Price elasticity of supply and its determination; variety of supply curves; applications of supply, discussion of demand and elasticities in practice **Consumers, producers and efficiency of markets: [Ch: 7]** Calculation of consumer surplus, and producers surplus; effect of price on these surpluses evaluating market efficiency and reasons for market failures; discussion of cases
3	**Firms in competitive markets: [Ch: 14]** What is a competitive market, profit maximization principles of firms marginal cost curve and firm's supply decisions, measuring profit of competitive firm, firm's short and long run decisions, shifts in demand and its impact, examples
4-5	**Monopoly: [Ch: 15]** Why monopolies arise, monopoly vs. competition, monopoly's profit maximization decisions, deadweight loss, social costs of monopoly, x-inefficiency Price discrimination in monopoly markets, public policy towards monopolies, examples **Monopolistic Competition: [Ch: 16]** Competition with differentiated products, long run equilibrium, monopolistic vs. perfect competition, advertising to differentiate
6-7	**Oligopoly: [Ch: 17]** Duopoly and oligopoly markets, measure of market concentration, equilibrium for an oligopoly, prisoner's dilemma in oligopoly, cartels and collusion, Nash equilibrium Public policies towards oligopolies, restraints of trade and antitrust laws, controversies of antitrust policies, discussion with examples
8-9	**Externalities: [Ch: 10]** Externalities and market inefficiency, positive and negative externalities, discussion of examples **Public goods and common resources:** Public policies towards externalities, private solutions to externalities

	Private versus public goods, free rider problem, tragedy of the commons, positive and negative externalities, internalizing externalities, Pigovian taxes and subsidies
9-10	**Factors of production: [Ch: 18]** Production functions and marginal product of labour, shift of labour demand curve trade between work and leisure, equilibrium in the labour market, the other factors of production – land and capital **Theory of consumer choice: [Ch: 21]** Consumer preferences, indifferent curve analysis, utility theory, examples **Frontiers in Microeconomics Research [Ch: 22]** Information asymmetry, Moral hazard and adverse selection problems, network effects
11	**National Economy:** National income, expenditure, consumption, investment, GDP calculations, real and nominal GDP **Cost of Living:** Cost of living calculations, Consumer Price Index, price deflators, real and nominal Interest rates
12	**Productivity and Growth**: Productivity and growth, factors of production, productivity models, government policies for improving productivity, productivity across different countries
13	**Money Growth and Inflation:** Supply and demand of money, Fisher effect, inflation, central bank policies on supply and demand for money
14	**Unemployment:** Relationship between employment and wage, reasons for unemployment, trade-off between inflation and unemployment, minimum wages, trade unions and bargaining, Philips curve, sticky price and sticky wage models **Make-up Quiz**
15	**Open Economy:** International trade, relationship between currency values, exchange rates, imports and exports

Learning Resources

1. Mankiw, G. (2012) Principles of Microeconomics (6th Edition). Cengage Learning.
2. Mankiw, G. (2012) Principles of Macroeconomics (6th Edition). Cengage Learning.

Assessment Plan

Component	Marks
Microeconomics Quizzes (5 × 5)	25%
Macroeconomics Quizzes (5 × 5)	25%

Mid Term Exam in Microeconomic	25%
End Term Exam in Macroeconomics	25%
Total	**100%**

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
	Not Applicable	

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

1. Automatic evaluation of MCQ quizzes on Moodle or other online platforms
2. Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not Applicable

Make-up Exam/Submission Policy

One make-up quiz is given to accommodate anyone who missed one of the quizzes due to unavoidable circumstances. There are no make-ups for mid or end term exams.

Citation Policy for Papers (if applicable)

Not Applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	HSS 102: A History of Ideas		
Course Instructor Name(s)	Bidisha Chaudhuri		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
		Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*
Course Category	Select **one** from the following: *(Place X appropriately)*
Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Programme:

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category:

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	Yes	Introduces students to the idea of technology as part of complex social problems
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Trains students with critical thinking, analytical thinking and writing

Course Context and Overview

[*Provide introduction to the course*]

History of Ideas or Intellectual History is an interdisciplinary field of studies traversing the disciplinary boundaries of philosophy, history, natural science, art and literature, political and social thought and so on. As a field it focuses on how ideas about the world, either natural or social, have originated, evolved and transformed over time. The motive for studying such a wide field is to understand how knowledge is produced and disseminated and how epistemological lenses shape the way we perceive and conceptualize the world around us. There is no single way of talking about the history of ideas. Rather, there are many ways in which this field can be approached depending on the area of focus, historical time frame, and spatial dimensions and so on.

This course is in no way an exhaustive account of history of ideas. Rather, it is a selection of intellectual trajectories and their proponents on the basis of the relevance and impact of their ideas across time and space, and their ability to permeate disciplinary boundaries and influence the overall pursuit of knowledge in the social sciences. Thus, the focus of the course remains on the economic, political and social ideas growing out of different temporal and intellectual contexts that represent different organizing principles of state and society.

The course starts with a focus on modern political, economic and sociological thought. It starts with a brief introduction to early liberal political philosophy on the nature of the modern state, society and sovereignty through the works of Hobbes, Locke and Rousseau. It also examines the ideas of Adam Smith and Karl Marx and Karl Polanyi to trace the emergence of modern economic thought. It then proceeds to major epistemological traditions in classical sociological thought developed by Weber, Durkheim and Gramsci while exploring a range of ideas on the state and economy, power and domination, the division of labour and social control, religion and society.

Then we move on to focusing on the relationship between individual, society and system of knowledge. We explore social psychological ideas by Sigmund Freud and G.H. Mead through their works on the relationship between individual and society. These ideas lead to the relationship between society and knowledge through the works of Karl Mannheim (Sociology of Knowledge), Berger and Luckmann (Social Construction of Reality).

The following section presents a critical understanding of modernity and modern thought through the works of Michel Foucault and Anthony Giddens.

The course also touches upon modern Indian social and political thought through the writings of Indian thinkers such as Gandhi, Tagore, Ambedkar, Nehru and their ideas of nation, community, state, democracy and development. In each module, we will touch upon contemporary issues facing India and the relevance of modern social thought in assessing these issues.

The objective of the course is to provide students with a cursory yet critical understanding of some of the major philosophical traditions of 19th and 20th century and the contexts in which they originated and evolved. This basic understanding will help them firstly to comprehend how social sciences perceive and analyze the world around us and secondly how such analytical lenses influence and inform our understanding of the contemporary society in general.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the contemporary political, economic and social systems through the historical lens of modernity	PSO6	U	F, C	12	4
CO2	Understand the role of science and technology in modern societies	PSO6	U	F,C	6	1
CO3	Critically evaluate modern institutions on individual freedom, relations of power and social structures	PSO 7, 8	R,U, Ap	F, C,MC	6	2
CO4	Understand the influence of modernity on Indian state and society	PSO6	U	F,C	9	3
CO5	Analyse the impact of modern economy and polity on challenges of development and environment	PSO6, 7, 8	U,An	F, C, MC	6	2
CO6	Examine the relationship between modernity, technology and social issues in contemporary India	PSO6, 7,8	U, An	C, MC	6	3
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

- Introduction to the Modernity and Enlightenment
- Introduction to Modern Political Thought
- Introduction to Modern Economic Thought
- Modernity and Culture, Society and Economy
- Introduction to Modern Sociological Thought
- Modernity and Mind
- Knowledge and Modernity
- Critiques of Modernity
- Modernity and Indian Thinkers
- Modernity and Indian Politics
- Modernity and Development in India
- Technology and Indian Modernity

Instruction Schedule

[Provide session-wise schedule]

Week	Topics
1, 2	Introduction to the Course and Introduction to the Modernity and Enlightenment
3	Introduction to Modern Political Thought: Hobbes, Locke, Montesquieu, Rousseau
4	Introduction to Modern Economic Thought: Smith and Marx
5	Culture, Society and Economy: Gramsci and Polanyi
7	Introduction to Modern Sociological Thought: Durkheim and Weber
8	Modernity and Mind: Freud and Mead
9	Knowledge and Modernity: Sociology of Knowledge: Mannheim, Social Construction of Reality: Berger and Luckman
10	Critique of Modernity: Power/Knowledge: Foucault and Reflexive Modernity: Giddens
11,12	Modernity and Indian Thinkers: Gandhi, Tagore, Ambedkar, Nehru
13	Modernity in India Politics: State, Caste and Religion
14	Modernity and Development in India: Urbanization, Employment, Environmental Challenges
15	Technology and Indian Modernity

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Bertrand Russell, History of Western Philosophy , George Allen and Unwin Ltd, 1947: 568-579, 642-665,711-727, 568-579, 642-665,711-727

Adam Smith, "Of the Division of Labour" (Chapter I, Book I) in The Wealth of Nations-1776 edited by Edwin Cannan, Bantam Books, 2003: 9-21

Karl Marx and Frederick Engels, "The Communist Manifesto-1848" in Marx/Engels Selected Works, Vol. One, Progress Publishers, 1969: Excerpts

Femia, J. V. (1987). Gramsci's political thought: hegemony, consciousness, and the revolutionary process.

Polanyi, K. The Great Transformation. New York: Farrar & Rinehart, 1944, selected pages

George Ritzer, Classical Sociological Theory, Second Edition, McGraw-Hill Companies, 1996: 217-263; 183-216; 362-385

Daniel K. Lapsley and Paul C. Stey, "Id, Ego and Superego" in Encyclopedia of Human Behavior, Second Edition edited by V.S. Ramachandran, Elsevier, 2011: 1-9

Lewis Coser, Masters of Sociological Thought, Indian Edition, Rawat Publications, 1996: 429-464

Peter Berger and Thomas Luckmann, "The Foundation of Knowledge" in Everyday Life in Social Construction of Reality: A Treatise in the Sociology of Knowledge, Penguin Books, 1966: 31-62

Michael Foucault, "Introduction" in The Foucault Reader edited by Paul Rabinow, Pantheon Books, 1984: 31-75

Anthony Giddens, Chapter 1 in The Consequences of Modernity, Polity Press, 1990, 1-53

Ramachandra Guha, Makers of Modern India, Penguin Books, 2010: Excerpts

Ahmad, N. (2006). A note on Gandhi, Nation and Modernity. Social Scientist, 50-69

Jodhka, S. S. (2002). Nation and village: Images of rural India in Gandhi, Nehru and Ambedkar. Economic and Political Weekly, 3343-3353.

Gail Omvedt, "Ambedkarism: The Theory of Dalit Liberation" in Dalits and the Democratic Revolution: Dr Ambedkar and the Dalit Movement in Colonial India, SAGE Publications, 1994: Excerpts

Parekh, B. (1991). Nehru and the national philosophy of India. Economic and Political Weekly, 35-48.

Kaviraj, S. (2005). On the enchantment of the state: Indian thought on the role of the state in the narrative of modernity. European Journal of Sociology/Archives Européennes de Sociologie, 46(2), 263-296.

Jayal, N. G. (1994). The gentle leviathan: Welfare and the Indian state. Social Scientist, 18-26.

Rudolph, L. I. (1965). The modernity of tradition: The democratic incarnation of caste in India. American Political Science Review, 59(4), 975-989)

Dirks, N. B. (1992). Castes of Mind. Representations, (37), 56-78.

Mitra, S. K. (1991). Desecularising the State: religion and politics in India after independence. Comparative Studies in Society and History, 33(4), 755-777.

Pantham, T. (1997). Indian secularism and its critics: Some reflections. The Review of Politics, 59(3), 523-540.

Escobar, A. (2011). Development and the Anthropology of Modernity. The postcolonial science and technology studies reader, 269

Sen, A. (2001). "Introduction" in Development as Freedom. Oxford Paperbacks.

Basole, A. (2005). The Economics of Ahimsa: Gandhi, Kumarappa, and the Non-Modern Challenge to Economics

Bhaduri, A. (2017). A study in development by dispossession. Cambridge Journal of Economics, 42(1), 19-31.

Ramachandra Guha and Joan Martinez Aller, Varieties of Environmentalism: Essays North and South, Routledge, 1997: 3-45

Baviskar, A. (1997). Ecology and development in India: A field and its future. Sociological bulletin, 46(2), 193-207.

Gandy, M. (2008). Landscapes of disaster: water, modernity, and urban fragmentation in Mumbai. Environment and planning A, 40(1), 108-130

and Indian Modernity

Arnold, D. (2013). Everyday Technology: Machines and the Making of India's Modernity. University of Chicago Press. [Selected Chapters]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- *Classroom Learning: 10%*
- *Group Activity (4*15= 60%)*
- *End-Term Examination: 30%*

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Classroom learning will include attendance and students' engagement in the classroom discussion	CO1-6
2.	This will take the form of storyboard-based group assignments. Groups will be fixed throughout the semester. There will be 2 components for scoring: Presentation (10): 10 minutes to present for each group. Student groups will be presented storyboards ahead of time and asked to present their ideas in class on the designated activity day. These storyboards may include texts as well as audio visual materials. All group members will be uniformly marked. Peer review Score (5): Each member of the group will give a score to their team members on the basis of their engagement and contribution to the group activity.	CO-3, 5, 6
3.	End-Term Exam	CO 3, 5, 6

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	**DT 203: Information and Communication Technology Policy and Regulation**
Course Instructor Name(s)	V Sridhar

Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	45	Lecture (1hr = 1 credit)
	15	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 45:15:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*		
	X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* None

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Provides students an appreciation of the socio-technical challenges posed by the behavior of individuals, firms and governments in the ICT industry and the associated regulations and policies to govern them in the positive directions.

Course Context and Overview

There is a paradigm shift in the ICT industry today due to convergence in various technologies and services, the ubiquity of the Internet, the emergence of app economy, the pervasiveness of social media and peer-to-peer networking, the intelligence of terminal devices and applications, and the voluminous data that is being collected by networks and networking firms. These pose challenges in the areas of privacy, security, market power, pricing, interconnection, radio spectrum management, industry structure and Intellectual Property Rights. This course provides the theoretical and policy base for analyzing these issues. It is the objective of the course to expose students of technology to various socio-economic challenges such as mentioned above in te ICT sector and corresponding policy and regulatory guidelines for encouraging positive effects of innovation at the same time mitigating the negative effects, if any.

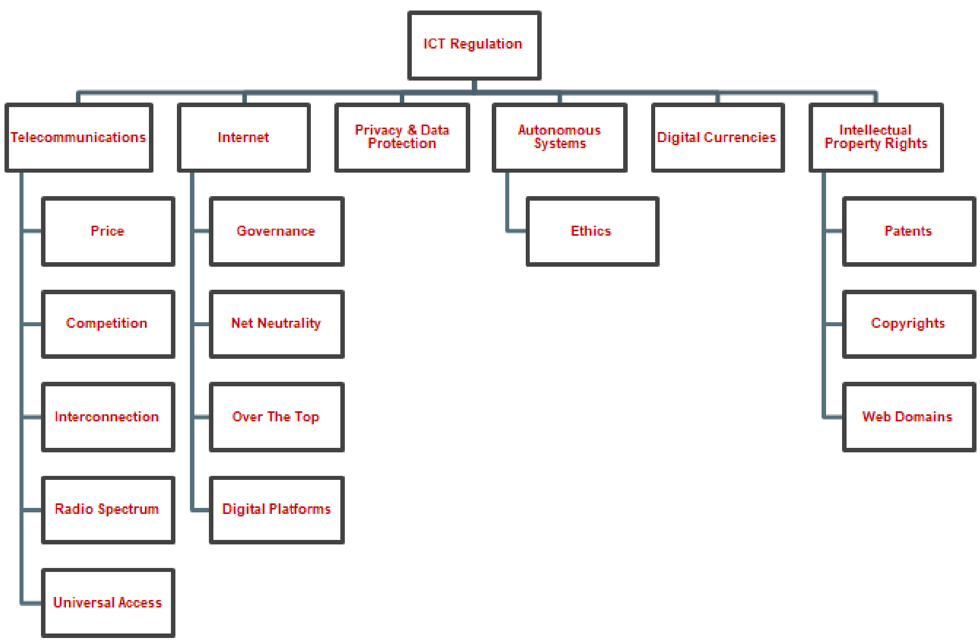
Course Outcomes and Competencies

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand theories of economic regulation and principles of price, competition, interconnection, universal access and net neutrality regulation as applicable to the Information and Communication Technologies (ICT) sector	PO3, PO4	U, Ap, An	F, C, P	9	3
CO2	Analyze the radio spectrum regulation for mobile services industry across countries	PO3, PO4	U, Ap, E	F,C,P	9	3

CO3	Understand the administrative functioning and governance of the Internet	PO3, PO4	U	F,C,P	3	1
CO4	Analyze the principles of Over The Top regulation as applicable to digital firms in different countries	PO3, PO4	U, Ap, E	F,C,P	9	3
CO5	Understand the application of privacy and ethical principles as applicable to digital firms across countries	PO3, PO4	U, Ap, E	F,C,P	9	3
CO6	Understand the principles of intellectual property rights and the corresponding regulations in different countries	PO3, PO4	U, Ap, E	F,C,P	3	1
CO7	Understand the properties and functioning of digital currencies and the corresponding regulatory approaches governing the same	PO3, PO4	U, Ap, E	F,C,P	3	1
	Total				**45**	**15**

Legend: *<u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs</u>): Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)



Course Content

Telecommunications Regulation

1. Theory and principles of regulation
2. Regulatory institutions and processes
3. Competition regulation: monopoly and oligopoly structures, market dominance, antitrust
4. Price regulation: ex-ante and ex-poste, tariff regulation: ceiling and floor; predatory pricing, tying
5. Interconnection regulation: mobile termination, international settlements

6. Universal service regulation: definition of universal service, universal service levies, funding options, types of schemes
7. Scarce resource regulation: spectrum allocation and assignment, pricing and methodology of assignment. Optimal use and flexible use of radio spectrum, spectrum fragmentation vs. consolidation
8. Open access regulation

Internet Policy and Regulation

1. Infrastructure Commons and Economics
2. Internet governance: multi-stake holder community model
3. Regulation and governance of Domain Name Systems
4. Quality of Service/ Experience regulation of data services
5. Net Neutrality Regulation
6. Cyber and Information security policies
7. Content regulation: Digital TV, Internet

Regulation of the App Economy

1. Over-The-Top services and the associated “light touch” regulation
2. E-Commerce taxonomy: Associated regulations
3. Sharing and Peer-to-Peer economy and associated regulations
4. Regulatory arbitrage versus social benefits
5. Implications for tax, investment, privacy, and labour policies
6. Policies on start-ups across countries and best practices
7. Privacy and data protection principles and associated regulation
8. General Data Protection Regulation of the European Union, Indian Personal Data Protection Bill and their impacts
9. Artificial Intelligence and Machine Language: Ethics and Standards

Intellectual Property Laws and Regulation

1. Intellectual Property Rights: patents, copyright, trademark. Trade secret, domain names
2. Cross licensing, pooling, trolls
3. Standard Essential Patents and FRAND conditions
4. Patent Law: cross country comparison
5. Open source versus proprietary software

Digital Finance Regulation

1. Taxonomy of digital finance: Digital currency, wallets, Fintech, payment gateways, crypto currencies
2. Properties and functions of money: comparison of crypto currency and Gold against money
3. Regulatory issues in Crypto currencies

Instruction Schedule

Week	Topic
1	**Q1) Why regulation is required in the ICT sector? When, how and who will regulate?** Why regulate telecom and ICT markets? What is the need to regulate? – market structure, externalities, rival and excludability of goods and services; when to regulate? – ex-ante/ ex-poste How to regulate – licensing as a method; taxonomy of licenses; regulatory processes and institutions. **Readings:** Chapter -1: Why regulate the ICT sector? In Sridhar (2019).
2	**Q2) Why was that landline considered as a “natural monopoly”? How should natural monopolies be regulated?**

	Competition Regulation: taxonomy of markets, monopoly: super normal profits, landline as a natural monopoly, regulation of monopolies and oligopolies, cartelization and collusion, Network effects and associated market power, market power assessment, anti-trust regulation **Readings:** Section 1.2.7 "Competition Regulation" in Sridhar (2019). **Discussion paper:** **[1] Arnbak, J. (2000). Regulation for next-generation technologies and markets. Telecommunications Policy, 24(6-7), 477-487.**
3	**Price Regulation:** Price squeeze, predatory pricing, taxonomy of bundling, associated regulatory interventions. **Q3) Why are handsets and apps bundled in some markets? Can the regulation allow bundling?** **Readings:** Section 1.2.8 "Price Regulation" in Sridhar (2019). Chapter 2. "What is the effect of bundling in Telecom". In Sridhar (2019) **Discussion paper:** **[2] Telecom Regulatory Authority of India (TRAI). (2019). Consultation Paper on Tariff Issues of Telecom Services.**
4	**Universal Access Regulation**: Theories of universal access, universal service obligation fund and associated policies, method of funding universal access, BharathNet and its implications for rural broadband access, Open Access regulation and its implications **Q4) What are the methods to provide universal service?** **Readings:** Section 1.2.9 "Universal Service Regulation" in Sridhar (2019). **Discussion paper:** **[3] Preeti Mudliar. (2020). A Reality Check on India's Search for Digital Utopia**
5	**Interconnection Regulation:** taxonomy of interconnection charges**,** mobile termination charges: domestic and international, associated regulations, international settlement charges, effect of Over The Top (OTT) apps on termination charges, **Q5) How should International Termination Charges (ITC) be regulated and what are the effects of the same? Should the Mobile Termination Charges be regulated in view of emerging Internet Telephony type services being offered?** **Readings** Chapter 3 on "Interconnection Regulation" in Sridhar (2019). **Discussion video:** **[4] Discussion on recent reduction in Mobile Termination Charges by TRAI: Interview with Former Chairman of TRAI, Dr. R.S. Sharma, Available at:** **https://www.youtube.com/watch?v=AxORXXT8Ct0&t=864s**
6-7	**Spectrum Regulation:** rival/non-rival, excludable/ non-excludable nature of licensed and unlicensed spectrum, India's spectrum policies, liberalized and un-liberalized spectrum, property rights management: spectrum trading, sharing, and leasing **Q6) What should be the policy makers' approach to scarce resource allocation (such as radio spectrum assignment for mobile services)?**

	Readings Chapter 4 on "Spectrum Regulation" in Sridhar (2019). **Discussion paper:** [3] **Discussion on 5G spectrum allocation in India & Indonesia**
8	**Regulatory Impact Assessment**: The framework for RIA; example cases
9	**Internet policy and regulation:** infrastructure commons and public good nature of Internet, domain name and IP system governance and regulation, Internet governance: from US to global stakeholder community, Internationalized Domain Names (IDNs) **Q8) Who governs the Internet? Is the new form of multi-stakeholder model of Internet governance encourage plurality of views or increase administrative and bureaucratic overhead?** **Readings:** Sridhar, V. (2019). Chapter 6: Who Governs the Internet. In Emerging ICT Polices and Regulations: Roadmap to Digital EconomiesDiscussion Paper: **Discussion paper:** **[6] Internationalized Domain Names. Chapter 6.6 of Sridhar (2019).**
10	**Net Neutrality Regulation:** Taxonomy of Net Neutrality, cases on Net Neutrality, Voice over IP **Q9) What are the nuances of Net Neutrality? What should be the regulatory directives when Net Neutrality rules are breached?** **Readings:** Sridhar, V. (2019). Chapter 7: What are the nuances of Net Neutrality? **Discussion paper:** **[7] Sridhar, V. (February 2019). Net Neutrality: Contradicting postures in the U.S. and India. CUTS International Washington DC Centre Policy Note #8.**
11	**Regulation of OTT communication and broadcasting services**: Definition and Characteristics of OTT services, Taxonomy of OTT services, substitutability with TSP and broadcast services, Regulatory issues – emergency services, Unsolicited Commercial Communication, universal service obligation, mandatory channel provisioning in broadcasting **Q10) Should OTT services be regulated? Should there be level playing field between telecom operators and OTT service providers?** **Readings:** Sridhar, V. (2019). Chapter 11. Over The Top (OTT) Services – Should they be regulated much like Telecom Services? **Discussion Papers** [8] Australia New Media Act: https://www.cnbc.com/2021/02/25/australia-passes-its-news-media-bargaining-code.html
12	**Regulation of Digital Platforms**: Taxonomy of digital platforms, characteristics of two-sided markets, regulatory issues in digital two-sided platforms, use cases from: transportation, and e-commerce **Readings:**

	Sridhar, V. Chapter 10. Should digital platforms be regulated? If so, why? **Discussion Papers** [9] How home sharing platforms such as Airbnb are doing self-regulation in Covid times?
13-15	**Privacy Laws and Regulations:** Taxonomy of privacy, cases of privacy violations, associated laws and regulations, global data protection acts, General Data Protection Regulation, implications for OTTs, national identities and associated privacy regulations **Q) What is the trade-off between convenience and privacy? Should regulators intervene or leave it to parties to decide?** **Readings:** **Daniel J. Solove, A Taxonomy of Privacy, 154 U. Pa. L. Rev. 477 (2006).** **Sridhar, V. Chapter 12. What are the privacy issues over data collected by the Internet and telecom firms?** **Discussion Papers:** **[10] Kalman, L. (2019). New European data privacy and cyber security laws: one year later. Communications of the ACM, 62(4), 38-38.**
13-15	**Artificial Intelligence and Machine Language: Impact on public policy:** **Q) Should AI/ML based technology services be regulated? What are the trade-offs between innovation and ethics?** AI for all principles, Challenges in adopting Autonomous systems, Trustworthy AI, Ethical principles for building AI systems, Standardization efforts, Public policy and regulatory challenges in the context of AI and autonomous systems **Discussion Paper:** **[14] Monroe, D. (2018). AI, explain yourself. Communications of the ACM, 61(11), 11-13.**
13-15	**IP laws and regulation:** patents, copyrights, copylefts, trademarks, trade secrets, patent filing and administration of patents, patent trolls, litigation, NPEs, patent cross licensing, software patents, Standard Essential Patents and FRAND, design and utility patents, cases in software patents and arbitrations, Copyrights of APIs **Q) Should the IP Policies encourage patenting? How can market power of patent holder be regulated? Should software programs to be allowed to be patented? What should be the policies regarding SEPs?** **Readings:** **Readings**: Sridhar (2019). Chapter 5: Intellectual Property or Creative Commons? **Discussion Paper:** **[11] Samuelson, P. (2019). API copyrights revisited. Communications of the ACM, 62(7), 20-22.**
13-15	**Digital Finance regulation:** **Q) Should digital currencies be regulated? What is the regulatory trade-offs between digital finance and financial security and liability?** taxonomy of digital finance, monetary policies and digital cash economy, crypto currencies and associated policies, Bitcoin exchanges **Discussion papers:** **[12] Kirkpatrick, K. (2019). Regulating information technology.Communications of the ACM. 62(12). 19-21.**

	[13] Prayogo, G. (2018). Bitcoin, regulation and the importance of national legal reform. Asian Journal of Law and Jurisprudence, 1(1), 1-9.
13-15	**Cyber Security Regulation:** **Q) What are cyber crime? How should laws and regulations be framed to prevent cyber crime and terrorism?** Taxonomy of cyber crime and cyber terrorism, different clauses of IT Act 2000, International treaties for cyber terrorism

Learning Resources

Text Book

Sridhar, V. (2019). Emerging ICT Polices and Regulations: Roadmap to Digital Economies. Springer Nature.

Reference Books

1. **[VS]** Sridhar, V. (2012). Telecom Revolution in India: Technology, Regulation and Policy. New Delhi, India: Oxford University Press, ISBN-13: 978-0-19-807553-0; ISBN-10: 0-19-807553-7.
2. **[PS]** Prasad, R., and Sridhar, V. (2014). The Dynamics of Spectrum Management: Legacy, Technology, and Economics. Oxford University Press, ISBN-13: 978-0-19-809978-9; ISBN-10: 0-19-809978-9.
3. **[NW]** Nuechterlein, J., & Weiser, P. (2005). "Digital Crossroads". Cambridge, MA: MIT Press.
4. **[LP]** Lehr, W.H., and Pupillo, L.M. (2009). Internet Policy and Economics: Challenges and Perspectives (Edited), Springer, ISBN: 978-1-4419-0037-1.
5. **[LM]** Liebowitz, S.J., and Margolis, S.E. (1999). Winners, Losers & Microsoft: Competition and Antitrust in High Technology, ISBN: 0-945999-80-1.
6. **[VHV]** Viscusi, W.K., Harrington, J.E., and Vernon, J.M. (2005). Economics of Regulation and Antitrust. MIT Press. ISBN: 0-262-22075-X.
7. **[GP]** Guellec, D., and Potterie, B. (2012). The Economics of the European Patent System. Oxford University Press. ISBN: 978-0-19-929206-6.
8. **[Infodev]** Telecommunications Regulation Handbook. (Ed.) Colin Blackman and Lara Srivastava.
9. **[CDL]** Chuen, David Lee. (2015). Handbook of Digital Currency. Academic Press.
10. Selected papers from Communications of the CACM, Review of Network Economics, and Telecommunications Policy will be given for class discussions.

Assessment Plan

Component	Marks
In-class attendance and off-line video viewing >90%: 10%; 85-90%: 7.5%; 80-85%: 5%; 75-80%-2.5%; <75%: 0%	10%
Discussion Paper Presentation	20% (2×10%)
Quizzes	15% (3 × 5%)
Group Project: Regulatory Impact Assessment Interim deliverable: 5% Final deliverable: 10%	15%
Mid Term Exam	20%
End Term Exam	20%

Total	100%

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
1	**Discussion Papers** presented by groups of students to help anchor the concepts more firmly, student groups will be assigned papers of contemporary regulatory issues. Groups will present a critical review of the issues discussed in the paper	PO3, PO5
2	Groups of students work on a **regulatory problem and propose a Regulatory Impact Assessment**.	PO3, PO5

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

1. Automatic evaluation of MCQ quizzes on Moodle or other online platforms
2. Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not Applicable

Make-up Exam/Submission Policy

One make-up quiz is given to accommodate anyone who missed one of the quizzes due to unavoidable circumstances. There are no make-ups for mid or end term exams.

Citation Policy for Papers (if applicable)

Not Applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	SM-102, MATH-II		
Course Instructor Name(s)	Prof. Manisha Kulkarni		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3 :1 : 0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		NA

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	Yes	Develops Analytical thinking,
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Learn to write proofs by using proper argument, Communicate Mathematical interpretation in proper language.

Course Context and Overview

This is a first course in linear algebra. The course will cover basic concepts and techniques of linear algebra, will develop theoretical results. Proofs and consequences of results will require the use of mathematical rigor and also geometry. The course will provide insight into how linear algebra theorems and results are used in everyday life.

At the end of the course I expect students to know the following:

- Solve systems of linear equations and understand of the nature of the solutions.
- Demonstrate matrix representation of linear operator and understand that one can get all information about linear operator through study of matrices.
- Perform calculations with vectors, eigenvalues and eigenvectors in "n" dimensions.
- demonstrate an understanding of orthogonality and projection in arbitrary dimensions.
- Familiarity with ordinary differential equations which is necessary for Physics course.

Perform calculations involving Finite fields and use them comfortably in other courses.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand Properties of and Operations on Matrices	PO1	U	C, P	5	2
CO2	Solve a given system of linear equations AX = B by using RREF of Matrices and Gauss-Jordan Method	PO1	Ap	C, P	6	2
CO3	Compute orthonormal basis of vector spaces using Gram-Schmidt Process, and coordinates of elements of vector space with respect to a given basis.	PO1	Ap	C, P	7	3

CO4	Determine Matrix Representation of a linear transformation	PO1	Ap	C, P	6	2
CO5	Diagonalize a given matrix using eigen value and eigen vectors	PO1	Ap	C, P	6	2
CO6	Determine the diagonalisability of a given linear operator using the spectral theorem	PO1	Ap	C, P	7	2
CO7	Solve linear ordinary 1st order Differential equations	PO1	Ap	C, P	4	1
CO8	Determine Orthogonal trajectories and approximate solutions using Picard's Theorem for IVP.	PO1	Ap	C, P	4	1
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Topic 1. Matrices

- Matrix operations,
- type of matrices,
- Inverse of Matrices,
- RREF,
- Rank of matrix.

Topic 2. System of Linear equations

- Solutions of the system AX=B
- Existence of solutions of the system
- Relation between rank and solutions of AX=0

Topic 3. Vector Spaces

- Basis and dimension,
- Coordinates with respect to a basis,
- Column space, Row space
- Complementary Subspaces,
- Standard inner product, Norm,
- Gram-Schmidt Orthogonalization

Topic 4. Linear Transformations

- Image of a basis identifies the linear transformation,
- Range Space and Rank, Null Space and Nullity,
- Matrix Representation of a linear transformation.

Topic 5. Eigen Values and Eigen Vectors

- Eigenvalues and eigenvectors of a linear operator,
- Properties of eigenvalues and eigenvectors,
- Characteristic Equation,
- Diagonalisability of a linear operator,
- Spectral theorem for Normal operators

Topic 6. Ordinary Differential Equations

- Introduction and Motivation to Differential Equations
- Geometrical interpretation of solution,
- Orthogonal trajectories,
- Picard's Theorem for IVP
- Euler's Method, Improved Euler's Method.

Instruction Schedule

Lecture 1, 2, 3: Matrices, Matrix Operations (Addition, Scalar Multiplication, Multiplication, Transpose, Adjoint) and their properties; Special types of matrices (null, Identity, Diagonal, Triangular, Symmetric, Skew-Symmetric, Hermitian, Skew-Hermitian, Orthogonal, Unitary, Normal), Solution of the matrix equation Ax=b, Row-reduced Echelon form, Rank of matrix

Lecture 4, 5, 6, 7 Linear system of equations, Structure of the solutions of the matrix equation Ax=b and AX= 0, Finding solutions using Gauss- Jordan elimination method, relation between rank and Number of solutions

Lecture 8, 9, 10, 11,12: Vector Spaces, Basis and dimension, Coordinates with respect to a basis, Column space, Row space, Complementary Subspaces, Standard inner product, Norm, Gram-Schmidt Orthogonalization.

Lecture 13 14, 15, 16 Linear Transformations, Matrix representation of linear transformations, Rank-Nullity theorem, range space, null space, relations between two matrix representations of same linear transformation.

Lecture 17, 18, 19, 20 : Eigenvalues and Eigenvectors of a linear operator, Properties of eigenvalues and eigenvectors, Characteristic Equation, Similar Matrices, Condition for Diagonalisability of matrix, Schur's Lemma, Spectral theorem for Normal operators.

Lecture 21, 22, 23, 24: Introduction and Motivation to **Differential Equations**, First Order ODE, Geometrical interpretation of solution, Equations reducible to separable form, Exact Equations, integrating factor, Linear Equations, Orthogonal trajectories, Picard's Theorem for IVP (without proof) and Picard's iteration method.

Learning Resources

- Linear Algebra by K. Hoffman and R. Kunz, Prentice-Hall, 1971.
- Algebra, written by Artin,
- Modern Algebra by Herstain
- Linear Algebra and its applications by Gilbert Strang, Nelson Engineering, 2007.

- Finite Dimensional Vector Spaces by P. R. Halmos, Princeton University Press.
- Linear algebra by Helson, Holden-day, 1990.
- Lectures on Abstract Algebra, volumes by N. Jacobson, Springer.

Assessment Plan

Final grade will be based on weights given below:
20%: Quizzes
40%: Mid-Term Exam
40%: End-Term Exam

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	**Quiz- 1**	CO1, CO2
2	**Mid-Term**	CO1, CO2,CO3
3	**Quiz-2**	CO4,
4	**Quiz-3**	CO5, CO6
5	**End-term**	CO4, CO5, CO6, CO7, Co8
6	**Assignment – 1:** Operations on Matrices	CO1
7	**Assignment – 2:** RREF of Matrix and AX=0	CO1, CO2
8	**Assignment – 3:** System of linear equations	CO2
9	**Assignment – 4:** Solutions of AX=b and AX=0$, Vector Spaces	CO2,CO3
10	**Assignment – 5:** Basis of subspaces, vector spaces	CO2, CO3
11	**Assignment – 6:** Null space, row space, column space	CO3
12	**Assignment – 7:** Linear Transformation, Rank and Nullity	CO4
13	**Assignment – 8:** Orthogonal vectors and Orthogonal complements	CO3
14	**Assignment – 9:** QR- decomposition of Matrix	CO3,CO4
15	**Assignment – 10:** Eigen Values and Eigen vectors	CO5, CO6
16	**Assignment – 11:** Characteristic polynomial and diagonalization	CO6
17	**Assignment – 12:** Ordinary differential equations	CO7,CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Manual evaluation of descriptive questions

- Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission
NA

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

*[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "*Not applicable*" if section is not applicable to the course]*

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	SM202/Maths 4	
Course Instructor Name(s)	Dr. Amit Chattopadhyay	
Credits (L:T:P) **(Lecture: Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	X	4-point scale (A, A-, B+, B, B-, C+, C, D, F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* Maths 1, Maths 2 and Maths 3 (understanding of Calculus and Linear Algebra)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	The course helps in developing basic skills for Data Analysis and Machine Learning
Focus on skill development	Yes	The course focuses on foundational mathematical skill development required for other core subjects in CSE and ECE.
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

The aim of this course is to provide students with the foundations of (1) probabilistic and statistical analysis and (2) complex analysis used in varied applications in engineering and science. The first part of this course concentrates on the fundamentals of probability and statistics, event spaces, and random variables. Density and distribution functions for single and multivariate random variables, expectation, variance, and covariance, the binomial, uniform, Poisson, exponential, and normal distributions, gamma beta, limit theorems, sampling distributions, understanding point and interval estimations of population parameters.

The second part of this course focuses on complex analysis. This part covers complex numbers and functions, analytic functions, Cauchy-Riemann equations, contour integrals, Cauchy theorem, Taylor's and Laurent's series, singularities, poles and Residue theorem.

Students will be given periodic problem sets which encourage them to think through concepts of the course.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Compute probabilities of events using the basic principles of probability theory.	PO1	Ap	C, P	6	2

CO2	Compute properties of discrete and continuous (single and multi-dimensional) random variables for well-known distributions, including Binomial, Poisson, Uniform, Normal, Beta1, Beta2, Gamma and Cauchy, and for transformations.	PO1	Ap	C, P	6	2
CO3	Compute expectations for single and multi-dimensional distributions, mean, variance, moments, covariance, correlation coefficients, moment generating functions, characteristic functions, regression curves, and reproductive properties of Binomial, Poisson, Normal and Gamma distributions.	PO1	Ap	C, P	6	2
CO4	Understand limit theorems for a sequence of random variables, including central limit theorem, limit theorem of characteristic functions and DeMoivre-Laplace limit theorem.	PO1	U	C, P	3	1
CO5	Compute the point and interval estimation of population parameters using sample data.	PO1	Ap	C, P	3	1
CO6	Understand the properties and geometrical interpretation of complex numbers.	PO1	U	C, P	3	1
CO7	Determine analytic functions using Cauchy-Riemann Equations.	PO1	Ap	C, P	6	2
CO8	Compute contour integral using Cauchy integral formula.	PO1	Ap	C, P	3	1
CO9	Compute real and improper integrals using Residue theorem.	PO1	Ap	C, P	9	3
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Probability and Statistics:

- **The Concept of Probability:** Random Experiments, Events, Mutually Exclusive Events, Exhaustive Set of Events, Statistical Regularity, Classical and Frequency Definitions and Drawbacks.
  The Axiomatic Construction: Axiomatic Definition and Deductions, Conditional Probability, Multiplication Rule, Bayes' Theorem, Independence of Events, Pairwise and Mutual Independence.
  Compound or Joint Experiment: Independence of Random Experiments, Independent Trials, Bernoulli Trials, Binomial Law, Multinomial Law, Poisson Trials.

- **Probability Distributions:** Single and two-dimensional and Random Variables, Discrete Distribution-*p.m.f.*, Binomial, Poisson, Geometric Distributions; Continuous Distribution-*p.d.f.*, uniform, normal, Cauchy, Gamma, Beta1, Beta2 distributions; Conditional Distributions, Transformation of continuous random variables in two dimensions.

- **Mathematical Expectation:** Expectation of a Continuous Function of a Single and Two-dimensional Random Variable. Properties: Mean, Variance, SD, Moments, Skewness, & Kurtosis of a Distribution; Moment Generating Function, Characteristic Function; Median, Quartiles and Mode. Covariance and Correlation Coefficients, Conditional Expectations-Regression Curves, Principle of Least Squares-Regression Lines, Reproductive Property.

- **Convergence of a Sequence of Random Variables and Limit Theorems:** Convergence in Probability and Convergence in Distribution, Tchebycheff's Inequality and Theorem, Bernoulli's Theorem, Law of Large Numbers. Asymptotically Normal Distribution, Limit Theorem for Characteristic Functions, Central Limit Theorem, DeMoivre Laplace Limit Theorem. **Some Important Continuous Distributions:** Chi-square, *t*- and *F*-Distributions.

- **Random Samples:** Populations and samples, statistics; Distribution of the Sample; Sample Characteristics - Sample Mean, Sample Variance, Moments, Mode, Median, Quartiles, Coefficient of Skewness, Coefficient of Kurtosis.
  Sampling Distributions: Sampling distributions– sample mean, sample variance and other important statistics.

- **Estimation of Parameters:** Point Estimation – Consistency, Unbiasedness, Minimum Variance; MLE; Interval Estimates, Approximate Confidence Interval for the Mean of a Bernoulli Random Variable.

Complex Analysis:

- **Complex Numbers:** Complex numbers, properties, Geometrical representation of complex numbers, powers and roots of complex numbers.
- **Complex Functions:** Functions of complex variables, Analytic Functions, Cauchy-Riemann Equations and Problems, Elementary Functions.
- **Contour Integration:** Contours, Contour Integration, Cauchy theorem, Cauchy Integral Formula.

- **Complex Series:** Power Series, Term by term differentiation, Taylor Series, Laurent Series, Zeros, Singularities, Poles, Essential Singularities, Residue theorem, Evaluation of Integrals.

Instruction Schedule

[Provide session-wise schedule]

Section/Topic	Week	CO Mapping
The Concept of Probability, The Axiomatic Construction, Compound or Joint Experiment	Week 1, Week 2	CO1
Probability Distributions	Week 3, Week 4	CO2
Mathematical Expectation	Week 5, Week 6	CO3
Convergence of a Sequence of Random Variables and Limit Theorems	Week 7	CO4
Random Samples, Sampling Distributions	Week 7	CO4
Estimation of Parameters	Week 8	CO5
Complex Numbers	Week 9	CO6
Complex Functions	Week 10, Week 11	CO7
Contour Integration	Week 12,	CO8
Complex Series	Week 13, Week 14, Week 15	CO9

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Text Books:
1. Introduction to Probability and Statistics for Engineers and Scientists, Sheldon M. Ross, Fourth Edition.
2. Sheldon Ross, "A first course in Probability", Eighth Edition, Prentice Hall.
3. Complex Analysis with Applications: Richard A. Silverman.

Reference Books:
4. John E. Freund's Mathematical Statistics with Applications, Eighth Edition, Miller and Miller.
5. Complex Analysis, by Ahlfors, McGraw Hill, 1979.
6. Complex Variables and Applications, by James Brown and Ruel Churchill, McGraw Hill, 2008.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Quiz1-20%, Midterm-25%, Quiz2-20%, Endterm-25%, Class participation-10%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	SM103/ Mathematics 1	
Course Instructor Name(s)	Amit Chattopadhyay, Pradeesha Ashok	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)*

Programme:

X	iMTech
	M.Tech
	M.Sc.
	CSE
	ECE
	Digital Society

Branch:

X	*CSE*
	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)* X — Basic Sciences CSE Core ECE Core CSE Branch Elective ECE Branch Elective Engineering Science and Skills HSS/M General
Course Pre-Requisites	*(Where applicable, state exact course code/name)*

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The course imparts mathematical rigour and provides a mathematical foundation for core Computer Science subjects.
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills	No	

Course Context and Overview

The objective of this course is to provide the students foundational skills of real analysis and calculus. Students will also learn to express mathematical statements using propositional logic, and write formal mathematical proofs. This course is a balance between writing mathematical proofs of theorems and applying theorems for solving problems.

Students learn and apply the concepts of convergence/divergence of sequences and series, continuity, differentiability and Riemann integrability of real-valued functions of single and multiple variables, improper integrations, partial derivatives, Jacobian, Taylor's theorem, minima-maxima and double and triple integrations.

The concepts covered in this course will further be applied in for future courses in Basic Science, CSE and ECE like Machine Learning and Optimization.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the method of formal mathematical proofs using logic	PO1	U	C	5	2
CO2	Determine the convergence/divergence of sequences and series using limit theorems.	PO1	Ap	C, P	6	2
CO3	Determine the continuity and the differentiability of a given function.	PO1	Ap	C, P	5	2
CO4	Find the derivative of a given function if it is differentiable.	PO1	Ap	C, P	6	2
CO5	Determine the Riemann integrability of a given class of functions.	PO1	Ap	C, P	3	1
CO6	Compute the integral of a given function using the fundamental theorem of integral calculus.	PO1	Ap	C, P	4	1
CO7	Compute improper integrations using Beta and Gamma functions	PO1	Ap	C, P	4	1
CO8	Compute partial derivatives, Jacobian, Taylor's series, and minima-maxima-saddles of functions of several variables.	PO1	Ap	C, P	6	2
CO9	Compute double and triple integrals using Fubini's rule and transformation of variables.	PO1	Ap	C, P	6	2
	Total Hours				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

- **Introduction to Logic:** Negation, Disjunction, Conjunction, Implication, Equivalence
  Proof Techniques,
  Introduction to Set Theory, Real Numbers.

- **Sequences and Series:** Limits, Limit Theorems, Infinite Series.
- **Continuous Functions:** Continuous Functions on Intervals, Monotone and Infinite Functions.
- **Differentiation:** The Derivative, The Mean Value Theorem, L'Hospital's Rules, Taylor's Theorem, Power Series, Critical points, Convexity.
- **The Riemann Integration:** Riemann Integration, Riemann Integrable Functions, The Fundamental Theorem.
- **Improper Integration:** Integration of Unbounded Functions over Bounded Intervals, Infinite Range of Integration, Beta and Gamma Functions.
- **Calculus of Several Variables:** Functions of Several Variables, Limits, Continuity, Partial Derivatives, Chain Rule, Tangent Planes and Differentials, Taylor's, Formula for Two Variables, Extreme Values and Saddle Points.
- **Parametric Equations and Polar Coordinates:** Space Coordinates, Lines and Planes, Polar Coordinates, Cylinders, Quadric Surfaces, Volume, Area, Length, Curve Tracing, Graphs of Polar Equations.
- **Multiple Integration:** Double, Triple Integrals (over Rectangular and General Regions), Jacobians, Application in Computing Area and Volume.

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

Mention textbooks, reference books and other learning resources required as part of the course

Text Books:

1. Sets, Functions, and Logic: An Introduction to Abstract Mathematics, by Keith Devlin, Third Edition (Chapman Hall/CRC Mathematics Series)
2. Introduction to Real Analysis by Robert G Bartle and Donald R Sherbet, Fourth Edition, Wiley India.
3. Mathematical Analysis by S.C. Malik and S. Arora (Fifth Edition).

Additional References:

4. Thomas Calculus by Maurice D Weir, Joel Hass and Frank R Giordano, Eleventh Edition, Pearson
5. Principles of Mathematical Analysis by Walter Rudin, Third Edition, McGraw -Hill International
Editions
6. A Course of Mathematical Analysis by Shanti Narayan.

Assessment Plan

List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)

1. **Quiz 1:** 20%
2. **MidSem Exam:** 30%
3. **Quiz 2:** 20%
4. **Final Exam:** 30%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1		

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]
Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	AI 703: Geographic Information Systems (GIS)		
Course Instructor Name(s)	Prof. Uttam Kumar		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
X	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:* X iMTech X M.Tech X M.Sc. X CSE X ECE X Digital Society
Course Category	Select **one** from the following: *(Place X appropriately)* Basic Sciences CSE Core ECE Core X CSE Branch Elective ECE Branch Elective Engineering Science and Skills HSS/M General
Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The students taking the GIS course can be employed in academics, research organisations, NGOs, and industries focusing on research and developmental projects involving techniques for remote sensing applications including resource management, disaster mitigation, geospatial services, smart city projects, climate change, spatial database and geospatial software development.
Focus on skill development	Yes	The students develop necessary skills to understand and analyse real time small to large geo-spatial databases. They learn hands-on with GIS software, data types, data analysis strategies, algorithms and skills to generate possible results / scenarios with multi-criteria decision support system.
Focus on entrepreneurship	Yes	The students can work on real time projects focusing on development and maintenance of spatio-temporal database, application development, designing graphical user interface in the form of decision support system for small, medium and large enterprises through entrepreneurship/self-employability and start-ups.
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

This course will help students understand how to obtain and analyse geospatial datasets. It introduces principles, applications, trends and pertinent research issues in GIS, including remote sensing, cartography, global positioning systems (GPS) and geospatial data analysis. Hands-on experience in solving problems with spatial analysis are provided using GIS software (specifically open source tool sets).

Goal of the course:

- To introduce the fundamental concepts of GIS, remote sensing, spatial data types, data entry and preparation, data processing systems, determining and mapping positions and maps.

- To understand the fundamentals of spatial data analysis.
- To learn basics of digital image processing and geospatial data visualisation techniques.

At the end of the course, the students should have knowledge and competencies in the following areas:

- Understand the principles of GIS.
- Understand remote sensing, sensors and platforms, panchromatic, multispectral and hyperspectral data.
- Image enhancement, interpretation and visualisation.
- Knowledge of digital image classification.
- Application of machine learning and deep learning in geospatial data analysis.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand the introductory concepts of GIS, purpose of GIS, spatial data and geoinformation, spatial database, spatial data mining, applications of GIS and GIS project ideas.	PO1, PSO2, PSO3	U	F, C	9	0
CO2	Understand the geographic information and spatial data types – geographic fields and objects, boundaries, tessellations, raster and vector data, scale, resolution and temporal dimension.	PO1, PSO2	U	F, C	6	0
CO3	Understand remote sensing, frequencies, wavelength, spectral bands and their features, remote sensing satellites and their characteristics.	PO1, PSO2	U	F, C	6	0
CO4	Understand geometric correction aspects, image enhancement and visualisation, image interpretation and image classification.	PO1, PSO2	U	F, C, P	6	0
CO5	Understand data processing systems and mapping positions – stages of spatial data handling, GIS and DBMS, data quality, accuracy and precision, latitude and longitude, spatial referencing, datums, from model to maps, map projections, measures of error, satellite based positioning - global positioning system (GPS) and differential GPS (DGPS).	PO1, PSO2	U	F, C, P	6	0
CO6	Understand spatial data analysis - data acquisition and preparation, advanced operations on continuous raster fields, classification and clustering of spatial data, automatic extraction of features, pattern analysis, data visualization, recent advances in GIS analytics and case studies.	PO1, PSO2, PSO3	U	F, C, P	5	0
CO7	Implement spatial database creation, data preparation, data analysis and results visualisation in GRASS GIS.	PO1, PO7, PSO2,	Ap, An	C, P	0	4

		PSO4				
CO8	Implement spatial data preparation, data analysis, and GIS application using QGIS.	PO1, PO7, PSO2, PSO4	Ap, An	C, P	0	3

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Introduction to GIS: What is GIS? Purpose of GIS, spatial data and geoinformation, spatial database, spatial data mining, applications of GIS.

2. Geographic Information and Spatial Data Types: Geographic fields and objects, boundaries, tessellations, raster and vector data, scale, resolution and temporal dimension.

3. Introduction to Remote Sensing: Remote sensing, frequencies, wavelength, spectral bands and their features, remote sensing satellites and their characteristics.

4. Introduction to Open Source GIS Packages: Demo / hands-on experience of using open source vector GIS (QGIS) and raster data analysis tools (GRASS GIS).

5. Data Processing Systems and Mapping Positions: Stages of spatial data handling, GIS and DBMS, data quality, accuracy and precision, latitude and longitude, spatial referencing, datums, from model to maps, map projections, measures of error, satellite based positioning - global positioning system (GPS) and differential GPS (DGPS).

6. Spatial Data Analysis: Data acquisition and preparation, advanced operations on continuous raster fields, classification and clustering of spatial data, automatic extraction of features, pattern analysis, data visualization, recent advances in GIS analytics and case studies.

Instruction Schedule

[Provide session-wise schedule]

Session 1 – Introduction to GIS: Definition of GIS, spatial data, modelling, maps, spatial databases.

Session 2 – Geographic Information and Spatial Data Types: Geographic phenomenon, fields, objects, boundaries, regular and irregular tessellations, vector, topology and spatial relationships, scale and resolution, temporal dimension.

Session 3 – Data Processing System: Hardware and software trends, stages of spatial data handling, database management system.

Session 4 – Determining and Mapping Positions: Data quality, spatial referencing, satellite-based positioning.

Session 5 – Data Entry and Preparation: Spatial data input, data preparation, point data transformation, advanced operations, applications.

Session 6 – Introduction to Remote Sensing: Electromagnetic energy, sensors and platforms, active and passive sensors, spectral reflectance curve, geometric correction, image enhancement, interpretation and visualisation, image classification.

Learning Resources

[Mention textbooks, reference books and other learning resources required as part of the course]

1. Class slides and current Literatures.
2. Encyclopedia of GIS, Shashi Shekhar, Hui Xiong, Xun Zhou, Springer International Publishing, 2nd Edition, 2017, ISBN 978-3 319-17884-8
3. Lillesand, T.M., and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley & Sons, Inc., New York, 2000.
4. Richards, J. A., and Jia, X., Remote Sensing Digital Image Analysis, Springer-Verlag: Berlin, 2006.
5. Schowengerdt, R. A., Remote Sensing: Models and Methods for Image Processing (2nd Ed), Academic Press, San Diego, CA, USA, 1997.
6. Jensen, J. R., Digital change detection. Introductory digital image processing: A remote sensing perspective, Prentice-Hall: New Jersey, 2004.
7. Russ, J. C., The image processing handbook, Second Edition, London, CRC Press, 1995.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- 30%: Mid-term Exam
- 30%: End-term Exam
- 40%: Course Project

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	To understand and have a working knowledge of the concepts, analysis, methods and applications of GIS and remote sensing data in solving real world problems with hands-on experience.	CO6

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

All deadlines are due on the date and time indicated in LMS. The penalties for late submission are as follows:

- > 4 and < 24 hours late submission: 25% penalty
- > 24 and < 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy.

Citation Policy for Papers (if applicable)

[If the course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable.

Academic Dishonesty/Plagiarism

As per institute policy.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy.

Course Syllabus

Course Code / Course Name	AI 825 / Visual Recognition		
Course Instructor Name(s)	Prof. Dinesh Jayagopi, Prof. G. Viswanath		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (3hr = 3 credit)	
	1	Tutorial (1hr = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	
Area of Specialization (if applicable) *(Choose by placing X in box against not more than two areas from the list)*			

	Theory and Systems for Computing and Data			Networking and Communication
X	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:* X iMTech X M.Tech M.Sc. X CSE X ECE Digital Society
Course Category	Select **<u>one</u>** from the following: *(Place X appropriately)* Basic Sciences CSE Core ECE Core X CSE Branch Elective ECE Branch Elective Engineering Science and Skills HSS/M General
Course Pre-Requisites	Mathematics for Machine Learning, Machine Learning

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Practical knowledge in training vision based machine learning models is handled
Focus on skill development	Yes	Focus on pytorch based ML model training skills.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

This course involves methods to automate human visual recognition capabilities using computational techniques. The course focuses on design of systems performing fundamental visual recognition tasks like Image Classification, Object Recognition, Image captioning and Image Segmentation, primarily using deep-learning methods. The course will introduce both theory and practice of various visual recognition techniques covering both the mathematical foundations as well as various practice level considerations.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand Edge detection and basic image segmentation	PO4	U	F, C	8	0
CO2	Apply edge detection and basic image segmentation on real problems	PO4	Ap	C, P	8	0
CO3	Understand CNN and apply for object recognition and detection	PO4	U	F, C	8	0
CO4	Apply object recognition and detection on real problems	PO4	Ap	C, P	8	0
CO5	Understand theory of Recurrent Neural Networks and LSTMs	PO4	U	F, C	4	2

CO6	Solve sequence modeling problems using RNNs and LSTMs	PO4	Ap	C, P	6	2
CO7	Understand un-supervised, semi-supervised and supervised segmentation techniques	PO4	U	F, C	4	2
CO8	Solve image segmentation problem using combination of un-supervised, semi-supervised and supervised methods	PO4	Ap	C, P	6	2

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1 (Traditional Visual Recognition)

Edges, Segmentation, Interest points, Bag-of-visual words, VLAD

Module 2 (Convolutional Neural Networks)

CNN as a special case of NN, Object recognition using several CNN architectures, Object detection using CNN

Module 3 (Sequence Modeling)

Recurrent Neural Networks and Applications, LSTMs & GRUs, Word Embeddings, Image Captioning Using LSTMs

Module 4 (Segmentation)

Graph Cut Based semi-supervised segmentation - Unsupervised Segmentation (SLIC, Graph method, Spectral Clustering)- Semantic Segmentation using CNNs- Mask RCNN based Instance Segmentation.

Instruction Schedule

Learning Resources

Assessment Plan

Module1 & Module 2:
Assignment 1 : 10 Marks
Assignment 2 : 10 Marks
Assignment 3 : 10 Marks
Mini Project 1 : 20 Marks

Module3 & Module 4:

Assignment 4 : 15 Marks
Mini Project 2 : 15 Marks
Assignment 5 : 15 Marks

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Assignment 1	CO1, CO2
2	Assignment 2	CO1, CO2
3	Assignment 3	CO3, CO4
4	Mini project 1	CO3, CO4
5	Assignment 4	CO5
6	Mini Project 2	CO6
7	Assignment 5	CO7, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)
[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs
[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	CS 513 Software Systems - Enterprise Software Development		
Course Instructor Name(s)	Chandrashekar Ramanathan		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	2	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 2:0:0	**Total Credits = 2**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
X	M.Tech
X	M.Sc.
X	CSE
X	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The course focuses on full-stack application development. This approach to software development is followed extensively by the industry and hence enhances employability.
Focus on skill development	Yes	This course provides skills in Javascript, SQL, Twitter Bootstrap, jQuery, REST, AngularJS
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

Two major components of CS513 Software Systems are a) System Software and b) Enterprise Software Development. The "System Software" module covers the rudiments of Operating Systems. This module is on Enterprise Software Development. As part of this module, students will get to understand what Enterprise Software is and how it is different from other software. The course will give exposure to the students to different architectural considerations for addressing the complexities associated with Enterprise Software. The course provides an in-depth insight into three-tier architecture and the software programming elements of developing software applications using three-tier architecture. At the end of this course, students are expected to have sufficient proficiency and skills in implementing the front-end, middleware and backend components of enterprise software.

Course Outcomes and Competencies

[Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Differentiate between design and architecture	P03	U	C	3	
CO2	Explain the different options for implementing services in service-oriented-architecture	PO3	U	C	3	
CO3	Define all the terms in the terminology associated with object-oriented programming	P03	R	F	2	
CO4	Design components of n-tier architecture for a given application requirements	P03	Ap	P	2	

CO5	Design and implement relational database schema using conceptual modeling	P03	Ap	P	5	
CO6	Design web application for a given n-tier architecture	PO1, P03	Ap	P	5	
CO7	Explain different components of mobile application development	P03	U	C	2	
CO8	Develop specific web application front end using Javascript, Twitter Bootstrap, jQuery, REST, AngularJS for solving specific problems.	PO1, P03	Ap	P	4	
CO9	Develop web application backed using REST services and SQL	PO1, PO3	Ap	P	4	
CO10						

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide topic-wise list]

Topic 1: Fundamentals of Object-oriented Analysis and Design
- Design vs Architecture
- OO concepts
- Unified Modeling Language (UML)

Topic 2: Software Architectures
- Understanding large scale systems – n-Tier architectures.
- Understanding quality attributes of architectures

Topic 3: Database application development
- Database Design through Conceptual Modeling
- Database Implementation through SQL
- Database Programming through Hibernate

Topic 4: Web application development
- MVC for Web - Twitter Bootstrap (rendering view), jQuery, Ajax (from jQuery) and servlets (controller), REST service, back-end model - MySql, Java programming and concepts of key value pair (like mongo DB – implemented using MySql)

Topic 5: Mobile application development
- Connectivity, security, online/offline modes, integration of sensors, location services, responsiveness.
- AngularJS and related frameworks

Instruction Schedule

[Provide session-wise schedule]

S. No.	Date	Topic
1	Session 1	Introduction
2	Session 2	Handson - Environment setup
3	Session 3	Enterprise Software Elements
4	Session 4	Database Design
5	Session 5	Handson - Frontend development
6	Session 6	HOLIDAY
7	Session 7	OR Mapping
8	Session 8	Handson - SQL
9	Session 9	N-Tier Architecture
10	Session 10	Handson - OR Mapping with hibernate
11	Session 11	Service Oriented Architecture
12	Session 12	Handson - REST services
13	Session 13	Deployment Architecture
14	Session 14	Software Testing
15	Session 15	Handson - Full-stack Integration
16	Session 16	Handson - Basic Devops

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Software Architecture in Practice by Bass and Clements, Addison Wesley.
2. Ajax - https://www.youtube.com/watch?v=f46WEeM8HTA
3. REST Services - https://www.youtube.com/watch?v=xkKcdK1u95s
4. Jquery Tutorial - https://www.youtube.com/watch?v=8mwKq7_JlS8

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

25%: Tests / assignments
40%: Project
35%: End-Term Exam

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Database Design using Conceptual Modeling	CO5

2	Develop a web application use the principles of full-stack software development	C04, C05, CO6, CO8
3	Write a program to implement CRUD operations using JDBC	C05
4	Write a program to implement CRUD operations using Hibernate	C05

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Late submission will be handled as noted in the respective assignment problem statements.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	CS 604: Artificial Intelligence	
Course Instructor Name(s)	Shrisha Rao	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
X	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: Branch:

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

CS 302: Introduction to Automata Theory and Computability and other CS core courses, with a grade of B or better.

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	NO	
Focus on skill development	NO	
Focus on entrepreneurship	NO	
Provides value added / life skills (language, writing, communication, etc.)	YES	This course teaches students how to do cutting-edge academic research and gain an international-standard research profile.

Course Context and Overview

[*Provide introduction to the course*]

This is a *seminar* course in artificial intelligence, with students expected to do a lot of independent reading and presentations in class. There are no conventional lectures, assignments, or examinations, but a student is required to complete a research project and to write a paper on a chosen topic. There is no specific textbook.

This course has typically been preferred by students who wish to carry out high-quality research and get a start on a publication record that puts them on a solid footing for admission to quality PhD programs and a future research career. Papers written by former students have been accepted in well-known research conferences and journals.

The following are some of the published papers that arose out of work done in this course:

- Sheril Lawrence, Aishwarya Yandapalli, Shrisha Rao. *Matrix Multiplication by Neuromorphic Computing*. Neurocomputing, vol. 431, March 2021, pp. 179–187. doi:10.1016/j.neucom.2020.10.064.
- Aditya Hegde, Vibhav Agarwal, Shrisha Rao. *Ethics, Prosperity, and Society: Moral Evaluation Using Virtue Ethics and Utilitarianism*. 29th International Joint Conference on Artificial Intelligence, and the 17th Pacific Rim International Conference on Artificial Intelligence (IJCAI-PRICAI 2020). doi:10.24963/ijcai.2020/24.
- Gopalakrishnan Venkatesh, Aayush Grover, G. Srinivasaraghavan, Shrisha Rao. *MHCAttnNet: predicting MHC-peptide bindings for MHC alleles classes I & II using an attention-based deep neural model*. 28th Conference on Intelligent Systems for Molecular Biology (ISMB 2020). Bioinformatics (Oxford University Press), vol. 36 (Supplement 1), July 2020, pp. i399–i406. doi:10.1093/bioinformatics/btaa479.
- Ananth Shreekumar, Biswesh Mohapatra, Shrisha Rao *Incorporating Autonomous Bargaining Capabilities into E-Commerce Systems*. 20th ACM International Conference on Intelligent Virtual Agents (IVA 2020), October 2020. doi:10.1145/3383652.3423865.
- Ashutosh Trivedi, Shrisha Rao. *Agent-Based Modeling of Emergency Evacuations Considering Human Panic Behavior*. IEEE Transactions on Computational Social Systems, vol. 5 (1), March 2018, pp. 277–288. doi:10.1109/TCSS.2017.2783332.
- Akshay Jindal, Shrisha Rao. Agent-Based Modeling and Simulation of Mosquito-Borne Disease Transmission. Sixteenth International Conference on Autonomous

Agents and Multiagent Systems (AAMAS 2017), pp. 426–435, São Paulo, Brazil, May 2017.

- Sneha Singhania, Nigel Fernandez, Shrisha Rao. *3HAN: A Deep Neural Network for Fake News Detection*. 24th International Conference on Neural Information Processing (ICONIP 2017), Guangzhou, China, November 2017, pp. 572–581. doi:10.1007/978-3-319-70096-0_59.
- Abhinandan S. Prasad, Shrisha Rao. *A Mechanism Design Approach to Resource Procurement in Cloud Computing*. IEEE Transactions on Computers, vol. 63 (1), January 2014, pp. 17–30. doi:10.1109/TC.2013.106.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand and appreciate the theory and applications of artificial intelligence (broadly construed).	PO4	U	C,P	10	5
CO2	Mature professionally by interacting as independent, peer learners with good communications skills.	PO9	Ap	C,P	10	5
CO3	Gain hands-on experience with cutting-edge academic research on par with international standards, and have an opportunity to add to their research profiles.	PO13	Ap	C,P	10	5

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

This is an *indicative* list of some broad topics that students work on for their research:

- Neuromorphic computing
- Multi-agent systems and agent-based modeling
- Bioinformatics and computational biology
- Game theory and mechanism design
- Computational psychology
- Machine learning and deep learning

Instruction Schedule

[Provide session-wise schedule]

This is somewhat of a "flipped classroom" where the students learn and act outside, and bring their results to the classroom setting. There is no fixed instruction schedule or teaching, and the instructor merely acts as a facilitator and mentor for student-led activities of study, presentation, research, and writing.

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Not applicable.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Goal Statement: 10%
Class Presentations and Interactions: 30%
Final Paper: 60%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Goal statement	CO1
2	Weekly class presentations	CO2
3	Final research paper	CO3

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

Students are evaluated on the goal statement, class presentations and interactions, and on the quality of the final research paper that is produced.

Late Assignment Submission Policy

State any penalty policy for late submission

Not applicable.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

Not applicable.

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

In line with common academic standards in place worldwide.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy.

Course Syllabus

Course Code / Course Name	CS 606/ Computer Graphics		
Course Instructor Name(s)	T. K. Srikanth (tk.srikanth@iiitb.ac.in) Jaya Sreevalsan Nair (jnair@iiitb.ac.in)		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	4	Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 4:0:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): (*Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Prerequisites	*(Where applicable, state exact course code/name)* ESS201 Programming II Mathematics courses

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Students learn programming using graphics library OpenGL, which is important for industrial opportunities
Focus on skill development	Yes	Use of Eclipse, VS Code development tools
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	Yes	Students learn to read a top-tier conference paper, write a technical report, and present the same to the class

Course Context and Overview

[*Provide introduction to the course*]

This course aims at introducing the theory and practice of computer graphics with an emphasis on applications programming. The following concepts shall be covered:

- Theory and practice of computer graphics
- Graphics programming using OpenGL API (v3.0)
- Introduction to shader programming
- Introduction to state-of-the-art applications, e.g. Virtual Reality, game engines, etc.

The outcome of this course is to bring up the knowledge and practice of graphics in students to the requirements of a graduate-level course. Hence while the first half of the course can be broadly seen as an advanced undergraduate level course, the second half of the course ramps up to the more advanced concepts. The lectures cover the architecture of a graphics pipeline in a modeling-rendering paradigm. Graphics pipeline embodies the processes involved in converting primitives to pixels and the algorithms required for the processes to generate photo-realistic images in real time.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)

CO1	Understand the graphics processing pipeline (fixed functionality and programmable) and its implementation using OpenGL	PO1	U	C	10
CO2	Write graphics programs in C++ for 2- and 3-dimensional objects and OpenGL using MVC architecture	PO1	Ap	F, C, P, PC	10
CO3	Apply concepts of geometric transformations and mesh models in graphics programs	PO1, PO4	Ap	F, C, P, PC	8
CO4	Apply concepts of lighting and shading in graphics programs	PO1, PO4	Ap	F, C, P, PC	11
CO5	Apply concepts of textures and parametric mapping in graphics programs	PO1, PO4	Ap	F, C, P, PC	5
CO6	Apply concepts of animation of rigid bodies and hierarchical models in graphics programs	PO1, PO4	Ap	F, C, P, PC	12
CO7	Explain state-of-the-art methods from research papers in computer graphics with technical reports and in-class discussions	PO2	U	F, C, P	4
				Total	60

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1: Introduction - History of computer graphics, applications, graphics pipeline, physical and synthetic images, synthetic camera, modeling, animation, rendering, relation to computer vision and image processing, review of basic mathematical objects (points, vectors, matrix methods).	**Module 2: Introduction to OpenGL -** OpenGL architecture (fixed functionality and programmable pipelines), primitives and attributes, simple modeling and rendering of two- and three-dimensional geometric objects, RGB color models, frame buffer, double buffering, interaction, events and callbacks, picking.
Module 3: Geometric transformations - Homogeneous coordinates, affine transformations (translation, rotation, scaling, shear), concatenation, matrix stacks and use of modelview matrix in OpenGL for these operations.	**Module 4: Viewing -** Classical three dimensional viewing, computer viewing, specifying views, parallel and perspective projective transformations; Visibility- z-Buffer, BSP trees, Open-GL culling, hidden-surface algorithms.
Module 5: Lighting & Shading - Light sources, illumination model, Gouraud and Phong shading for polygons. Rasterization - line segment and polygon clipping, 3D clipping, scan conversion, polygonal fill, Bresenham's algorithm, Vertex and fragment shaders.	**Module 6: Discrete Techniques -** Parametric mapping, texture mapping, compositing, textures in OpenGL, Ray Tracing- Recursive ray tracer, ray-sphere intersection.
Module 7: Animation & Kinematics - Hierarchical models (scene graph, hierarchy of transforms, rendering/integration with OpenGL), keyframe animation, forward kinematics, collision detection.	**Module 8:** Shader Programming and Introduction to Virtual Reality Applications.

Instruction Schedule

[Provide session-wise schedule]

S.No.	Topic	Hours	CO
1	Introduction to Computer Graphics and Graphics Systems	1	CO1
2	Graphics Processing Pipeline: Introduction and Overview	4	CO1
3	Introduction to Graphics Programming	5	CO2
4	Coordinate Systems	2	CO3
5	Affine Transformations of Vertices	6	CO3

6	Viewing	4	CO4
7	Lighting Models	5	CO4
8	Shading Models	3	CO4, CO5
9.	Textures and parametric mapping	4	CO5
10.	Vertex and Fragment Shaders	2	CO1, CO2
11.	Animation and Kinematics	4	CO6
12.	Hierarchical Models and Scene Graphs	4	CO6
13.	Data Structures for 3D models - Collision Detection	4	CO6
14.	Rasterization Algorithms	4	CO1, CO2
15.	Advanced graphics applications and Introduction to AR/VR	8	CO1, CO2, CO7
	(Total)	60	

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Lecture notes and reading materials provided in class.
- Text Books:
    - Edward Angel and Dave Shreiner, Interactive Computer Graphics. A Top-Down Approach with Shader-based OpenGL, 6E, Addison Wesley, 2012.
    - Peter Shirley and Steve Marschner, Computer Graphics (first edition), A. K. Peters, 2010.
- Additional References:
    - Donald Hearn and Pauline Baker, Computer Graphics with OpenGL (third edition), Prentice Hall, 2003
    - F. S. Hill Jr. and S. M. Kelley, Computer Graphics using OpenGL (third edition), Prentice Hall, 2006

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- 4 programming assignment - 60%
- Reading-writing-presenting assignment - 10%
- Midterm - 15%
- End Term - 15%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Programming assignment in 2-dimensional rendering to introduce students to OpenGL programming and widget/windowing system	CO1, CO2
2.	Programming assignment in 3-dimensional rendering to introduce students to mesh rendering, affine transformations, object-oriented programming for computer graphics application, basic lighting	CO1, CO2, CO3
3.	Programming assignment to include lighting, shading, texture mapping	CO1, CO2, CO4, CO5
4.	Programming assignment to include animation and optionally, virtual reality	CO1, CO2, CO6
5.	Reading-writing-presenting assignment to introduce students to comprehend research in computer graphics, and develop technical writing and presentation skills	CO1, CO7

- The assignment description with all logistics are provided to the students on LMS. "*Start early and finish on time*" is the guiding principle for all assignments in this course.
- All programming assignments and tests shall be submitted on LMS..

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses the following evaluation procedures as part of the course:

- Manual evaluation of programming assignment code and demonstrations
- Plagiarism check using tools and manual evaluation

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

To incentivize early submissions and discourage late submissions the following bonus scheme will be used on the total for final grade:

- +1 for submission before the designated Sunday, −0.5 for submission on the subsequent Monday or Tuesday, −1 for submission before the next Sunday, −3 any later. +1 is applicable only if the early submission is the final submission for the assignment.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per Institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

As per Institute policy

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This course has zero-tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact the instructor. All material that will be used for the assessment of the student's performance shall be original work.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per Institute policy

Course Syllabus

Course Code / Course Name	CS 616 Foundations of Cryptography
Course Instructor Name(s)	ASHISH CHOUDHURY and SRINIVAS VIVEK

Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
		Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems	x	Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
X	M.Tech
	M.Sc.

Branch:

X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	CS201 : Discrete Mathematics CS202 : Design and Analysis of Algorithms

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The focus of this course is on definitions and constructions of various cryptographic objects, what security properties are desirable in such objects, how to formally define these properties, and how to design objects that satisfy the definitions.
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

As the digitization of our lives continue with a rapid pace, so is the acute need for information security. We constantly hear about misuse of personal data for anti-social activities or commercial gains, purported state-sponsored hackers targeting vital infrastructure, etc. The number of such incidents reported has been increasing alarmingly. Also, in a software product development life cycle, the security measures are no longer considered as an afterthought. Instead, such measures need to be incorporated in the design phase itself. The above are still open challenges for researchers and system developers.

As a society and as a nation we need to deal with the above challenges with a highly skilled workforce. There has been a 350% increase in open cybersecurity positions from 2013 to 2021, and that there will be about 3.5 million unfilled cybersecurity positions globally by 2021. Further, with the advancement of the research frontier of cryptography and cybersecurity in general, these disciplines are becoming highly specialized. As a nation and eco-system we need a huge number of highly specialized persons with theoretical and systems level understanding. Because, advanced cyber physical systems becoming a norm of the future, such as autonomous vehicles, robots, smart city's various requirements etc., we can expect much higher proliferation of security and privacy protocols from tiny IoT devices to powerful cloud servers.

This course provides the basic paradigm and principles of modern cryptography. The focus of this course will be on definitions and constructions of various cryptographic objects. We will try to understand what security properties are desirable in such objects, how to formally define these properties, and how to design objects that satisfy the definitions. The aim is that at the end of this course, the students are able to understand a significant portion of current cryptography research papers and standards. The topics covered in the course will be also useful for the students who are willing to take Network Security course in the future semester, as knowledge of principles of cryptography is necessary for a better understanding of network security course. In a nutshell, this course will build the required foundation on top of which various complex and real-world cryptographic applications are built.

This course is offered every year during the Jan-April semester and it serves as a pre-requisite for the following elective courses:

- Computing on Private Data

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)
CO1	Understand the limitations of perfect-security	PO1, PSO1, PSO4	U	C	5
CO2	Construct stream ciphers based on pseudo-random number generators	PO1, PSO1, PSO4	U	C, P	8
CO3	Determine whether a given mode of encryption is chosen-plaintext-attack (CPA)-secure or not	PO1, PSO2, PSO4	Ap	C, P	14
CO4	Determine whether a given message-authentication code (MAC) is secure or not	PO1, PSO2, PSO4	Ap	C, P	9
CO5	Construct secure authenticated encryption schemes by generically combining secure MAC and CPA-secure encryptions	PO1, PSO2, PSO4	U	C	5
CO6	Determine whether a given hash function is secure or not	PO1, PSO2, PSO4	Ap	C, P	6
CO7	Understand the basic concepts from number theory and abstract algebra	PO1, PSO2, PSO4	U	C	9
CO8	Construct public-key cryptosystems and digital signature schemes	PO1, PSO4	Ap	C, P	6
				Total	**62**

Concept Map of the Course (Optional)

Course Content

1. **Module 1**
   I. **Introduction and Classical Cryptography**
   - Cryptography and Modern Cryptography
   - Historical Ciphers and Their Cryptanalysis

- The Basic Principles of Modern Cryptography

II. **Perfectly-secure Encryption**
- Definition and properties
- The One-Time Pad (Vernam's Cipher)
- Limitations of Perfect Secrecy (Shannon’s theorem)

III. **Private-key Encryption and Pseudorandomness**
- A Computational Approach to Cryptography
- Defining Computationally-Secure Encryption
- Pseudorandomness
- Constructing Secure Encryption Schemes
- Security Against Chosen-Plaintext Attacks (CPA)
- Constructing CPA-Secure Encryption Schemes
- Security Against Chosen-Ciphertext Attacks (CCA)

2. Module 2

I. **Message Authentication Codes and Collision-Resistant Hash Functions**
- Secure Communication and Message Integrity
- Encryption vs. Message Authentication
- Message Authentication Codes - Definitions
- Constructing Secure Message Authentication Codes
- CBC-MAC
- Collision-Resistant Hash Functions

II. **Practical Construction of Pseudorandom Permutations (Block Ciphers)**
- Substitution-Permutation Networks
- Feistel Networks
- DES: The Data Encryption Standard
- AES: The Advanced Encryption Standard

3. Module 3

I. **Theoretical Constructions of Pseudorandom Objects**
- One-way Functions
- From One-way Functions to Pseudorandomness
- A Hard-Core Predicate for Any One-Way Function
- Constructing Pseudorandom Generators
- Constructing Pseudorandom Functions

II. **Number Theory and Cryptographic Hardness Assumptions**
- Basic Group Theory
- Primes, Factoring, and RSA
- Assumptions in Cyclic Groups
- Cryptographic Applications of Number-Theoretic Assumptions

III. **Private-key Management and Public-key Revolution**
- Limitations of Private-Key Cryptography

- A Partial Solution- Key Distribution Centers
- The Public-Key Revolution
- Diffie-Hellman Key Exchange

IV. **Public-key Encryption**

- Overview and Definition
- RSA Encryption
- The El Gamal Encryption Scheme
- Additional Public-key Encryption Schemes

4. **Module 4**

I. **Digital Signature Schemes**

- Definition and Overview
- RSA Signatures
- The "Hash-and-Sign" Paradigm
- Signatures from Collision-Resistant Hashing
- The Digital Signature Standard (DSS)
- Certificates and Public-Key Infrastructures

II. **Public-Key Cryptosystems in the Random Oracle Model**

- The Random Oracle Methodology
- Public-Key Encryption in the Random Oracle Model
- Signatures in the Random Oracle Model

Instruction Schedule

Week	**Lessons/Topics**
1	Course Overview, Symmetric-key Encryption, Historical Ciphers, Perfect Security and Its Limitations
2	Computational Security, Semantic Security and Pseudorandom Generators (PRGs)
3	Stream Ciphers, Provably-secure Instantiation of PRG, Practical Instantiation of PRG, CPA-security and Pseudo-random Functions (PRFs)
4	CPA-Secure Ciphers from PRF, Modes of Operations of Block Ciphers, Theoretical Constructions of Block Ciphers and Practical Constructions of Block Ciphers
5	DES, AES and Message Authentication Codes (MAC)
6	Information-theoretic Secure MAC, Cryptographic Hash Functions, Ideal-Cipher Model, Davies-Meyer construction and Merkle-Damgård Paradigm
7	Birthday Attacks on Cryptographic Hash Functions, Applications of Hash Functions, Random Oracle Model and Authenticated Encryption
8	Generic Constructions of Authenticated Encryption Schemes, Key-exchange Problem, One-way Trapdoor Functions and Cyclic Groups
9	Discrete-Logarithm Problem, Computational Diffie-Hellman Problem, Decisional Diffie-Hellman Problem, Elliptic-Curve Based Cryptography and Public-Key Encryption

10	El Gamal Encryption Scheme, RSA Assumption, RSA Public-key Cryptosystem, KEM-DEM Paradigm and CCA-security in the Public-key Domain
11	CCA-secure Public-key Hybrid Ciphers Based on Diffie-Hellman Problems and RSA-assumption, Digital Signatures, RSA Signatures and Schnorr Identification Scheme
12	Schnorr Signature, Overview of TLS/SSL, Number Theory, Interactive Protocols and Farewell

Learning Resources

1. Introduction to Modern Cryptography by Jonathan Katz and Yehuda Lindell.
2. Cryptography Theory and Practice by Douglas Stinson

Assessment Plan

- Take-home assignments 100%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not applicable

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	CS 716: Computing on Private Data	
Course Instructor Name(s)	ASHISH CHOUDHURY	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
		Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems	x	Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	CS616 : Foundations of Cryptography

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	This course discusses about how using various cryptographic primitives, one can do computation on distributed and sensitive data, also known as secure multi-party computation (MPC), which unarguably is one of the most fundamental problems in distributed computing
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

The need for distributed computation on private data arises in several real-world applications that require computations involving sensitive data from two or more mutually distrusting entities. Consider the following example, which is one of the latest applications of secure computation investigated by DARPA: The Earth is orbited by thousands of man-made satellites and several thousands of orbital debris. The growing number of satellites and space debris orbiting the planet increases the danger of collisions. And this is not a hypothetical scenario, as several such "high profile" collisions have been reported in the recent past. Given the expensive cost of satellites, the host countries would like to avoid collision. A collision can only be predicted if the detailed orbit information of the individual satellites is known. However, such information can be highly sensitive and in fact, it can even be a national secret. So what is needed here is a way to determine whether two satellites are about to clash with each other based on the detailed locations of the satellites, but without the need of disclosing the locations of the satellites to other host countries.

Secure MPC models the above and several such applications that make simultaneous demands for the privacy and usability of sensitive data. Other examples include secure e-voting, secure e-auction, secure signal-processing, secure bioinformatics, secure biometrics, secure machine learning, secure outsourcing, privacy-preserving data-mining, to name a few. The problem of secure computation abstracts out the afore-mentioned applications and alike and goes beyond the capabilities of conventional cryptography to offer the dual demands of privacy and computation on secret data as required. The problem of secure computation was first formulated by the Turing award winner Andrew Yao in his seminal work published in Foundations of Computer Science (FOCS) 1982. The problem is as follows: we have a set of n mutually distrusting parties $P_1, \cdots, P_n$ with private inputs $x_1, \cdots, x_n$ respectively. Together they want to compute some publicly known function, say f, on their inputs, by keeping their inputs "as private as possible".
Due to its powerful abstraction, secure computation problem is also considered as the "holy-grail"

of cryptography. And this is a highly popular research topic both in the theoretical as well as in the applied cryptography community. This is one of the first courses of its kind to be offered in India, covering the formal details of this topic and promises to unfold the evolution of this topic since 1982 to till date.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)
CO1	Understand the various dimensions to study the secure MPC problem	PO1, PSO1, PSO4	U	C	3
CO2	Understand secret-sharing protocols	PO1, PSO1, PSO4	U	C, P	8
CO3	Compare perfectly secure MPC protocols	PO1, PSO2, PSO4	U	C, P	14
CO4	Design protocols for oblivious transfer	PO1, PSO2, PSO4	C	C, P	9
CO5	Understand Yao's secure 2-party protocol	PO1, PSO2, PSO4	U	C	5
CO6	Compare MPC protocols for small number of parties	PO1, PSO2, PSO4	AU	C, P	6
				Total	**45**

Concept Map of the Course (Optional)

Course Content

The following is the tentative list of topics to be covered in this course.

1. **Why Secure Computation?:** Introduction, Motivation and History.
2. **Models for Secure Computation:** Honest vs dishonest- majority setting, Semi-honest vs active(malicious) adversary, Static vs adaptive corruption, Computational vs information-theoretic security, Synchronous vs asynchronous network
3. **Defining Secure Computation:** Computational/statistical/perfect indistinguishability, Real-world/Ideal-world paradigm, Simulation based security notion.

4. **Secure Computation with Semi-honest Security:** Secret sharing, BenOr-Goldwasser-Wigderson (BGW) construction, Optimizations using Beaver's trick (secure computation in the preprocessing mode and circuit randomization)
5. **Dishonest-majority Setting:** Impossibility of the information-theoretic secure computation in the dis-honest majority setting,Oblivious transfer (OT), Two-party Goldreich-Micali-Wigderson (GMW) construction, Optimizations of GMW (Random input OT and OT extension), Yao's 2-party protocol, Optimizations of Yao's protocol (free XOR technique, point and permute technique), Beaver-Micali-Rogaway (BMR) construction and multi-party GMW construction

Instruction Schedule

Weeks		Topics Covered
Week 1	:	Secure Computation: motivation and real-world examples, various dimensions, recalling relevant topics from abstract algebra (groups, rings, fields) and cryptography
Week 2	:	Secret sharing (motivation, definition and applications), Shamir secret-sharing, additive secret-sharing, replicated secret-sharing
Week 3	:	Linear secret-sharing, monotone span programs (MSP), secure message transmission (SMT)
Week 4	:	BenOr-Goldwasser-Wigderson (BGW) protocol: security proof and detailed analysis
Week 5	:	Degree-Reduction problem and various solutions, efficient protocols for evaluating multiplication gates
Week 6	:	Oblivious transfer (OT), OT protocols, OT extension
Week 7	:	Goldreich-Micali-Wigderson (GMW) protocol: security proof and detailed analysis
Week 8	:	Yao's protocol for secure 2-party computation, various optimizations of Yao's protocol
Week 9	:	MPC for small number of parties, various optimizations
Week 10	:	Mixed world MPC protocols
Week 11	:	MPC protocols against general adversaries
Week 12	:	Fail-stop corruptions: MPC and consensus protocols, asynchronous protocols

Learning Resources

This is an advanced level research course where the contents are based on research papers. There is as such no single textbook which contains all the proposed topics. However, for few of the topics, the following textbooks can be used for the reference purpose:

1. Efficient Two-party Protocols- Techniques and Constructions; by Carmit Hazay and Yehuda Lindell. Springer-Verlag, 2010.
2. Engineering Secure Two-party Computation Protocols, by Thomas Schneider. Springer Verlag, 2010.
3. Secure Multiparty Computation and Secret Sharing, by Ronald Cramer, Ivan Damgard and Jesper Buus Nielsen. Cambridge University Press, 2015.

Assessment Plan

- Take-home assignments 50%
- Research paper presentations 50%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not applicable

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	CS715 Computational Geometry	
Course Instructor Name(s)	Pradeesha Ashok	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	4	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
X	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* CS511 or an equivalent course

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The course discusses problems and techniques that can be applied in many real world scenarios. The ideas and techniques can be applied in a variety of areas including robotics, data science, machine learning and visualization.
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

This course covers algorithms and techniques from the field of geometry. The problems are motivated by applications in areas like computer graphics, geographic information systems (GIS), robotics etc. The emphasis of the course will be on different classes of geometric problems and the concepts and techniques needed to solve it. These algorithms can be applied in a number of areas like data science, visualization and machine learning.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	**Course Outcome**	**PO/ PSO**	**CL**	**KC**	**Class (Hrs)**	**Tut (Hrs)**
CO1	Compute the convex hull of a set of points in the planes using incremental algorithm and Jarvis March	PO4	Ap	C, P	3	
CO2	Solve the Line Segment intersection problem and Map overlay problem using suitable data structures	PO4	Ap	C, P	6	
CO3	Solve the orthogonal range searching problem using geometric data structures	PO4	Ap	C, P	6	

CO4	Solve the point location problem in the plane using randomized incremental algorithm and appropriate data structures	PO4	Ap	C, P	6	
CO5	Compute the voronoi diagram and delaunay triangulation of a set of points in the plane.	PO4	Ap	C, P	8	
CO6	Solve the Art Gallery problem using the algorithms for triangulation of a set of points in the plane	PO4	Ap	C, P	8	
CO7	Compute the VC Dimension of a geometric set system using basic theorems of Combinatorial Geometry	PO4	Ap	C, P	4	
CO8	Understand the concept of Epsilon nets and Epsilon Net Theorem.	PO4	U	C	4	
	Total hours				45	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Convex Hulls : Definition and properties of convex hull, Jarvis March Algorithm, Incremental Algorithm

• Line Segment Intersection and Map Overlay problem : Doubly Connected Edge List, The incremental algorithm,

• Polygon triangulation : Art Gallery problem, Partitioning to monotone pieces, Triangulating a monotone polygon

• Range Searching : Kd- Trees, Range trees

• Point Location : Kirkpatrick's decomposition, Trapezoidal Maps

• Voronoi Diagrams and Delaunay Triangulation : Properties of Voronoi diagram and Delaunay triangulation, Fortune's Algorithm, Randomised algorithm for Delaunay triangulation

Combinatorial Geometry : Basic Theorems - Radon's lemma, Helly's theorem, Centerpoint theorem

• Epsilon nets : VC Dimension, definition of epsilon nets, Epsilon net theorem, Epsilon nets for basic geometric set systems

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Text Book:
Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars, Computational Geometry: Algorithms and Applications, third edition, Springer-Verlag, 2008.

References:
Franco P Preparata and Michael Shamos, Computational Geometry: An Introduction, Springer-Verlag, 1985.
J. R Sack & J. Urrutia, Handbook of Computational Geometry, Elsevier Science, 2000.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments - 30%
Seminar - 30%
Implementation Project - 30%
Course Participation - 10 %

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Assignment 1	CO1, CO2, CO3
2	Assignment 2	CO4, CO5, CO6
3	Assignment 3	CO7, CO8
4	Project	CO1-8
5	Seminar	CO1-8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Manual evaluation of essay type / descriptive questions
- Manual evaluation of oral presentations

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	CS731/Software Testing		
Course Instructor Name(s)	Meenakshi D'Souza		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*
Course Category	Select **one** from the following: *(Place X appropriately)*
Course Pre-Requisites	*(Where applicable, state exact course code/name)* CS 511/CS202: Algorithms/Design and Analysis of Algorithms

Programme / Branch:

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category:

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The course teaches all the algorithmic aspects of Software Testing, including test case design techniques, testing at different phases/levels of software development and testing of different applications.
Focus on skill development	Yes	This course will directly help the students to learn Software Testing and take up jobs as a test engineer in a IT or product firm.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

It is well known that software testing is the most time consuming phase of development. The importance of software testing is increasing steadily with emphasis on software being ubiquitous and controlling several safety critical systems. In addition, agile development methodologies focus on developers unit testing their code themselves, without help from a testing team. All of these make testing a very important activity in software development.

This course will cover the technical aspects of software testing, especially on techniques for test case design. We will cover techniques for both black-box and white-box testing, covering a broad range of languages, platforms and applications. The course will also teach novel testing research techniques that have matured in the past decade.

Course Outcomes and Competencies

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand all the basic definitions and terms used in Software Testing.	PO4	U	F, C	3	
CO2	Understand graphs based criteria for testing, both control flow and data flow based techniques.	PO4	U	F, P	4	1
CO3	Understand logic based criteria for testing.	PO4	U	F, P	4	1
CO4	Understand syntax-based testing along with the criteria.	PO4	U	F, P	4	1
CO5	Apply graphs-based, logic-based and syntax-based testing techniques to test source code, design elements and specifications.	PO3	U, Ap	C, P	6	2

CO6	Understand symbolic execution and its use in concolic testing.	PO4	U	F, P	2	1
CO7	Understand testing techniques specific to object-oriented applications and web applications.	PO4	U	F, P	4	1
CO8	Understand black-box testing technique of input space partitioning.	PO4	U	F, P	2	1
CO9	Understand an overview of regression testing, non-functional testing and mobile applications testing.	PO4	U	C	2	0
CO10	Create a combination of testing techniques to apply for the project whose code is to be tested.	PO3	Ap	C, P	1	4

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Not applicable.

Course Content

- Introduction, software testing process levels, terminology
- Techniques and algorithms for test case design:
  - Graphs based testing: Structural coverage criteria, data flow coverage criteria, graph coverage for source code, design elements and specifications
  - Logic based testing: Predicates and clauses, coverage criteria based on logic expressions.
  - Symbolic testing, concolic testing.
  - Specification-based logic coverage.
  - Logic coverage for finite state machines.
  - Input space partitioning: Input domain modeling, combination strategies criteria.
  - Syntax based testing: Coverage criteria based on syntax, mutation testing
- Test case design (as learnt above) applied to
  - Testing OO-applications.
  - Testing web applications.
  - Testing embedded software.
  - Testing GUI.

Instruction Schedule

Week Lessons/Topics

Week 1	Motivation, testing terminologies, testing based on models and criteria, test automation (JUnit).
Week 2	Graphs, as used in testing, structural graph coverage criteria, data flow coverage criteria.

Week 3	Graph coverage criteria applied to test source code,, classical source code testing criteria.
Week 4	Software design and integration testing, graph coverage applied to test for design integration (call graphs), graph coverage applied to test specifications.
Week 5	Basics of logic as needed for testing (propositional and predicate logic, decidability problems), logic coverage criteria.
Week 6	Logic coverage criteria applied to test code, specifications and finite state machines.
Week 7	Functional testing, input space partitioning and its various types used for black-box testing.
Week 8	Syntax-based testing, mutation testing, mutation testing for source code.
Week 9	Mutation testing for integration and inputs, comparison of mutation testing with graph and logic based criteria.
Week 10	Testing of object-oriented applications (OO-call coverage, Yo-Yo graphs for testing of OO features), testing of web applications.
Week 11	Symbolic testing, concolic testing, DART algorithm.
Week 12	Overview of regression testing, non-functional testing techniques, testing of mobile applications.

Learning Resources

- Paul Ammann and Jeff Offutt, Introduction to Software Testing, First South Asian Edition, Cambridge University Press, 2009.
- Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Special Indian Edition, CRC Press, 2014.
- Research papers and survey articles on Software Testing, files made available to students.

Assessment Plan

S. No.	Focus of Assignment / Project	Percentage of distribution
1	First quiz	15%
2	Mid-term examination	25%
3	Second quiz	15%
4	Project	20%
5	Final exam	25%

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
1	First quiz	CO1, CO2.
2	Mid-term examination	CO2, CO3, CO5.
3	Second quiz	CO4, CO8.
4	Project	All the COs.
5	Final exam	CO6, CO7, CO9.

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms.
- Manual evaluation of essay type / descriptive questions.
- Automatic plagiarism check using tools.
- Manual code walk through and automatic evaluation through execution of projects.

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

Not applicable.

Make-up Exam/Submission Policy

As per institute policy.

Citation Policy for Papers (if applicable)

Not applicable.

Academic Dishonesty/Plagiarism

As per institute policy.

Accommodation of Divyangs

As per institute policy.

Course Syllabus

Course Code / Course Name	CS 816 Software Production Engineering	
Course Instructor Name(s)	Prof. B. Thangaraju	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
X	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
X	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
X	ECE Branch Elective
X	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

NONE

Software Engineering and Linux System Program knowledge would be preferable.

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Engineers trained on DevOps are sought for. This course provides a strong foundation for the same.
Focus on skill development	Yes	Developing skills on DevOps methods of software development is very much required for the software project development.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

The traditional Software Development Life Cycle (SDLC) has various barriers between business, developers, testing, quality assurance team and Operation teams, which causes lot of delay in delivering software to the end user. The implementation of agile methodologies has removed barriers between different teams in development and target to achieve continuous delivery and limited to only with development team. To remove the barrier between Dev and Ops and integration between all the stages with automation and achieve Continuous deployment -DevOps process is the only solution. The Software Production Engineering course teaches you DevOps based Software Development Method from ground zero. You will get familiar with the choices of DevOps process types, concepts of Continuous Integration, Configuration Management, Continuous Deployment and Continuous Monitoring.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand DevOps method of software development including DevOps barriers, types of DevOps models and automation tools.	PO1, PSO1	U	F,C	5	0
CO2	Implement continuous integration of software development life cycle (CI/CD pipeline) including git repository, build and test stages with Jenkins tool.	PO1, PO5, PSO1	Ap	P	10	0

CO3	Perform configuration management to configure the deployment servers with Ansible tool.	PO1, PO5 PSO1	Ap	P	12	0
CO4	Implement continuous deployment of incremental changes of software products to the end user with Rundeck tool.	PO1, PO5, PSO1	Ap	P	9	0
CO5	Perform Continuous monitoring of the deployment servers with ELK stack, generate status reports and send notification to the concerned person if it encounters any issue.	PO1, PO5, PSO1	Ap	P	9	0
	TOTAL				**45**	**0**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content
[Provide list-wise topics]

This course will cover the following topics:
1. Introduction to Software Production Engineering
2. Continuous Integration
3. Configuration Management
4. Continuous Deployment
5. Continuous Monitoring

Instruction Schedule
[Provide session-wise schedule]

Week	Topics
1-3	**1. Introduction to Software Production Engineering** ✓ Business Agility ✓ Challenges to Achieve Business Agility ✓ Components of Software Delivery ✓ Traditional Vs Agile Vs DevOps ✓ DevOps Basics ✓ DevOps Software Development Model ✓ Components of Software Delivery ✓ Popular Misconceptions about DevOps ✓ DevOps Barriers and Solutions ✓ Various DevOps types ✓ DevOps – Dev's Perspective ✓ DevOps – Ops's Perspective ✓ DevOps – Org's Perspective ✓ DevOps Tools ✓ Future of DevOps
4-6	**2. Continuous Integration** ✓ Introduction on Continuous Integration ✓ Continuous Integration Principles ✓ Continuous Integration Components ✓ Source Control Management -GIT ✓ Build Automation ✓ Types of Testing ✓ Test Automation ✓ Artifact Repository ✓ Benefits of Continuous Integration ✓ Continuous Delivery ✓ Continuous Delivery Vs Continuous Deployment ✓ Introducing Jenkins ✓ Jenkins Server Various Configuration Options ✓ Build your code ✓ Automate Artifcatory Deployment ✓ Implement Continuous Delivery

	✓ Notifications
7-10	**3. Configuration Management** ✓ Importance of Configuration Management ✓ Infrastructure as a Code (IaC) ✓ Types of Approaches to IaC – Functional and Procedural ✓ Methods of IaC – Push and Pull ✓ IaC – Automation ✓ Configuration Management Tools Vs Platform ✓ The Evolution of Chef ✓ Chef Architecture
11-12	**4. Continuous Deployment** ✓ Importance of Continuous Deployment ✓ Who Needs Continuous Deployment ✓ Who doesn't Need Continuous Deployment ✓ Continuous Delivery Vs Continuous Deployment ✓ Myths on Continuous Deployment ✓ Traditional Deployment Automation Tools ✓ Key Functions of Deployment Automation Tools ✓ Continuous Deployment Enablers ✓ Evolution of Infra Path ✓ Infra -on premises or Cloud ✓ Infra – Physical Server/VM/Container ✓ Blue-Green Deployment Method -Reduce Downtime and Increase High Availability ✓ Rundeck Automation Tools
13-15	**5. Continuous Monitoring** ✓ Importance of Continuous Monitoring ✓ Monitoring Computing Resources ✓ Balancing System Load ✓ Various Sources of log Messages ✓ Platform for log Messages Handling ✓ Data Science Methodology ✓ Analysis of Log Messages ✓ Choices of Tools to Monitor ✓ Enable Continuous Monitoring ✓ Notifications

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. The DevOps Handbook by Gene Kim et al., IT Revolution Press, 2016
2. Site Reliability Engineering by Betsy Beyer et al., O'Reilly Publisher, 2016
3. DevOps - A Software Architect's Perspective by Len Bass, Ingo Weber and Liming Zhu, Addison-Wesley, 2015.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Software Production Engineering	**Marks (%)**
Mid Term Exam	20
Mini Project	20
End Term Exam	20
Final Project	30
Attendance	10
Total	**100**

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Project: Implement DevOps method of Software product development with open source automation tools.	CO2 to CO5

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Manual evaluation of projects

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

A penalty of 10% of the Lab assignment/ project marks will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	CS825/Graph Theory	
Course Instructor Name(s)	Pradeesha Ashok and Meenakshi D'Souza	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* CS 512: Discrete Mathematics and Computability (For M. Tech./M. S. (By Research and Ph. D. students) CS 511/CS202: Algorithms/Design and Analysis of Algorithms CS201: Discrete Mathematics (For iM. Tech. students)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas are covered as part of the course. [NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The course teaches fundamentals of graph theory. Graphs are widely used in several areas in Computer Science including algorithms, computer networks and web science. A thorough understanding of the fundamentals in this area will help students with taking up jobs in these areas.
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

This course is a beginner course on Graph Theory with focus on understanding the structure of graphs and techniques used in solving problems involving graphs. Specifically, this is a theoretical study of graphs that covers many combinatorial results and classical theorems in graph theory.

Graphs are considered to be one of the most important data structures in Computer Science and are also used in several adjacent areas including communication networks, Biology, Chemistry etc. Graphs are extensively used by current day social networks, for study of routes and maps and in web science. There are several interesting theoretical problems in Graph Theory that are induced by these applications and also by its use in Mathematics. A thorough study and understanding of concepts in Graph Theory will pave the way for understanding applications and theoretical foundations in this area.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand all the basic terminologies related to graphs, including trees and forests.	PO4	U	C, P	8	

CO2	Understand matchings on graphs and special classes of bipartite graphs and the basic results regarding them.	PO4	U, Ap	C, P	4	
CO3	Understand the min-max relations between the notions of matching, independent set, vertex covers and edge covers.	PO4	U, Ap	C, P	6	
CO4	Understand the notion of vertex and edge connectivity, specifically 2- and 3-connectedness in graphs.	PO4	U	C, P	6	
CO5	Understand the notion of graph vertex coloring and chromatic number, bounds of chromatic number with respect to other graph parameters.	PO4	U, Ap	C, P	8	
CO6	Understand the notion of graph edge coloring and chromatic index, bounds of chromatic index with respect to other graph parameters.	PO4	U, Ap	C, P	3	
CO7	Understand the concept of planar graphs, properties of planar graphs and their connection to graph coloring and graph minors.	PO4	U, Ap	C, P	7	
CO8	Understand the basic concepts of Hamiltonian graphs and Ramsey theory.	PO4	U	C, P	3	
	Total hours				45	

Legend: *<u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Not applicable.

Course Content

The following topics will be taught in the course. For each of the topics, all the definitions, basic and landmark results will be covered in the respective areas.

- Basics Graphs, the degree of a vertex, Paths and cycles, Connectivity, Trees
and Forests, Bipartite Graphs, Contraction and minors.
- Matching, Matching in Bipartite graphs- Konig's Theorem, Hall's Theorem, Matching in General graphs - Tutte's theorem, Path Covers - Gallai Milgram Theorem.
- Connectivity 2-connected and 3-connected graphs, Menger's Theorem.

- Graph Colouring - Chromatic number, Brooks Theorem, Color-critical graphs, Hadwiger's conjecture, Perfect graphs. Edge Coloring -Chromatic index, Line graphs, Vizing's Theorem.
- Planar Graphs - Euler's formula, Outerplanar graphs, Kuratowski's Theorem, Four colour theorem
- Advanced Topics: Hamiltonian Paths, Ramsey theory.

Instruction Schedule

Week Lessons/Topics

Week 1	Motivation, introduction to graphs and all elementary definitions and terms related to graphs.
Week 2	Paths, cycles, trails, bipartite graphs, Eulerian circuits, vertex degrees and counting, graphic sequences.
Week 3	Trees, their basic properties, distance in trees and graphs, spanning trees, enumeration of trees.
Week 4	Matchings, maximum and perfect matchines.
Week 5	Hall's matching condition.
Week 6	Independent sets, vertex and edge covers, min-max theorems.
Week 7	Cuts and connectivity (vertex and edge), 2-connected graphs
Week 8	3-connected graphs, Menger's theorem.
Week 9	Graph Colouring - Chromatic number, Brooks Theorem
Week 10	Color-critical graphs, Hadwiger's conjecture
Week 11	Perfect graphs
Week 12	Edge Coloring -Chromatic index, Line graphs, Vizing's Theorem.
Week 13	Planar Graphs - Euler's formula, Outerplanar graphs
Week 14	Kuratowski's Theorem, Four colour theorem
Week 15	Hamiltonian Paths, Ramsey theory

Learning Resources

- Douglas B. West, *Introduction to Graph Theory*, 2nd edition, Pearson, 2018.
- Introduction to Graph Theory by Douglas B. West, Pearson Education, Second Edition, 2001

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Quizzes - 30%
Mid- term exam - 25%
Final exam - 25%

Project - 20%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	First quiz	CO1, CO2
2	Mid-term examination	CO2, CO3, CO4
3	Second quiz	CO5, CO6
4	Project (theory project)	All the COs.
5	Final exam	CO7, CO8

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not applicable.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Not applicable.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]

As per institute policy

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Course Syllabus

Course Code / Course Name	CS732/DS732 / Data Visualization		
Course Instructor Name(s)	Jaya Sreevalsan Nair (jnair@iiitb.ac.in)		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	4	Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 4:0:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Prerequisites	*(Where applicable, state exact course code/name)* ESS201, Mathematics courses, Data structures and algorithms

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Students learn programming in Visualization libraries in Python or graphics libraries in C++, either of which are important for industrial opportunities
Focus on skill development	Yes	Use of Eclipse, VS Code development tools
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	Yes	Students learn to read a top-tier conference paper, write a technical report, and present the same to the class

Course Context and Overview

[*Provide introduction to the course*]

This course is a graduate-level course for which the goal is "to provide students with concepts and a firm mathematical foundation, as well as technical aspects of algorithms. Practical skills in programming visualization algorithms, using commercial visualization tools, and applying methodologies and techniques to new problems are taught in accompanying exercises." – this is as stated in "Curriculum for a Course on Scientific Visualization," a peer-reviewed paper by Rotard et. al in Proceedings of Eurographics/ACM Siggraph Workshop on Computer Graphics Education, in 2004, and can be extended to information visualization as well.

In short, this course will cover techniques and evaluation of visualizations of scientific and information data. The outcome of this course is to bring up the knowledge and practice of visualization in students to requirements of a graduate level course. The lectures cover the areas of scientific and information visualization.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)
CO1	Understand the definition of data visualization including its scope and limitations through theory and classical visualizations	PO1	U	C	4
CO2	Understand the basic building blocks of visualization -- data types, marks and channels, color theory	PO1	U	C	10

CO3	Write programs in C/C++ with OpenGL or Python using visualization libraries to implement visualization for given datasets	PO1	Ap	F, C, P, PC	12
CO4	Apply scientific visualization algorithms for gridded data of scalar and vector fields in executable programs	PO1, PO4	Ap	F, C, P, PC	14
CO5	Apply information visualization algorithms for networks, trees, and multivariate datasets in executable programs	PO1, PO4	Ap	F, C, P, PC	5
CO6	Apply visual analytics workflow for publicly available complex datasets and specific analytic tasks in executable programs	PO1, PO4	Ap	F, C, P, PC	9
CO7	Explain state-of-the-art methods from research papers in information visualization with technical reports and in-class discussions	PO2	U	F, C, P	6
				Total hours	60

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1: Theory of Visualization 1. Introduction to color theory, visualization design, perception. 2. Visual channels and encoding. 3. Dimensionality reduction. 4. Best practices in visualization.	**Module 2: Scientific Visualization** 1. Data representation - grids, dimensionality. 2. Scalar, vector, second-order tensor field visualization techniques. 3. Interpolation and data handling.
Module 3: Information Visualization 1. Visualization techniques for hierarchical data, network data, multivariate data. 2. Data transformations.	**Module 4: Visual Analytics** 1. Introduction. 2. Case studies.

Instruction Schedule

[Provide session-wise schedule]

S.No.	Topic	Hours	CO
1	Introduction to Visualization -- Definition, Classical Examples	4	CO1
2	Building blocks of visualization -- Marks and channels, Data types, Color theory, User interactions	10	CO2
3	Scalar field visualization for 2- and 3-dimensional grids	11	CO3, CO4
4	Vector field visualization for 2-dimensional grids	8	CO3, CO4
5	Information visualization	8	CO5, CO7
6	Network and tree visualization methods	4	CO3, CO5
7	Multivariate data visualization methods	3	CO3, CO6
8	Visualization models - focus+context	2	CO4, CO5
9.	Visual analytics	8	CO3, CO6
10.	Geospatial visualizations	2	CO6
	(Total)	60	

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Lecture notes and reading materials provided in class
- There is no single textbook for this course. The following are representative, but not exhaustive, reference textbooks:
  - Alexandru C. Telea, “Data Visualization: Principles and Practice,” A. K. Peters Ltd, 2008.
  - Tamara Munzner, “Visualization Analysis and Design,” CRC Press, December 2014.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- 4 programming assignments -- 70%

- Reading-writing-presenting assignment -- 10%
- Midterm -- 10%
- End-term -- 10%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Programming assignment in visualization of 2-dimensional scalar and vector datasets, given the datasets	CO1, CO2, CO3, CO4
2.	Programming assignment in visualization of 3-dimensional scalar and vector datasets, given the datasets	CO1, CO2, CO3, CO4
3.	Programming assignment in visualization of hierarchical, network, and multivariate datasets, given the datasets	CO1, CO2, CO3, CO5
4.	Programming assignment to implement visual analytics workflow for chosen dataset and visualization tasks	CO1, CO2, CO3, CO6
5.	Reading-writing-presenting assignment to introduce students to comprehend research in information visualization, and develop technical writing and presentation skills	CO1, CO2, CO7

- The assignment description with all logistics are provided to the students on LMS. "*Start early and finish on time*" is the guiding principle for all assignments in this course.
- All programming assignments and tests shall be submitted on LMS.

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses the following evaluation procedures as part of the course:
- Manual evaluation of programming assignment code and demonstrations
- Plagiarism check using tools and manual evaluation

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

To incentivize early submissions and discourage late submissions the following bonus scheme will be used on the total for final grade:
- +1 for submission before the designated Sunday, −0.5 for submission on the subsequent Monday or Tuesday, −1 for submission before the next Sunday, −3 any later. +1 is applicable only if the early submission is the final submission for the assignment.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per Institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

As per Institute policy

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This course has zero-tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact the instructor. All material that will be used for the assessment of the student's performance shall be original work.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per Institute policy

Course Syllabus

Course Code / Course Name	Topological Data Analysis (TDA)	
Course Instructor Name(s)	Dr. Amit Chattopadhyay	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	4	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	*X*	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
X	M.Tech
	M.Sc.

Branch:

X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Mathematics I, II, III, IV
Algorithms and Data-Structure

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course. [NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	The course helps developing Skills for Data Analysis
Focus on skill development	Yes	The course helps developing Skills in TDA
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

Topological Data Analysis (TDA) is an emerging area of data science where the goal is to understand the data by computing different topological features. The aim of the current course is to understand the techniques from computational algebraic topology for developing tools in TDA. In particular, at the end of this course one will expertise in computing Betting numbers, persistent homology, bottleneck distance, cohomology, Morse theory and important data-structures necessary for TDA.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the axioms and properties, e.g., continuity, compactness, connectedness of a topological space.	PO1	U	C, P	8	
CO2	Decide whether two topological spaces are equivalent or not by homeomorphism, homotopy, isotopy or topological invariants.	PO1	U, Ap	C, P	4	
CO3	Compute a topologically equivalent simplicial complex corresponding to a known surface.	PO1, PSO4	Ap	C, P	4	
CO4	Compute homology groups and Betti numbers of a given simplicial complex.	PO1, PSO4	Ap	C, P	12	
CO5	Compute topology of a surface using Morse theory	PO1, PSO4	Ap	C, P	12	
CO6	Compute persistence diagram by considering a filtration in a simplicial complex	PO1, PSO4	Ap	C, P	8	

CO7	Compute Bottleneck distance between two persistence diagrams	PO1, PSO4	Ap	C, P	8	
CO8	Understand how TDA improves ML algorithms	PO1, PSO4	U	C, P	4	
	Total				60	

Legend: *<u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

- **Basic Topology:** Topological spaces, Invariants, Continuity, Compactness, Connectedness, Quotient Space, Surfaces, Homeomorphisms, Homotopy, Isotopy.

- **Simplicial Complex:** Simplices, Simplicial Complex, Euler characteristics, Simplicial Maps.

- **Simplicial Homology:** Chain complexes, Cycles and boundaries, Homology groups and Betti numbers, Reduced homology, Induced maps, Matrix reduction: Euler-Poincaré formula, Boundary matrices, Smith normal forms, Reduction algorithm; Relative homology groups; Excision, Maps between vector spaces, Exact sequences: Chain complexes and chain maps, Connecting homomorphism, Mayer-Vietoris sequence, Duality, Cohomology.

- **Morse Theory:** Generic smooth functions, Morse functions, Morse lemma, Gradient vector field on a manifold, Attaching cells, Transversality, Integral lines, Stable and unstable manifolds, Morse-Smale functions and complexes, Morse inequalities, Floer homology, Relation between Morse theory and Homology.

- **Persistent Homology:** The elder rule, Filtrations, Persistence diagrams, Matrix reduction, Pairing lemma, Sparse matrix representation, Extended persistence, Spectral sequence, Stability, Bottleneck distance, Tame functions, Wasserstein distance, Length and total curvature of a curve using stability, Bipartite graph matching for computing bottleneck distance.

- **TDA for Machine Learning:** Gaps in Machine Learning Algorithms, How TDA improves the ML algorithms, TDA approaches to Deep Learning: Utility of TDA to all parts of Deep Learning pipelines.

Instruction Schedule

[Provide session-wise schedule]

Section/Topic	Week	CO Mapping
Basic Topology	Week 1-3	CO1, CO2
Simplicial Complex	Week 4	CO3
Simplicial Homology	Week 5-7	CO4
Morse Theory	Week 8-10	CO5
Persistent Homology	Week 11-14	CO6, CO7
TDA for Machine Learning	Week-15	CO8

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Computational Topology: An Introduction, Gunter Rote and Gert Vegter (Springer book chapter)
2. Computational Topology: An Introduction-Herbert Edelsbrunner, John Harer, American Mathematical Society, 2010.
3. Topology for Computing-Afra Zomorodian, Cambridge University Press, 2005.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

1. Mid-term: 40%
2. Project: 40%
3. Presentation: 20%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Final Project will be implementation of an algorithm on: Simplicial Homology/Topology of Surfaces/ Persistence Diagram/ Data-structure to capture Scalar Topology	CO4, CO5, CO6, CO7

Evaluation Procedures
Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy
State any penalty policy for late submission

As per institute policy

Make-up Exam/Submission Policy
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)
[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs
[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	CS/DS 704 / Multi-Agent Systems	
Course Instructor Name(s)	Srinath Srinivasa	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	40	Lecture (1hr = 1 credit)
	8	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 40:8:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	IIITB scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data			Networking and Communication
X	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	First level course on Probability, Statistics and Linear Algebra First level course on Discrete Mathematics

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	Topics covered in this course is used in several application areas including Agent-based modeling, Autonomous Vehicles, Strategic Management, Policy Design, etc. However, the course itself is not modeled for any specific employability requirement.
Focus on skill development	Yes	Develop skills in Agent based modeling tools.
Focus on entrepreneurship	No	Course focuses on technology and concepts
Provides value added / life skills (language, writing, communication, etc.)	Yes	Mandate system of evaluation requires students to develop design, synthesis and presentation skills.

Course Context and Overview

Thinking about systems in terms of autonomous agents and their interactions, has elicited a number of advancements in AI and even insights into possible Artificial General Intelligence (AGI). At the core of this pursuit, is the question of autonomy and agency that individual agents are endowed with. The idea of agency itself has been proposed using different paradigms. Currently, models from rational choice theory, behavioural economics, and game theory are seen as most promising underpinnings for modeling multi-agent systems.

In this course, we will briefly introduce different models of computational agency, as well as essential elements of distributed computing, rational choice theory, game theory, extensive game modeling and reinforcement learning, negotiations, voting and auction theories.

Multi-agent simulations are also increasingly used to understand the implications of policy interventions in human societies, where autonomous agents represent human individuals or collectives. Human rationality is known to have important differences from classical rational choice theory. This course also addresses human rationality and its various traits like bounded rationality, risk aversion, rational empathy, common rational fallacies, etc.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand concepts of autonomy and agency, and model systems in terms of populations of agents	PSO3, PO4	U, An	F, C	10	0
CO2	Model situations as rational games and solve them according to multiple solution concepts	PO3, PO4	U, Ap, An	C, FDP	6	2
CO3	Understand different models of rationality and different implications of using any of these models	PO3, PO4	U, An	C, FDP	12	2
CO4	Understand extensive games and reinforcement based adaptive behaviour	PO3, PO4	U, Ap, An	C, FDP	8	2
CO5	Understand negotiation theory, auction theory, voting theory, and mechanism design	PO3, PO4	U, Ap, An	C, FDP	4	2

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Mandate - 1: Introductory concepts and fundamentals of distributed systems

Introductory concepts:

- Machines versus Societies
- Characteristics of multi-agent systems
- Definitions of autonomous behaviour
- Paradigms of Computational Autonomy

Essentials of distributed computing:

- Time, events and ordering in distributed systems
- Logical clocks, vector clocks, matrix clocks
- The consensus problem
- The many faces of consensus in distributed systems
- Global snapshot computation

Mandate - 2: Rational choice and Simultaneous games

Rational choice theory

- Classical model of rational choice (von Neumann and Morgenstern)
- Rational Empathy and welfare theory (Amartya Sen)
- Bounded rationality (Herbert Simon)

- Prospect theory (Kahnemann and Tversky)

Simultaneous games

- Definition of a game, types of games
- Beliefs, Strategies and Payoffs
- Analysis of simultaneous games
    - Pure and mixed strategies
    - Dominant strategies
    - Game resilience to beliefs
    - Nash equilibrium
    - Pareto optimality
    - Minmax and iterated dominance
    - Collusion and subgames

Mandate - 3: Iterated and Evolutionary Games, Extensive Games and Reinforcement Learning

- Iterated simultaneous games
    - Incorporating memory into games
    - Stable strategies
    - Evolutionary games
    - Modeling evolution and demographics
    - Evolutionary stability and the evolution of cooperation
    - Robustness of ESS
- Extensive Games
    - Robotic sensing and planning
    - Markov Decision Process and Q learning
    - Other models of Reinforcement Learning
    - Multi-armed Bandit problem

Mandate - 4: Collective Choice, Negotiation, Auction and Voting Theory

- Definitions of social consensus
- Negotiation elements: equilibrium
- consistency, validation, fairness, increased utility
- Monotonic concession protocol;
- Zeuthen strategy;
- Multi-lateral negotiations
- Basic Auctions: English auction, Dutch auction, First-price sealed-bid, Vickrey auction, All-pay auction;
- Reverse auctions;
- Expected payoff;
- Collusions;
- Combinatorial auctions and the winner determination problem.

Instruction Schedule

- Mandate - 1: 3 weeks
- Mandate - 2: 2 weeks

- Mandate - 3: 5 weeks
- Mandate - 4: 3 weeks
- Mandate - 5: 3 weeks

Learning Resources

1. Jose M Vidal. Fundamentals of Multi-agent Systems using NetLogo. Available online.
2. C.H. Papadimitriou. Algorithms, Games, and the Internet. Proc. STOC-2001, ACM Press, 2001. Invited talk write-up.
3. M. Wooldridge and N.R. Jennings. Intelligent Agents: Theory and Practice. *Knowledge Engineering Review*, 10(2):115-152, 1995. (URL: http://www.csc.liv.ac.uk/~mjw/pubs/ker95.pdf)

Topics from Game Theory

1. M.J. Osborne. An Introduction to Game Theory. Oxford University Press, 2004. (Chapters: 1,2,9,13,14)

Negotiations

1. Eithan Ephrati and Jeffrey S. Rosenschein. Multi-Agent Planning as a Dynamic Search for Social Consensus. The Thirteenth International Joint Conference on Artificial Intelligence, Chambery, France, August 1993, pages 423-429.
2. Eithan Ephrati and Jeffrey S. Rosenschein. Journal of Artificial Intelligence. Deriving Consensus in Multi-agent Systems. Volume 87, Numbers 1-2, November 1996, pages 21-74.

Auctions

1. R.P. McAfee and J. McMillan. Auctions and Bidding. *Journal of Economic Literature*, 25:699-738, 1987.
2. T.W. Sandholm. Distributed Rational Decision Making. In G. Weiss (ed.), *Multiagent Systems*, MIT Press, 1999. (URL: http://www.cs.cmu.edu/~sandholm/rational.ps)
3. T.W. Sandholm. Optimal Winner Determination Algorithms. In P. Cramton *et al.* (ed.), *Combinatorial Auctions*, MIT Press, 2006. (URL: http://www.cs.cmu.edu/~sandholm/windetalgs.pdf)
4. L.M. Asubel and P. Milgrom. The Lovely but Lonely Vickrey Auction. In P. Cramton *et al.* (ed.), *Combinatorial Auctions*, MIT Press, 2006. (URL: http://www.stanford.edu/~milgrom/publishedarticles/Lovely%20but%20Lonely%20Vickrey%20Auction-072404a.pdf)
5. H.R. Varian. Economic Mechanism Design for Computerized Agents. Proc. Usenix Workshop on Electronic Commerce, 1995. (URL: http://www.sims.berkeley.edu/~hal/Papers/mechanism-design.pdf)

Software Resources

- NetLogo. http://ccl.northwestern.edu/netlogo/
- VisualBots. http://www.visualbots.com/index.htm
- MASON. http://www.cs.gmu.edu/~eclab/projects/mason/
- Repast. http://repast.sourceforge.net/

Other WWW links

- Multi-Agent Systems and Agent Based Modeling. http://multiagent.com/

- Course on Multi-agent Systems at the University of Amsterdam: http://staff.science.uva.nl/~ulle/teaching/mas/
- Multi-Agents Lab at UMASS. http://dis.cs.umass.edu/
- SwarmWiki. A Wiki for Agent and Swarm Computing. http://www.swarm.org/wiki/Main_Page
- MIT OCW course on Topics in Game Theory. http://ocw.mit.edu/OcwWeb/Economics/14-147Spring-2005/CourseHome/index.htm
- Agentlink: European Network for Agent-based Computing. http://www.agentlink.org/
- MIT Center for Collective Intelligence. http://cci.mit.edu/index.html

Assessment Plan

Mandate system of assessment is used in this course. Each learning mandate requires every student to make at least one primary (and any number of secondary) mandate contributions, which are graded directly with the IIITB letter grade. Each mandate also has an end-of-mandate quiz that is administered as a pass/fail requirement. Overall grade is the average of letter grades obtained over all mandate contributions.

For large classes (60+ students), the mandate system is modified as follows:

1. Students need to make just one primary mandate contribution relevant to any mandate of their choice, over the entire course-- and not one contribution per mandate
2. The end-of-mandate quiz will be graded towards the final grade
3. All quizzes and the mandate contributions will have equal weightage. Hence, if the course has 4 mandates, then each reflection quiz, and the course-wide mandate contribution, will have a weightage of 1/5 each.

More details about the Mandate-oriented classroom model may be found here: https://docs.google.com/document/d/1suVvDnzqJkrFv1IywDiEdDaXihngMXh3cAPmoSR0DlE/edit?usp=sharing

Assignments / Projects

None. Please see details about mandate contributions above.

Evaluation Procedures

Mandate system of assessment is used in this course. Each learning mandate requires every student to make at least one primary (and any number of secondary) mandate contributions, which are graded directly with the IIITB letter grade. Each mandate also has an end-of-mandate quiz that is administered as a pass/fail requirement. Overall grade is the average of letter grades obtained over all mandate contributions.

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More details about the Mandate-oriented classroom model may be found here:
https://docs.google.com/document/d/1suVvDnzqJkrFv1IywDiEdDaXihngMXh3cAPmoSR0DlE/edit?usp=sharing

Late Assignment Submission Policy

A mandate is closed only after every student contributes to the mandate. The entire course remains incomplete for all students, until all students have contributed. Late submissions will result in entire class lagging behind, which the students will be made to understand and appreciate at the outset.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Referenced literature have to be cited in mandate contributions.

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	Digital Sociology		
Course Instructor Name(s)	Bidisha Chaudhuri		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
		Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
X	M.Sc.

Branch:

X	CSE
X	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	Yes	Students can assess the impact of digital technologies on social institutions and diverse groups
Focus on entrepreneurship	Yes	Train students to explore social impact of technologies and help them understand key areas where technology innovation is required
Provides value added / life skills (language, writing, communication, etc.)	Yes	This course focuses on multiple writing assignments

Course Context and Overview

[*Provide introduction to the course*]

Sociology as a discipline concerns itself with the intricate and infinite ways in which the relationships between individual and society unfold. Thus, there is hardly any sphere of our existence that sociologists are not interested in, starting from intimate personal relationships to large scale circulation of ideas, institutions, practices, goods and people (Warwick, Department of Sociology, n.d.). While the scope of the discipline is limitless, its uniqueness in dealing with this wide variety of subjects lies in what C.W. Mills called the "sociological imagination" (1959), the ability to connect all social events and human actions to specific historical and social contexts. Being fundamental pillar of the discipline, changing historical and social context considerably shape the scope of Sociology.

In this course, we will focus on the historical and social context of digital society – an increasingly digitized world that permeates everyday existence of our lives, from self to interpersonal relationships, from institutions to practices, from knowledge to ways of knowing. The term digital Sociology is meant to capture human relationships and events in connection to the larger context of digital society.

The work of digital sociologists is broadly categorised into four categories (Lupton 2015): a) Professional digital practice - using digital media tools for professional purposes of Sociological work; b) Digital data analysis -using digital data for social research; c) Sociological analyses of digital use - researching the ways in which people's use of digital media configures their sense of selves, their embodiment and their social relations; d) Critical digital sociology : undertaking reflexive and critical analysis of digital media informed by social and cultural theory. In this course we will take on a combination of the last two categories. In doing so, we will draw on research in Internet studies, information and communication studies, media and cultural studies, the sociology of science and technology, surveillance studies, and computer science to cultivate a "sociological imagination" that connects us to the contemporary digital society.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand Sociological Approach to Formulate Social Problem	PO6 (iMTech) PO 2, 5 (MSc)	Un	C	3	1
CO2	Understand the significance of sociological analysis of technology impact	PO6 (iMTech) PO 2, 5 (MSc)	Un	C	3	2
CO3	Analyse the impact of digital technologies on social institutions	PO6,7, 10 (iMTech) PO 2,3, 5 (MSc)	An	F, C	12	4
CO4	Analyse the impact of digital technologies on diverse social group, specifically the marginalised	PO 6, 7, 8, 10 (iMTech) PO 2,3, 4, 5 (MSc)	An	F, C	15	4
CO5	Analyse the emergence and workings of new social spaces due to digital technologies	PO 6,7, 10 (iMTech) PO 2,3, 5	An	F, C	12	4
CO6						
CO7						
CO8						
CO9						
CO10						

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Introduction – What is to be a Sociologist in a Digital Society?
   - Sociological Imagination
   - Sociological Consciousness
   - Critical Digital Sociology
2. Social Institutions in a Digital Society
   - Diverse Technology, Diverse Use
   - Digital Culture
   - Sharing Economy
   - E-health
   - Digital Politics
3. Social Relationships in a Digital Society
   - Self and the Intimate
   - Caste
   - Gender
   - Race
   - Labour
4. Digital Spaces
   - Moving beyond the Private and Public
   - Social Media
   - Smart Cities
   - Apps and Platforms
   - Bodies as Digital Spaces: Of Surveillance and Identities

Instruction Schedule

[Provide session-wise schedule]

Week	Topic
1	Introduction to the course Sociological Imagination & Sociological Consciousness
2	Critical Digital Sociology
3	Diverse Technology, Diverse Use
4	Digital Culture
5	Sharing Economy
6	E-health
7	Digital Politics
8	Self and the Intimate and the Digital
9	Digital Race
10	Digital Caste
11	Gender and the Digital
12	Digital Labour
13, 14, 15	Digital Spaces: Moving beyond the Private and Public Social Media Smart Cities Apps and Platforms Bodies as Digital Spaces: Of Surveillance and Identities

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Mills, C.W (1959). “The Promise” in Sociological Imagination. Oxford University Press Berger, P.L. (1963). “Sociology as a Form of Consciousness” in Invitation to Sociology, Anchor B
2. Lupton. D. (2015). Digital Sociology. Routledge (Selected Chapters)
3. Castells, M. (1996).The Rise of the Network Society. The Information Age: Economy, Society, and Culture Volume I (Information Age Series). London: Blackwell. (Selected Chapters)
4. Kate Orton-Johnson and Nick Prior (ed.) (2013). *Digital Sociology: Critical Perspectives.* Palgrave Macmillan, London. (Selected Chapters)
5. Deuze, M. (2006). Participation, remediation, bricolage: Considering principal components of a digital culture. The information society, 22(2), 63-75.
6. Sassen, S. (2016). “Digital Cultures of Use and their Infrastructures” (Chapter 5) in *The Sociology of Speed: Digital, Organizational, and Social Temporalitinv es*, 72
7. Hardey, M. (2001). 'E-health': the internet and the transformation of patients into consumers and producers of health knowledge. Information, Communication & Society, 4(3), 388-405.
8. Lupton, D. (2014). Apps as artefacts: Towards a critical perspective on mobile health and medical apps. Societies, 4(4), 606-622.
9. Couldry, N. (2015). The myth of ‘us’: digital networks, political change and the production of collectivity. Information, Communication & Society, 18(6), 608-626.
10. Milan, S.(2015).When algorithms shape collective action: Social media and the dynamics of cloud protesting.Social Media+Society,1(2)
11. Morozov, Evgeny. "The Internet, Politics and the Politics of Internet Debate." In Ch@nge: 19 Key Essays on How the Internet Is Changing Our Lives. Madrid: BBVA, 2013.
12. Pal, J., & Gonawela, A. (2016, September). Political social media in the global South. In *Conference on e-Business, e-Services and e-Society* (pp. 587-593). Springer, Cham.
13. “Serial Selfies” (Chapter 3) in Rettberg, J. W. (2014). Seeing ourselves through technology: How we use selfies, blogs and wearable devices to see and shape ourselves. Springer.
14. Lupton, D. (2016). The diverse domains of quantified selves: self-tracking modes and dataveillance. Economy and Society, 45(1), 101-122.
15. Nouwens, M., Griggio, C. F., & Mackay, W. E. (2017, May). WhatsApp is for family; Messenger is for friends: Communication Places in App Ecosystems. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (pp. 727-735). ACM.
16. McKay, D. (2010). On the face of Facebook: historical images and personhood in Filipino social networking. History and Anthropology, 21(4), 479-498
17. Boyd, D. (2013). White flight in networked publics. How race and class shaped American teen engagement with MySpace and Facebook. In L. Nakamura & PA Chow-White (Eds.), *Race after the Internet*, 203-222.
18. Gandy, O. H. (2013). “Matrix multiplication and the digital divide” (Chapter 6) in *Race after the Internet* (pp. 134-151). Routledge.
19. Wilson, E. J., & Costanza-Chock, S. (2011). New voices on the net? The digital journalism divide and the costs of network exclusion. Race after the internet.

20. Pramod K. Nayyar (2011) The Digital Dalit: Subalternity and Cyberspace, The Sri Lanka Journal of Humanities XXXVII (1&2)
21. Thirumal, P and Gary Michael Tartakov (2011) "India's Dalits Search for a Democratic Opening in the Digital Divide" (Chapter 2) in *International Exploration of Technology Equity and the Digital Divide: Critical. Historical and Social Perspectives*. Ed. Patricia Randolph Leigh. Hershey, New York: Information Science Reference, 2011. (20-39)
22. Chopra, Rohit. 'Global Primordialities': Virtual Identity Politics in Online Hindutva and Online Dalit Discourse', New Media and Society 8.2 (2006):187-206.
23. Kamath, A. (2018). "Untouchable" cellphones? Old caste exclusions and new digital divides in peri-urban Bangalore. Critical Asian Studies, 1-20.
24. Duffy, B. E., & Pruchniewska, U. (2017). Gender and self-enterprise in the social media age: A digital double bind. Information, Communication & Society, 20(6), 843–859
25. Tacchi, J., Kitner, K., & Crawford, K. (2012). Meaningful mobility: Gender, development and mobile phones. Feminist Media Studies, 12(4), 528–537
26. Schoemaker, E. (2015). "Digital purdah": How gender segregation persists over social media. Dawn. Retrieved from https://www.dawn.com/news/1197345
27. The Silicon Valley of Dreams and Nightmares of Exploitation:The Google Labour Aristocracy and Its Context (Chapter 9) in Fuchs, C. (2014). Digital Labour and Karl Marx. Routledge. pp. 213-232
28. Zuboff, S. (1985). Automate/informate: The two faces of intelligent technology. Organizational dynamics, 14(2), 5-18.
29. Fuchs, C., & Sevignani, S. (2013). What is Digital Labour? What is Digital Work? What's their Difference? And why do these Questions Matter for Understanding Social Media?. TripleC (Cognition, Communication, Co-Operation): Open Access Journal for a Global Sustainable Information Society, 11(2). Graham, M., Hjorth, I., & Lehdonvirta, V. (2017). Digital labour and development: impacts of global digital labour platforms and the gig economy on worker livelihoods. Transfer: European Review of Labour and Research, 23(2), 135-162.
30. Arcy, J. (2016). Emotion work: considering gender in digital labor. Feminist Media Studies, 16(2), 365-368.
31. Boyd, D. M., & Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. Journal of computer-mediated Communication, 13(1), 210-230
32. Juris, J. S. (2012). Reflections on# Occupy Everywhere: Social media, public space, and emerging logics of aggregation. American Ethnologist, 39(2), 259-279.
33. Boyd, D. (2008). Facebook's privacy trainwreck: Exposure, invasion, and social convergence. Convergence, 14(1), 13-20.
34. Lange, P. G. (2007). Publicly private and privately public: Social networking on YouTube. Journal of computer-mediated communication, 13(1), 361-380.
35. Gerlitz, C., & Helmond, A. (2013). The like economy: social buttons and the data-intensive web. New Media & Society, 15.
36. Townsend, Anthony M. Chapter 10, *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*. W.W. Norton & Company, 2014.
37. Cardullo, Paolo, and Rob Kitchin. 2018. "Smart Urbanism and Smart Citizenship: The Neoliberal Logic of 'citizen-focused' Smart Cities in Europe." SocArXiv. March 9
38. Datta, A. (2015). New urban utopias of postcolonial India: 'Entrepreneurial urbanization' in Dholera smart city, Gujarat. Dialogues in Human Geography, 5(1), 3-22.
39. Kitchin, R. (2014). The real-time city? Big data and smart urbanism. GeoJournal, 79(1), 1-14.

40. Vanolo, A. (2014). Smartmentality: The smart city as disciplinary strategy. Urban Studies, 51(5), 883-898. Bennett, C., Raab, C., & Regan, P. (2005). "People and place: Patterns of individual identification within intelligent transportation systems" (Chapter 8) in *Surveillance as Social Sorting*, Routledge
41. Gillespie, T. (2010). The politics of 'platforms'. New media & society, 12(3), 347-364.
42. Helmond, A. (2015). The platformization of the web: Making web data platform ready. Social Media+ Society, 1(2),
43. Nieborg, D. B. (2015). Crushing candy: The free-to-play game in its connective commodity form. Social Media+ Society, 1(2)
44. Singh, R. (2019). Give Me a Database and I Will Raise the Nation-State. South Asia: Journal of South Asian Studies, 1-18.
45. Weltevrede, E., Helmond, A., & Gerlitz, C. (2014). The politics of real-time: A device perspective on social media platforms and search engines. Theory, Culture & Society, 31(6), 125-150.
46. Hayles, N. K. (1999). Toward embodied virtuality (Chapter 1). How we became posthuman: virtual bodies in cybernetics, literature, and informatics, University of Chicago Press
47. Dubbeld, L. (2003). Observing bodies. Camera surveillance and the significance of the body. Ethics and Information Technology, 5(3), 151-162.
48. Van der Ploeg, I. (2012). The body as data in the age of information. Ball, K., Haggerty, KD, and Lyon, D.: Routledge Handbook of Surveillance Studies, London/New York: Routledge, 176-184.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Class attendance: 5%
Individual Reading Response: 20%
Group activities: 30%
Writing Assignments: (45%):

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Classroom learning will include attendance and students' engagement in the classroom discussion	CO 1-5
2	Two Individual Reading Response to asses students' understanding of the text and its connection to classroom discussion	CO1 -5
3.	This will take the form of storyboard-based group assignments conducted at the end of each of the three modules of instruction. Student groups will be	CO 3, 4, 5

	presented storyboards ahead of time and asked to present their ideas in class on the designated activity day. These storyboards may include texts as well as audio visual mediums	
4	Writing Assignments: This will include 4 write ups, one after each module. The last one will be considered as an end term essay will be graded with higher value.	CO 3, 4, 5

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	DT 304 Digital Product Development	
Course Instructor Name(s)	Janaki Srinivasan	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	4	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
X	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Teaches students how social divides shape the heterogeneous consequences of a technology initiative, and sensitises them to the importance of factoring this into the design, deployment and use of digital technologies for diverse populations
Focus on skill development	Yes	Teaches critical thinking and analytical skills
Focus on entrepreneurship	Yes	Highlights cases of development-focussed entrepreneurial ventures; teaches how to analyse the challenges and promise of such ventures
Provides value added / life skills (language, writing, communication, etc.)	Yes	Trains students in reading, writing and skills of constructing an evidence-based argument about the working of a technology initiative

Course Context and Overview

The objective of this course is to give the students a hands-on experience of various aspects of digital product development. The course will be conducted as a series of exercises and projects. In keeping with the larger goals of the Digital Society and other Masters programmes at IIITB, the readings and exercises would be designed to make the participants aware of the challenges involved and also help them experience what often goes wrong.

We will have a few reading exercises and presentations on digital product development and processes. However, the primary focus would be the actual exercises.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the basic elements of digital product management	PO3	R, U	C	4	

CO2	Define and fine-tune framework to evaluate digital products	PO4, PO5	R, U	C	4	4
CO3	Evaluate the working of public-facing websites in real time	PO3, PO4	Ap, E	F, C	7	5
CO4	Conceptualize digital solutions for a social cause.	PO3, PO4	U, An	F, C	10	2
CO5	Build digital solutions for a social cause.	PO3, PO4	U, Ap,	F, C, P	10	2
CO6	Understand SDLC, HDLC, Design for Six Sigma and Agile processeses	PO3	R, U	F, C	4	
CO7	Conceptualize and develop a metric to measure the effectiveness of a working system	PO3, PO4	U, Ap	F, C, P	6	2
					45	**15**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

The course will be conducted as a series of exercises and projects. The exercises would be designed to make the participants aware of the challenges involved and also help them experience what often goes wrong. We will have a few reading exercises and presentations on digital product development and processes. However, the primary focus would be the actual exercises, which could include:

1. Analysis of web based solutions used by people who don't understand the underlying technology, such as a) The railways reservation site b) Passport application and processing c) Income tax d) Flipkart e) GOI sites f) PF g) e-learning sites
2. Analysis of a social media based solution to serve a public cause like a) Driving discipline b) Better Queuing etiquette c) Public participation in road management.
3. Analysis and use of a method to gather and analyze data on the effectiveness of Ayurveda or Yoga, such that it can compare with the drug approval process followed by big pharma.
4. Examining a solution which includes a hardware component to help increase literacy.

For exercises similar to #2, #3 and #4, the students will have to go through the whole development life cycle. Implementation will have very minimal (or none) importance and thus the engineering knowledge expected is minimal. If teams can be formed with sufficient engineering strength, then one or more exercises (like say #2) will be implemented.

Instruction Schedule

[Provide session-wise schedule]

Week 1:
Introduction

Week 2:
Define an evaluation framework. Fine tune the evaluation framework each week.

Week 3:
Analyze IRCTC and IIIT Website

Week 4:
Analyze and compare Amazon and Flipkart.

Week 5:
Analyze IPTO and the PSK service.

Week 6 to 9:
Conceptualize and build a social network based solution for a social cause.

Week 10:
Student seminars on SDLC, HDLC, Design for Six Sigma and Agile processes

Week 11:
Discuss how the Month 2 exercise could have been done better. Analyze an Indian e-learning site.

Week 12, 13:

Conceptualize and develop (building a working prototype is not mandatory) a solution to measure the effectiveness of Yoga or Ayurveda. The aim is to make the measure comparable to the drug approval process followed by big pharma.

Week 14, 15:

Conceptualize and develop a solution using digital technologies to eliminate illiteracy in a geography.

Week 16:

Recap

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assessment criteria:

Presentation:	15%
Discussions and ideas:	15%
Workshops on analysis and evaluation:	20%
Workshops on conceptualization and product building:	50%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
	Presentation:	CO1-CO6
	Discussions and ideas:	CO4, CO5, CO6
	Workshops on analysis and evaluation:	CO3-CO6
	Workshops on conceptualization and product building:	CO7, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided an opportunity to view their graded essays over email or in person. They will also have an opportunity to view other components of their score and enquire about them.

Late Assignment Submission Policy

State any penalty policy for late submission
Students will not be allowed to submit their essays or other assignments later than the deadline other than for valid medical reasons.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Students may follow any recognized citation standard such as APA, or Chicago, as long as they do so consistently.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

Accommodations will be as per institute policy.

Course Syllabus

Course Code / Course Name	DT 305 From Territorial Place to Cyberspace: The Political Economy of Location	
Course Instructor Name(s)	Balaji Parthasarathy	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	4	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**x**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

x	iMTech
	M.Tech
x	M.Sc.

Branch:

x	CSE
x	ECE
x	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
x	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

NONE (but exposure to HSS102 is encouraged)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	x	Engages students to critically think about how/why social and political factors continue to influence the location of economic activity despite certain activities taking place in the “cloud” or in cyberspace.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	x	The readings for the class, the discussions around the readings, and the term paper force students to articulate their ideas about the relationship between technology, globalization and location,

Course Context and Overview

[*Provide introduction to the course*]

Overview: Economic globalization in recent decades, and advances in IT, has greatly increased international flows of ideas, capital, goods, and, to a lesser extent, people. Certain activities, such as retailing, can indeed be carried out effectively online. However, flows from one location to another, i.e., the spatial separation of, say, production from consumption, does not reduce the significance of the locations themselves. Further, a considerable proportion of socio-economic activity is not so footloose as to be able to flow across the globe. For instance, government activities, or the provision of services such as education or healthcare, are primarily local, as their social characteristics, and the regulatory demands they are subject to, vary across political jurisdictions. Similarly, visiting a tourist site, or going on pilgrimage, is experiential and not merely transactional. As a result, many activities demand physical proximity, the need for which cannot be wished away by technology.

Yet, locational determinants keep changing. As technological change makes possible the production of new goods and services, it opens up new “windows of locational opportunity”. Where those goods can be produced - either because of the cost and availability of inputs like specific skills, or because of politically negotiated policies governing intellectual property rights, or access to venture capital – opens up new locational possibilities which, in turn, is accompanied by shifts in the direction and volume of global flows.

The course will draw on theoretical frameworks from economic geography and development geography to unravel the complexity of locational decisions with examples. The course will begin with static theories of comparative advantage that explain how individual firms in specific sectors chose optimal locations based on access to raw materials and final markets. It will then move to explain how firm location is also determined by proximity to other firms, many of whom may be competitors. This is because of access to shared institutions, such as universities supplying skilled labor, or inputs such as new ideas, which are intangible. The short term costs of locating in such agglomerations are outweighed by the long term benefits of being in a place where, as the British economist Alfred Marshall, pointed out, “the secrets of the trade are in the air”.

The course will also examine how globalization opens up opportunities beyond national boundaries as firms and their activities are spread across the world. Countries and regions that have the infrastructure, the technology and the skills are in the best position to benefit. However, when such conditions are not met, development geography describes and explains the cases of countries like Korea or Taiwan, where political consensus to achieve economic goals has made it possible to “catch-up” with industrialized countries. Even in countries like India, where consensus and catch-up are less evident, improvement in economic prospects requires greater connections with the global economy. Such connections are being made easier by technological improvements, especially in IT. A happy outcome, at least for India, is the rise of Bangalore as a prominent agglomeration of the global software industry.

But contemporary globalization can be a double-edged sword especially since IT is a basket of general purpose technologies which transform all domains of socio-economic activity. The new combination of inputs required for the incorporation of IT to improve the reliability and efficiency of products and services in long-standing sectors might mean more opportunity in a place like Bangalore. On the other hand, when locations do not have the institutions to meet the demand for new inputs, their economic base can be devastated and turn into what sociologist Manuel Castells terms the “black holes of information capitalism”. The economic decline and social devastation in a city like Detroit, with the changes to the technologies underlying manufacturing and the globalization of manufacturing, is a poignant reminder. Similarly, there is enough evidence showing how globalization and IT can also lead to global networks of criminality and socially unwelcome behavior. Thus, this course will bring together the tensions between the local and global, and the role of cyberspace and territorial place in our lives.

Format: All participants will be expected to read the assigned material and come prepared to discuss it in class. Since the course will follow a seminar format, active participation in class discussion will enhance the value of the class for everyone. One or two participants will be asked to take charge of the readings in every class and make a twenty-minute presentation. The presentations are not to be descriptive summaries; instead, they must synthesize the key ideas and concepts in the readings and raise issues for discussion.

Duration: Two hours, twice a week,14 weeks

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand classical location theory	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand	Conceptual	6	

CO2	Understand (inter)national development theories	PO2, PO5, (M,Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	6	
CO3	Understand developmental impacts/outcomes of regional policies	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	6	
CO4	Conceptualize globalization	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	4	
CO5	Understand new institutional approaches to socio-spatial relationships	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand	Conceptual	12	
CO6	Understand critiques of development theories and the possibility of late industrialization	PO2, PO3 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	8	
CO7	Understand technology-enabled globalization, global commodity and production chains	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand	Conceptual	6	
CO8	Understand the transformation brought about by IT to the relationship between space and location	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	6	
CO9	Understand the promises and perils of globalization	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	4	
Total number of hours					58	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

See Instruction Schedule below

Instruction Schedule

[Provide session-wise schedule]

1: Introduction
2: The Germanic Origins of Location Theory
3. From Location to Agglomeration
4: Thinking about International Development
5: Import-Substitution-led Industrialization and Dependency in Latin America
6: Import-Substitution led Industrialization in India
7. The Role of Cities in Development
8. Urban and Regional Policies
9. Urban Bias
10: Conceptualizing Globalization with the Product Cycle Hypothesis
11: The New International Division of Labor
12: The Critical turn in Geography - I
13: The Critical turn in Geography - II
14: Transactions Costs Analysis and the Black Box of the Firm
15: Trusted Transactions, Flexible Organization and the Industrial District
16: Tacit Knowledge and Regional Advantage in Silicon Valley
17: From Post-Fordism to Post-industrial Manufacturing
18: The Washington Consensus and Development
19: Late Industrialization
20. The Developmental State
21. Late-late Industrialization in China and India
22. Global Commodity Chains and Global Value Chains
23. Fixing Global Commodity Chains I: World Cities and Global Cities
24. Fixing Global Commodity Chains: The Internationalization of Industrial Districts
25. The Spatial Logic of New Network Technologies
26. New and Old Networks for e-Commerce and m-Commerce I
27. New and Old Networks for e-Commerce and m-Commerce II
28. The Black Holes of Information Capitalism
29. The Promise and the Perils of Globalization

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Richard Peet. 1970. Von Thünen theory and the dynamics of agricultural expansion. *Explorations in Economic History*. 8(2):181-201.

C J Friedrich (ed.) 1929. *Alfred Weber's Theory of Location of Industries.* University of Chicago Press. Pp.1-34.

August Lösch. 1938. The nature of economic regions. *Southern Economic Journal*. 5(1):71-78.

Harold Hotelling. 1929. Stability in competition*. The Economic Journal.* 39(153):41-57.

Walt Whitman Rostow. 1991 [1960] 3rd ed. *The Stages of Economic Growth: A Non-Communist Manifesto.* Cambridge University Press. Pp.1-16.

P N Rosenstein-Rodan. 1957. Notes on the theory of the "Big Push". Typescript. Center for International Studies, Massachusetts Institute of Technology.

Haripriya Rangan. 2008. "Development" in question. Pp.563-578 in Kevin R Cox, Murray Low, and Jennifer Robinson. *The SAGE Handbook of Political Geography*. SAGE Publications.

Bert F Hoselitz.1953. The role of cities in the economic growth of underdeveloped countries. *Journal of Political Economy*. 61(3):195-208.

John Friedmann. 1969. The role of cities in national development. *American Behavioral Scientist.* 12(5):13-21.

N.V.Sovani. 1962. The analysis of "over-urbanization". *Economic Development and Cultural Change.* 12(2):113-122.

Harry W Richardson. 1972. Optimality in city size, systems of cities and urban policy: A sceptic's view. *Urban Studies.* 9(1):29-48.

D.F. Darwent. 1969. Growth poles and growth centers in regional planning – A Review. *Environment and Planning.* 1:5-32.

Albert O Hirschman. 1968. The political economy of import substituting industrialization in Latin America. *The Quarterly Journal of Economics.* 82(1):1-32.

Andre Gunder Frank. 1976. The development of underdevelopment. *Monthly Review.* 18(4):17-31.

Fernando Henrique Cardoso. 1972. Dependency and development in Latin America*. New Left Review.* 74:83-95.

Isher Judge Ahluwalia. 1991. *Productivity and Growth in Indian Manufacturing.* Oxford University Press. Pp.1-31.

Pranab Bardhan. 1984*. The Political Economy of Development in India.* Oxford University Press.

Michael Lipton. 1975. Urban bias and food policy in developing countries. *Food Policy.* 1(1):41-52.

Robert H Bates. 1993. 'Urban Bias': A Fresh Look. *Journal of Development Studies*. 29(4):219-228.

Ashutosh Varshney. 1993. Urban Bias in Perspective. *Journal of Development Studies.* 29(4):3-22.

Raymond Vernon. 1966. International Investment and International Trade in the Product Cycle. *Quarterly Journal of Economics*. 80(2):190-207.

Raymond Vernon. 1979. The Product Cycle Hypothesis in a New International Environment. *Oxford Bulletin of Economics and Statistics.* 41(4):255-267.

Michael Storper. 1985. Oligopoly and the Product Cycle: Essentialism in Economic Geography. *Economic Geography.* 61(3):260-282.

Folker Fröbel, Jürgen Heinrichs and Otto Kreye. 1978. The World Market for Labour and the World Market for Industrial Sites. *Journal of Economic Issues.* 12(4):843-858.

Alain Lipietz. 1982. Towards Global Fordism? *New Left Review*. 132:33-47.

Rhys Jenkins. 1984. Divisions Over the International Division of Labour. *Capital and Class*. 22:28-57.

Erica Schoenberger. 1988. Multinational Corporations and the New International Division of Labor: A Critical Appraisal. *International Regional Science Review*. 11(2): 105-119.

Richard A Walker. 1981. Industrial Location Policy: False Premises, Wrong Conclusions. *Built Environment.* 6(2):105-113.

Ricard A Walker and Michael Storper. 1981. Capital and Industrial Location. *Progress in Human Geography.* 5(4):473-509.

Doreen B Massey. 1973. Towards a Critique of Industrial Location Theory. *Antipode.* 5(3):33-39.

Michael Storper and Richard A Walker. 1983. The Theory of Labour and Theory of Location. *International Journal of Urban and Regional Research.* 7(1):1-44.

David Harvey. 1975. The Geography of Capitalist Accumulation: A Reconstruction of the Marxian Theory. *Antipode.* 7(2):9-21.

Allen J Scott. 1983. Industrial Organization and the Logic of Intra-Metropolitan Location I: Theoretical Considerations. *Economic Geography.* 59:233-250.

Allen J Scott. 1983. Industrial Organization and the Logic of Intra-Metropolitan Location II: A Case Study of the Printed Circuits Industry in the Greater Los Angeles Region. *Economic Geography.* 59:343-367.

Allen J Scott. 1984. Industrial Organization and the Logic of Intra-Metropolitan Location III: A Case Study of the Women's Dress Industry in the Greater Los Angeles Region. *Economic Geography.* 60:2-37.

Charles F Sabel and Jonathan Zeitlin. 1985. Historical Alternatives to Mass Production: Politics, Markets and Technology in Nineteenth Century Industrialization. *Past and Present.* 108:133-176.

Sebastiano Brusco. The Emilian model: Productive decentralisation and social integration. *Cambridge Journal of Economics.* 6:167-184.

Annalee Saxenian. 1991. The Origins and Dynamics of Production Networks in Silicon Valley. *Research Policy.* 20:423-437.

Annalee Saxenian. 1996. Inside-Out: Regional Networks and Industrial Adaptation in Silicon Valley and Route 128. *Cityscape.* 2(2):41-60.

Matthew A Zook. 2004. The Knowledge Brokers: Venture Capitalists, Tacit Knowledge and Regional Development. *International Journal of Urban and Regional Research.* 28(3):621-641.

Jaikumar Ramachandran. 1986. Post-industrial manufacturing. *Harvard Business Review.* November-December: 69-76.

Andrew Sayer. 1986. New developments in manufacturing: The just-in-time system. *Capital & Class.* 10(3):43-72.

Andrew Sayer. 1989. Post-fordism in question. *International Journal of Urban and Regional Research.* 13(4):666-695.

Deepak Lal. 2002 (3rd ed.). *The Poverty of 'Development Economics'.* Institute of Economic Affairs. pp.35-97, 125-149 (Introduction, Chapters 1, 2 and 4)

Michael Porter. 1990. The Competitive Advantage of Nations. *Harvard Business Review.* 90(2):73-91.

Alexander Gerschenkron. 1962. Economic Backwardness in Historical Perspective. Pp.5-30 (Chapter 1) in *Economic Backwardness in Historical Perspective: A Book of Essays.* Praeger.

Chalmers A Johnson. 1999. The Developmental State: Odyssey of a Concept. Pp.32-60 (Chapter 2) in Meredith Woo-Cummings (ed.). *The Developmental State.* Cornell University Press.

Alice H Amsden. 1987. The Paradigm of Late Industrialization. *Political Economy: Studies in the Surplus Approach.*3(2):133-159.

Manuel Castells. 1992. Four Asian Tigers with a Dragon Head: A Comparative Analysis of the State, Economy and Society in the Asian Pacific Rim. Pp. 33-70 (Chapter 2) in Richard P Applebaum and Jeffrey Henderson (eds.). *States and Development in the Asian Pacific Rim.* Sage.

Peter B Evans. 1989. Predatory, Developmental and other Apparatuses: A Comparative Political Economy Perspective on the Third World State. *Sociological Forum.* 4(4):561-587.

Pranab Bardhan. 2010. *Awakening Giants, Feet of Clay: Assessing the Economic Rise of China and India.* Princeton University Press.

Gary Gereffi. 1996. Global Commodity Chains: New Forms of Coordination and Control among Nations and Firms in International Industries. *Competition & Change* 1(4):427-439.

Gary Gereffi, John Humphrey, Timothy J Sturgeon. 2005. The Governance of Global Value Chains. *Review of International Political Economy.* 12(1):78-104.

John Friedmann. 1986. The World City Hypothesis. *Development and Change.* 17:69-83.

Saskia Sassen. 2005. The Global City: Introducing a Concept. *Brown Journal of World Affairs.* 11(2):27-43.

Ed Brown et al. 2010. World City Networks and Global Commodity Chains: towards a world-systems integration. *Global Networks.* 10(1):12-34.

Marco Bellandi and Lisa De Propris. 2015. The Generation of Industrial districts. *Journal of Regional Research.* 32:75-87.

Dan Breznitz and Michael Murphree. 2011. Shenzehn and the Pearl River Delta. Chapter 5 (pp.160-194) in *Run of the Red Queen: Government, Innovation, Globalization and Economic Growth in China.* Yale University Press.

Annalee Saxenian and Jinn-Yuh Hsu. 2001. The Silicon Valley-Hsinchu Connection: Technical Communities and Industrial Upgrading. *Industrial and Corporate Change.*10(4):893-920.

Anthony M Townsend. 2001. The Internet and the rise of new network cities 1969-1999. *Environment and Planning B: Planning and Design.* 28:39-58.

Anthony M Townsend. 2007. Seoul: birth of a broadband metropolis. *Environment and Planning B: Planning and Design.* 34:396-413.

Mathew A Zook and Stanley A Brunn. 2006. From Podes to Antipodes: Positionality and Global Airline Geographies. *Annals of the Association of American Geographers.* 96(3):471-490.

Yuko Aoyama. 2003. Sociospatial dimensions of technology adoption: recent M-commerce and E-commerce developments. *Environment and Planning A.* 35:1201-1221.

Janaki Srinivasan and Jenna Burrell. 2015. On the Importance of Price Information to Fishers and to Economists: Revisiting Mobile Use Among Fishers in Kerala. *Information Technologies and International Development.* 11(1):57-70.

Matthew A Zook. 2003. Underground globalization: mapping the space of flows of the Internet adult industry. *Environment and Planning A.* 35:1261-1286.

Gary Fields. 2003. Communications, innovation and territory: The production network of Swift Meat Packing and the creation of a national US market. *Journal of Historical Geography.* 29(3):599-617.

Gary Fields. 2006. Innovation, time, and territory: Space and the business organization of Dell Computer. *Economic Geography.* 82(2):119-146.

Alan Blinder. 2006. Offshoring: The next industrial revolution? *Foreign Affairs.* 85(2):113-128.

Manuel Castells. 2010 (2nd edition). The rise of the Fourth World: Informational capitalism, poverty, and social exclusion. Chapter 2 (pp.69-170) in *Volume III: The End of Millennium. The Information Age: Economy, Society, and Culture.* Blackwell.

Manuel Castells. 2010 (2nd edition). The perverse connection: The global criminal economy. Chapter 3 (pp.171-214) in *Volume III: The End of Millennium. The Information Age: Economy, Society, and Culture.* Blackwell.

Balaji Parthasarathy and Yuko Aoyama. 2016. Beyond ICTs and developmental domains: The historical specificity of ICTD. *Proceedings of the 8th IEEE Information and Communications Technologies and Development Conference*, Ann Arbor, USA, 3-6 June.

Jagdish Bhagwati. 2004. Anti-globalization: Why? *Journal of Policy Modeling.* 26:439-463.

Dani Rodrik. 2012. Globalization dilemmas & the way out. *Indian Journal of Industrial Relations.* 47(3):393-404.

Amartya Sen. 2002. Globalization, Inequality and Global Protest. *Development.* 45(2):11-16.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Class participation 15%
Class presentation 10%
Mid-term examination 20%
Final examination 20%
Final essay 35%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Active participation in class discussions based on assigned readings	All COs
2.	In-class presentation of reading material (a few times a semester)	Potentially any CO
3.	For the term paper, a student is expected to write an essay (6000-8000 words) that draws on the theoretical frameworks in the course to explain why an industry or economic sector has come to play a dominant role in a region. The choice of region, industry/sector is left to the student.	Potentially any CO

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

No late submission of essays without prior instructor permission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Please refer https://owl.purdue.edu/owl/purdue_owl.html and follow any of the formats (eg. APA, MLA) described there.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	DT 307 / The Web and the Mind		
Course Instructor Name(s)	Srinath Srinivasa		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	40	Lecture (1hr = 1 credit)	
	8	Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 40:8	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	IIITB scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites	None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	The course addresses a number of issues of web use that are of interest to employers like advertisers, strategic management, etc. But the course is not designed for any specific employability criteria.
Focus on skill development	No	Mostly conceptual
Focus on entrepreneurship	No	Mostly conceptual
Provides value added / life skills (language, writing, communication, etc.)	Yes	In addition to mandate contributions that require students to write and present, this course addresses cognition and challenges to mental wellbeing as a consequence of Internet and web usage.

Course Context and Overview

This course is an introduction to the cognitive and psychological dimension of human participation in the World Wide Web. The web is a global, participatory social space where human cognition is continuously moulded. This course provides the student a brief introduction to essential elements of cognitive science, and looks at how the web affects our cognition.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the history of the web and the way it has impacted several aspects of human society	PSO 3, PO3	R, U	F, C	6	30
CO2	Understand building blocks of human cognition, its memory processes, attention, cognitive heuristics, emotion, and models of sense of self.	PSO 3, PO3	U	C	10	0
CO3	Understand models of social cognition: territoriality and herding, transaction theory, acquaintance, trust, novelty, persuasion, conformity, affinity, and social identity	PSO 3, PO3	U	C	10	0
CO4	Understand how algorithms that power content on the web is based on and affects individual and social cognition	PSO 3, PO3	U	C	10	0

CO5	Apply models of cognitive and social psychology to elements of web usage	PSO 3, PO3	An, Ap	C, MC	2	4
CO6	Apply models of cognitive and social psychology to explain social media dynamics and its impact on business, governance, and personal well-being	PSO 3, PO3	An, Ap	C, MC	2	4

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Mandate - 1: Models of the web

- *History of the web*
- *Models of the web*
    - *Web as a database*
    - *Web as a digital library*
    - *Web as a cognitive extension of ourselves*
    - *Web as a socio-cognitive space rather than as a tool*
- *Introduction to social machines*
- *Introduction to Persuasive Computing*

Mandate - 2: Essential Cognitive Science

- *Organization of long-term memory and working memory*
- *Procedural and Declarative memory*
- *Semantic and Episodic memory*
- *Attention and its characteristics*
- *Priming, Anchoring and the Availability heuristic*
- *Modeling Emotions: Arity and Intensity*
- *Self, Persona and Identity*
- *Prospect theory and the handling of risk*

Mandate - 3: Essential Social Psychology

- *Acquaintance, FOAF and Triadic closure*
- *Entrenchment, Trust and Novelty*
- *Entrenchment and the Bystander Effect*
- *The strength of weak ties*
- *Affinty, Disaffinity and Network stability*
- *Social conformity*
- *Emotional contagion*

- *Social identity and branding*

Mandate - 4: Attention, Engagement and Persuasion on the web

- *PageRank and the dynamics of online attention flow*
- *Personalization and Attention traps*
- *Sustained versus cursory online attention*
- *Measuring Online Engagement*
- *Persuasive computing*

Mandate - 5: Privacy and online identity

- *The triad of social data utility*
- *Evolution of privacy concerns on the web*
- *Online disinhibition effect*
- *Informed consent models for the web*
- *Self, identity and online projection of identity*
- *Online avatars and the Proteus Effect*
- *Jung's collective subconscious and the web*

Instruction Schedule

- Mandate - 1: 3 weeks
- Mandate - 2: 4 weeks
- Mandate - 3: 5 weeks
- Mandate - 4: 2 weeks
- Mandate - 5: 2 weeks

Learning Resources

Suggested Reading:

Berners-Lee, Tim, Mark Fischetti, and Michael L. Dertouzos. *Weaving the Web: The original design and ultimate destiny of the World Wide Web by its inventor*. Harper Information, 2000.

Meira, Silvio RL, Vanilson AA Buregio, Leandro M. Nascimento, Elaine Figueiredo, Misael Neto, Bruno Encarnacao, and Vinicius Cardoso Garcia. "The emerging web of social machines." In *Computer Software and Applications Conference (COMPSAC), 2011 IEEE 35th Annual*, pp. 26-27. IEEE, 2011.

Fogg, Brian J. "Persuasive technology: using computers to change what we think and do." *Ubiquity* 2002, no. December (2002): 5.

M. Granovetter. The strength of weak ties. American Journal of Sociology, 78(6):1360-1380, 1973.

Easley, D. Kleinberg, J. Networks, Crowds, and Markets: Reasoning About a Highly Connected World. ISBN 9781139490306. http://books.google.co.in/books?id=atfCl2agdi8C 2010. Cambridge University Press

Suler, John. "The online disinhibition effect." Cyberpsychology & behavior 7, no. 3 (2004): 321-326.

Kahneman, Daniel, and Amos Tversky. "Prospect theory: An analysis of decision under risk." In Handbook of the fundamentals of financial decision making: Part I, pp. 99-127. 2013.

Sheehan, Kim Bartel. "Toward a typology of Internet users and online privacy concerns." The Information Society 18, no. 1 (2002): 21-32.

Yee, Nick, and Jeremy Bailenson. "The Proteus effect: The effect of transformed self-representation on behavior." Human communication research 33, no. 3 (2007): 271-290.

Kramer, Adam DI, Jamie E. Guillory, and Jeffrey T. Hancock. "Experimental evidence of massive-scale emotional contagion through social networks." Proceedings of the National Academy of Sciences 111, no. 24 (2014): 8788-8790.

Ribbink, Dina, Allard CR Van Riel, Veronica Liljander, and Sandra Streukens. "Comfort your online customer: quality, trust and loyalty on the internet." Managing Service Quality: An International Journal 14, no. 6 (2004): 446-456.

Gedi, Noa, and Yigal Elam. "Collective Memory—what is it?." History and memory 8, no. 1 (1996): 30-50.

Relevant WWW links

The Center for Humane Technologies

Future of Humanity Institute

Assessment Plan

Mandate system of assessment is used in this course. Each learning mandate requires every student to make at least one primary (and any number of secondary) mandate contributions, which are graded directly with the IIITB letter grade. Each mandate also has an end-of-mandate quiz that is administered as a pass/fail requirement. Overall grade is the average of letter grades obtained over all mandate contributions.

For large classes (60+ students), the mandate system is modified as follows:

1. Students need to make just one primary mandate contribution relevant to any mandate of their choice, over the entire course-- and not one contribution per mandate
2. The end-of-mandate quiz will be graded towards the final grade
3. All quizzes and the mandate contributions will have equal weightage. Hence, if the course has 4 mandates, then each reflection quiz, and the course-wide mandate contribution, will have a weightage of 1/5 each.

More details about the Mandate-oriented classroom model may be found here:
https://docs.google.com/document/d/1suVvDnzqJkrFv1IywDiEdDaXihngMXh3cAPmoSR0DlE/edit?usp=sharing

Assignments / Projects

None. Please see details about the mandate contributions model above.

Evaluation Procedures

Mandate system of assessment is used in this course. Each learning mandate requires every student to make at least one primary (and any number of secondary) mandate contributions, which are graded directly with the IIITB letter grade. Each mandate also has an end-of-mandate quiz that is administered as a pass/fail requirement. Overall grade is the average of letter grades obtained over all mandate contributions.

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https://docs.google.com/document/d/1suVvDnzqJkrFv1IywDiEdDaXihngMXh3cAPmoSR0DlE/edit?usp=sharing

Late Assignment Submission Policy

A mandate is closed only after every student contributes to the mandate. The entire course remains incomplete for all students, until all students have contributed. Late submissions will result in the entire class lagging behind, which the students will be made to understand and appreciate at the outset.

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

Referenced literature needs to be cited in mandate contributions.

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

ज्ञानमुत्तमम्

Course Syllabus

Course Code / Course Name	**Digital Platforms: Technology & Business Components**		
Course Instructor Name(s)	Ramesh Sundararaman & V Sridhar		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	1	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

Programme	
X	iMTech
X	M.Tech
X	M.Sc.
X	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Given that many of the recruitment organizations (commercial & social organizations) visiting campus are engaged in Platform business models, students could leverage their learning from this course for securing jobs during the interview and subsequently while working as part of those firms
Focus on skill development	No	However, students can understand the role & impact of platform technologies & business model on enterprises & social organizations
Focus on entrepreneurship	Yes	Students are encouraged to do market research, understand societal opportunities & challenges, competitive landscape, teardown potential role-models and launch prototypes
Provides value added / life skills (language, writing, communication, etc.)	Yes	This course focuses on multiple writing assignments including teardown and pitch deck

Course Context and Overview

[*Provide introduction to the course*]

This 4 credit course is being offered as one of the electives for MTech, IMTech, MSc (DS) and MS students.

In this course, you will learn about the fundamentals of digital platforms, understand why platforms are superior to products and how you can create your impact / business as a platform.

The course is open to students & researchers who want to learn the latest about platforms; gain an opportunity to build platforms and think of strategies to achieve the requisite social / business impact.

This course provides an opportunity to work on real-life platform-related business ideas and case studies.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

At the end of this course, participants will learn to:

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	• Define & Recognize platform businesses	IMTech (CSE) PO6, PO13 MTech (CSE) PO1 MSc (DS) PO1	U, An, E	F, C	15	
CO2	• Design & Develop Interaction-First Platforms	IMTech (CSE) PO6, PO13 MTech (CSE) PO1 MSc (DS) PO1	Ap, C	F, C, P, M	15	
CO3	• Create Virality / Network Effects	IMTech (CSE) PO6, PO13 MTech (CSE) PO1 MSc (DS) PO1	Ap, C	C	6	3
CO4	• Monetization approaches	IMTech (CSE) PO6, PO13	U	C	3	3

		MTech (CSE) PO1 MSc (DS) PO1				
CO5	• Launch & Scale Platforms	IMTech (CSE) PO6, PO13 MTech (CSE) PO1 MSc (DS) PO1	U, Ap	C	3	9
CO6	• Governance & Regulatory challenges & compliance	IMTech (CSE) PO6, PO13 MTech (CSE) PO1 MSc (DS) PO1	U	F	3	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Digital Platforms
2. Platform Business Model
3. Design & Development of Platforms
4. Platform Ventures

Instruction Schedule

[Provide session-wise schedule]

Wk 1 (Jan 01-03): Digital Platforms - Course Overview

Readings: None

Wk 2 (Jan 06-10): Platform Business Model - Motivation

Primary Readings:

- *Nokia, Our Platform is Burning*

Optional Readings:

- *RIM: Research, No Motion*
- *Interbrand Best Global Brands 2019*
- *Why Software is Eating the World*

Activities:

- *A few students to present (5 minutes) on their favourite platforms on 9th Jan - Upgrad, Aadhar, Wikipedia, HackerEarth, Github, Twitter, Instagram, Vimeo, LinkedIn, Airbnb, Gojek, ...*
- *Form Groups of 2 members (one with Customer / Revenue focus, another with Product / Design focus) and be ready with your team details - Submit the team details by 14th Jan*
- *Choose a platform startup / app of your choice and submit the name of the startup / app by 21st Jan - you need to conduct an analysis / teardown of the platform - using relevant business & technology frameworks*
- *As a team, start working towards identifying a commercial / social challenge that you would want to address using a platform. Submit details of your challenge by 23rd Jan*

Wk3 (Jan 13-17): Platform Business Model - Pipes vs Platforms

Primary Readings:

- *Platform Stack*
- *Platforms vs. Pipes*

Optional Readings:

- *India Stack*
- *Pipes, Platforms and the New Rules of Strategy*
- *Alibaba: Crocodile in the Yangtze*
- *Google is Defragging Android*
- *HBS on Platforms-Crowds*
- *Visa Acquires Plaid*

Activities:

- *Submit your 2 member team details by 14th Jan*

Wk4 (Jan 20-24): Platform Business Model - Strategy

Primary Readings:

- *Platform Canvas*

Optional Readings:

- *The Five Competitive Forces that Shape Strategy"*
- *The Art of Standards War*
- *Business Model Canvas*
- *Platform Business Canvas*
- *Platform Innovation Toolkit*
- *Platform Thinking Labs*

Activities:

- *Before 23rd Jan, 8:00am: Submit through email, the name of the Platform (startup / app). You could choose any Platform Startup / app of your choice. Kindly note this* is an individual activity. You need to conduct an analysis / teardown of the platform - using the relevant business & technology concepts that we learnt during this course

- On the 23rd: Introduce your team and each member's focus first. Then as a team, present an elevator pitch of the commercial / social challenge that you would want to address using a platform

Wk5 (Jan 27-31): Platform Business Model - Virality & Network Effects

Primary Readings:

- *What are Network Effects?*
- *Network Effects Manual?*

Optional Readings:

- *Demystifying Network Effects*
- *Virality vs Network Effects*
- *What are Network Effects?*
- *Big Tech & Network Effects*

Wk6 (Feb 3-7): Platform Business Model - Monetization

Activities:

- *This Week's Classes will be taken by Prof. Sridhar*

Wk7 (Feb 10-14): Platform Business Model - Monetization

Readings:

Activities:

- *11th Feb class will be taken by Prof. Sridhar - In this class, the students will be presenting their thoughts on Monetization, as detailed out by Prof. Sridhar*

- *External Talk by Mr. Salil, founder of QueryHome | AnswerCart on 13th Feb - Here is an opportunity for you to understand directly from the founder of a platform - their thoughts, strategies - and relate to the concepts learnt in class*

Wk8 (Feb 17-21): Design & Develop Interaction-First Platforms

Optional Readings:

- *The Stadium as a Platform*

Reference Websites:

- *Tech Stacks of Global Platform Players*
- *Popular Tech Stacks*
- *Free Marketplace Software - MarketPlace Kit and Open Cart*

Activities:

- *Quiz 1 will be held on Feb 18. This would revolve around all topics discussed in class during the past weeks. The duration of the quiz would be 60 minutes*

Wk9 (Feb 24-28): Design & Develop Interaction-First Platforms

Primary Readings:

- *The Strategic Value of APIs*
- *Corporate Alliances Matter Less Thanks to APIs*

Optional Readings:

- *The Secret to Amazon's Success*
- *Decoding the API Economy*

- *External Talk by [Mr. Saurabh Saha](), founder of TalentPegs and GaliJobs on 25th Feb - Here is an opportunity for you to understand directly from the founder of a platform - his thoughts, strategies - and relate to the concepts learnt in class*

Wk10 (Mar 2-7): Mid-Term Project Presentation Week

Activities:

- *On 5th March, 2:00 - 5:00pm - Each of the 10 teams will present in detail (10 min + 5 min feedback) the progress made over the past 1 month on the project. The other teams will provide feedback to the presenting team. Please load all your presentation in advance on the classroom laptop*

Wk11 (Mar 9-13): Design & Develop Interaction-First Platforms

Primary Readings:

- *When AI is the Product*
- *What if There is no Middleman*

Optional Readings:

- *The Future of Platforms*
- *Countries & Platforms*
- *Blockchain and Decentralization*
- *A Platform Strategy won't work Unless you are good at Machine Learning*
- *What Blockchain means for the Sharing Economy*
- *The TikTok Strategy*

Wk12 (Mar 30-Apr 3): Platform Ventures - Launch Planning

Readings:

- *Regulatory Awareness and Adherence*

Activities:

- *This Week's Classes will be taken by Prof. Sridhar*

Wk13 (Apr 6-Apr 10): Platform Ventures - Launch Planning

Readings:

- *Regulatory Awareness and Adherence*

Activities:

- *This Week's Classes will be taken by Prof. Sridhar*

Wk14 (Apr 13-17): Platform Ventures - Governance

Primary Readings:

- *Ethical Platforms*
- *Platform Cooperativism*

Optional Readings:

- *The Five Pillars of Fairwork*
- *Platforms post COVID*
- *Societal Platforms*

Reference Websites: Platforms & Pandemics

- *Johns Hopkins University*
- *US Digital Response*
- *Arogya Setu Mobile App*
- *SORMAS*
- *Kaggle COVID Challenge*
- *COVID19 India*
- *COVID19 GoK*

Activities:

<u>Wk15 (Apr 20-24): Plaform Ventures - Metrics</u>

Readings: Primary Reading:

- *[Metrics that Matter - Network Effects]*

Optional Readings:

- *[The Key Marketplace Metrics]*
- *[Platform Metrics]*
- *[Metrics for Platform Products]*

<u>Wk16 (Apr 27-May 1): Platform Ventures - Summing Up</u>

Primary Reading:

- *[Evolving your offering into a platform]*

Optional Readings:

- *[For Marketplace Entrepreneurs]*
- *[Accenture on Platform Product Management]*
- *[Open Innovation]*

Activities:

- *On 30th April, we will a talk by Mr. [Varad Krishnan], Co-Founder [100 Open Startups] - Here is an opportunity for you to understand his thoughts, strategies - and relate to the concepts learnt in class*

<u>Wk17 (May 4-8): 2nd Interim Project Presentation Week</u>

Activities:

- *This week, each of the 10 teams will make their 2nd interim presentation (10 min + 5min feedback) detailing the progress made over the past 2 months on the project. The other teams will provide feedback to the presenting team*
- *Kindly prepare a slide deck listing all the frameworks / concepts that you have learnt relating to platforms - which you are currently using to perform the teardown analysis as part of your individual paper submission*
- *Please submit this slide deck via email - by 6th May*
- *Quiz 2 will be held on May 7th. This would revolve around all topics discussed in class during the past weeks (beginning Feb 24th till May 1st)*

Wk18 (May 11-15): External Talk Week

Activities:

- *External Talks by leaders of Sonata - Here is an opportunity for you to understand directly - their thoughts, strategies - and relate to the concepts learnt in class*
- *All individual paper submissions are due before 18th May 8:00am*
- *All team project submissions (slide deck and audio presentation) are due before 22nd May 8:00am*

Wk19 (mid-July): Exam Week

Activities:

- *This week, each of the 10 teams will present in detail (10 min + 5min feedback) the progress made over the past 1 month on the project. The teams could ideally show their platform's website / mobile app (or) presentation deck. The other teams will evaluate and score each of the presenting teams. This is the final presentation for the team project.*
- *This week, we will also have the final examination for this course*

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

The following are the reference books:

1. Platform Revolution

2. [Modern Monopolies]
3. [Platform Scale]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Class Participation: 20%
Quiz: 20%
Case Study / Platform Teardown: 20%
End Exam: 20%
Group Project: 20%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	• *Choose a platform startup / app of your choice and submit the name of the startup / app by 21st Jan - you need to conduct an analysis / teardown of the platform - using relevant business & technology frameworks*	CO1-6
	• *As a team, start working towards identifying a commercial / social challenge that you would want to address using a platform. Submit details of your challenge by 23rd Jan* • *On Jan 23rd: Introduce your team and each member's focus first. Then as a team, present an elevator pitch of the commercial / social challenge that you would want to address using a platform* • *On 5th March, 2:00 - 5:00pm - Each of the 10 teams will present in detail (10 min + 5 min feedback) the progress made over the*	CO1-3

	past 1 month on the project. The other teams will provide feedback to the presenting team. Please load all your presentation in advance on the classroom laptop ● *At the end of the course, each of the 10 teams will present in detail (10 min + 5min feedback) the progress made over the past 1 month on the project. The teams could ideally show their platform's website / mobile app (or) presentation deck. The other teams will evaluate and score each of the presenting teams. This is the final presentation for the team project.*	

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Students will be provided opportunity to view the evaluations done where possible either in person or online

The participants of this course will be evaluated as per the following:

- Class Participation (Discussion on Pre-readings, 2 Member Team assessment, Jan-Apr): 5% each month, totaling 20% - Students to come prepared to the class (read through the pre-readings for each class)
- Best 2 of 3 Quizzes (Individual assessment, Conducted after every 6 weeks - Wk7, Wk13 and Wk19): 20%
- End Exam (Individual assessment): 20%
- Case Analysis / Platform Teardown (Critical review of a Platform - using relevant business and technology frameworks, Individual assessment, Midterm - Mar end): 20%
- Group Project - Platform Business (2 Member Team - Midterm & End term Presentations): 20%

Late Assignment Submission Policy

State any penalty policy for late submission

As per institute policy

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]
Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	DT385 Cyberspace, Globalization and Location	
Course Instructor Name(s)	Balaji Parthasarathy	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	4	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
X	M.Sc.

Branch:

X	CSE
X	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

NONE (but exposure to HSS102 is encouraged)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	X	Engages students to critically think about how/why social and political factors continue to influence the location of economic activity despite certain activities taking place in the "cloud" or in cyberspace.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	x	The readings for the class, the discussions around the readings, and the term paper force students to articulate their ideas about the relationship between technology, globalization and location,

Course Context and Overview

[*Provide introduction to the course*]

Overview: Economic globalization in recent decades, and advances in IT, has greatly increased international flows of ideas, capital, goods, and, to a lesser extent, people. Certain activities, such as retailing, can indeed be carried out effectively online. However, flows from one location to another, i.e., the spatial separation of, say, production from consumption, does not reduce the significance of the locations themselves. Further, a considerable proportion of socio-economic activity is not so footloose as to be able to flow across the globe. For instance, government activities, or the provision of services such as education or healthcare, are primarily local, as their social characteristics, and the regulatory demands they are subject to, vary across political jurisdictions. Similarly, visiting a tourist site, or going on pilgrimage, is experiential and not merely transactional. As a result, many activities demand physical proximity, the need for which cannot be wished away by technology.

Yet, locational determinants keep changing. As technological change makes possible the production of new goods and services, it opens up new "windows of locational opportunity". Where those goods can be produced - either because of the cost and availability of inputs like specific skills, or because of politically negotiated policies governing intellectual property rights, or access to venture capital – opens up new locational possibilities which, in turn, is accompanied by shifts in the direction and volume of global flows.

The course will draw on theoretical frameworks from economic geography and development geography to unravel the complexity of locational decisions with examples. The course will begin with static theories of comparative advantage that explain how individual firms in specific sectors chose optimal locations based on access to raw materials and final markets. It will then move to explain how firm location is also determined by proximity to other firms, many of whom may be competitors. This is because of access to shared institutions, such as universities supplying skilled labor, or inputs such as new ideas, which are intangible. The short term costs of locating in such agglomerations are outweighed by the long term benefits of being in a place where, as the British economist Alfred Marshall, pointed out, “the secrets of the trade are in the air”.

The course will also examine how globalization opens up opportunities beyond national boundaries as firms and their activities are spread across the world. Countries and regions that have the infrastructure, the technology and the skills are in the best position to benefit. However, when such conditions are not met, development geography describes and explains the cases of countries like Korea or Taiwan, where political consensus to achieve economic goals has made it possible to “catch-up” with industrialized countries. Even in countries like India, where consensus and catch-up are less evident, improvement in economic prospects requires greater connections with the global economy. Such connections are being made easier by technological improvements, especially in IT. A happy outcome, at least for India, is the rise of Bangalore as a prominent agglomeration of the global software industry.

But contemporary globalization can be a double-edged sword especially since IT is a basket of general purpose technologies which transform all domains of socio-economic activity. The new combination of inputs required for the incorporation of IT to improve the reliability and efficiency of products and services in long-standing sectors might mean more opportunity in a place like Bangalore. On the other hand, when locations do not have the institutions to meet the demand for new inputs, their economic base can be devastated and turn into what sociologist Manuel Castells terms the “black holes of information capitalism”. The economic decline and social devastation in a city like Detroit, with the changes to the technologies underlying manufacturing and the globalization of manufacturing, is a poignant reminder. Similarly, there is enough evidence showing how globalization and IT can also lead to global networks of criminality and socially unwelcome behavior. Thus, this course will bring together the tensions between the local and global, and the role of cyberspace and territorial place in our lives.

Format: All participants will be expected to read the assigned material and come prepared to discuss it in class. Since the course will follow a seminar format, active participation in class discussion will enhance the value of the class for everyone. One or two participants will be asked to take charge of the readings in every class and make a twenty-minute presentation. The presentations are not to be descriptive summaries; instead, they must synthesize the key ideas and concepts in the readings and raise issues for discussion.

Duration: Two hours, twice a week,14 weeks

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand classical location theory	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand	Conceptual	6	

CO2	Understand (inter)national development theories	PO2, PO5, (M,Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	8	
CO3	Conceptualize globabalization	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	4	
CO4	Understand new institutional approaches to socio-spatial relationships	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand	Conceptual	10	
CO5	Understand critiques of development theories and the possibility of late industrialization	PO2, PO3 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	8	
CO6	Understand technology-enabled globalization, global commodity and production chains	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand	Conceptual	4	
CO7	Understand the transformation brought about by IT to the relationship between space and location	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	8	
CO8	Understand the promises and perils of globalization	PO2, PO5 (M.Sc.) PSO3 (iMTech)	Understand, Analyze	Conceptual	6	
				Total number of hours	54	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

See below in Instruction Schedule

Instruction Schedule

[Provide session-wise schedule]

1: Introduction

2: The Germanic Origins of Location Theory

3. From Location to Agglomeration

4: Thinking about International Development - I

5.Thinking about International Development – II

6: Import-Substitution-led Industrialization and Dependency in Latin America

7: Import-Substitution led Industrialization in India

8: Conceptualizing Globalization with the Product Cycle Hypothesis

9: The New International Division of Labor

10: The Critical turn in Geography

11: Transactions Costs Analysis and the Black Box of the Firm

12: Trusted Transaction Networks and Economic Organization

13: Increasing Returns to Scale, Tacit Knowledge and Industrial Districts

14: Tacit Knowledge and Regional Advantage in Silicon Valley

15: The Washington Consensus and Development

16: Late Industrialization and the Developmental State

17. Late-late Industrialization in India

18. Late-late Industrialization in China

19. Global Commodity Chains and Global Cities

20. Anchoring Global Commodity Chains: The Internationalization of Industrial Districts

21. The Offshoring "Revolution" and the Informational Economy

23. The Newest International Division of Labour?: The Rise of the Platform Economy

24. The Platform Economy and "Gig" Work in India

25. The Global Criminal Economy in the Information Age

26. Globalization and Environmental Consequences

27. The Promise and the Perils of Globalization

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Richard Peet. 1970. Von Thünen theory and the dynamics of agricultural expansion. *Explorations in Economic History*. 8(2):181-201.

C J Friedrich (ed.) 1929. *Alfred Weber's Theory of Location of Industries.* University of Chicago Press. pp.1-34.

Harold Hotelling. 1929. Stability in competition. *The Economic Journal.* 39(153):41-57.

August Lösch. 1938. The nature of economic regions. *Southern Economic Journal*. 5(1):71-78.

D F Darwent. 1969. Growth poles and growth centers in regional planning: A review. *Environment and Planning B.* 1:5-32.

Marx's theory of History. https://www.youtube.com/watch?v=mmeUYLntZx4

Karl Marx and Friedrich Engels. 1848. *The Communist Manifesto.* https://www.marxists.org/archive/marx/works/download/pdf/Manifesto.pdf pp.14-21.

Walt Whitman Rostow. 1991 [1960] 3rd ed. *The Stages of Economic Growth: A Non-Communist Manifesto.* Cambridge University Press. Pp.1-16.

Haripriya Rangan. 2008. "Development" in question. Pp.563-578 in Kevin R Cox, Murray Low, and Jennifer Robinson. *The SAGE Handbook of Political Geography*. SAGE Publications.

Albert O Hirschman. 1968. The political economy of import substituting industrialization in Latin America. *The Quarterly Journal of Economics.* 82(1):1-32.

Andre Gunder Frank. 1976. The development of underdevelopment. *Monthly Review.* 18(4):17-31.

Fernando Henrique Cardoso. 1972. Dependency and development in Latin America*. New Left Review.* 74:83-95.

Rakesh Mohan and Vandana Aggarwal. 1990. Commands and controls: Planning for Indian industrial development, 1951-1990. *Journal of Comparative Economics.* 14:681-712.

Ashutosh Varshney. 1990. Ideas, interest and institutions in policy change: Transformation of India's agricultural strategy in the mid-1960s. *Policy Sciences.* 22:289-323.

Keshabananda Das. 1997. Politics of Industrial Location: Indian Federalism and Development Decisions. *Economic and Political Weekly.* 32(51):3268-3274.

Raymond Vernon. 1966. International investment and international trade in the product cycle. *Quarterly Journal of Economics*. 80(2):190-207.

Raymond Vernon. 1979. The product cycle hypothesis in a new international environment. *Oxford Bulletin of Economics and Statistics.* 41(4):255-267.

Michael Storper. 1985. Oligopoly and the product cycle: Essentialism in economic geography. *Economic Geography.* 61(3):260-282.

Folker Fröbel, Jürgen Heinrichs and Otto Kreye. 1978. The world market for labour and the world market for industrial sites. *Journal of Economic Issues.* 12(4):843-858.

Alain Lipietz. 1982. Towards global fordism? *New Left Review*. 132:33-47.

Rhys Jenkins. 1984. Divisions over the international division of labour. *Capital and Class*. 22:28-57.

Erica Schoenberger. 1988. Multinational corporations and the new international division of labor: A critical appraisal. *International Regional Science Review*. 11(2):105-119.

Richard A Walker. 1981. Industrial location policy: False premises, wrong conclusions. *Built Environment.* 6(2):105-113.

Ricard A Walker and Michael Storper. 1981. Capital and industrial location. *Progress in Human Geography.* 5(4):473-510.

Oliver E Williamson. 1981. The economics of organization: The transaction cost approach. *American Journal of Sociology.* 87(3):548-577.

Allen J Scott. 1983. Industrial organization and the logic of intra-metropolitan location I: Theoretical considerations. *Economic Geography.* 59:233-250.

Mark Granovetter. 1985. Economic action and social structure: The problem of embeddedness. *American Journal of Sociology.* 91(3):481-510.

Andrew Sayer. 1989. Post-fordism in question. *International Journal of Urban and Regional Research.* 13(4):666-695.

W Brian Arthur. 1990. Positive Feedbacks in the Economy. *Scientific American.* 262(2):92-99.

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Dic Lo and Mei Wu. 2014. The state and industrial policy in Chinese economic development. Pp.307-326 (Chapter 11) in José M. Salazar-Xirinachs, Irmgard Nübler, and Richard Kozul-Wright (eds.). *Transforming Economies: Making Industrial Policy Work for Growth, Jobs and Development.* Geneva, CH: International Labour Organization.

Yasheng Huang. 2012. How did China take off? *Journal of Economic Perspectives.* 26(4):147-170.

Nirmal Kumar Chandra. 2009. China and India: Convergence in economic growth and social tensions? *Economic and Political Weekly.* 44(4):41-53.

Gary Gereffi. 1996. Global commodity chains: New forms of coordination and control among nations and firms in international industries. *Competition and Change.* 4:427-439.

Gary Gereffi. 2013. Global value chains in a post-Washington consensus world. *Review of International Political Economy.* 21(1):9-37.

Marco Bellandi and Lisa De Propris. 2015. Three generations of industrial districts. *Journal of Regional Research.* 32:75-87.

Annalee Saxenian and Charles Sabel. 2008. Venture capital in the "periphery": The new argonauts, global search and local institution building. (The Roepke Lectures in Economic Geography) *Economic Geography.* 84(4):379-394.

Alan Blinder. 2006. Offshoring: The next industrial revolution? *Foreign Affairs.* 85(2):113-128.

Balaji Parthasarathy. 2010. The computer software industry as a vehicle of late industrialization: Lessons from the Indian case. *Journal of the Asia Pacific Economy.* 15(3):247-270.

Balaji Parthasarathy and Yuko Aoyama. 2016. Deploying ICTs for development: An evolutionary perspective. *Information Technologies and International Development.* 13:157-170.

Gary Fields. 2003. Communications, innovation and territory: the production network of Swift Meat Packing and the creation of a national US market. *Journal of Historical Geography.* 29(3):599-617.

Janaki Srinivasan and Jenna Burrell. 2015. On the importance of price information to fishers and to economists: Revisiting mobile use among fishers in Kerala. *Information Technologies and International Development.* 11(1):57-70.

Jamie Woodcock and Mark Graham. 2020. *The Gig Economy: A Critical Introduction.* Polity Press.

Balaji Parthasarathy and Oindrila Matilal. 2019. *The Platform Economy and Digital Work: A Developmental State Perspective.* Developmental Impacts of Digital Economies Working Paper no. 9, Centre for Development Informatics, Global Development Institute, University of Manchester.

Pradyumna Taduri. 2019. *Delivering Consent: Work Games in On-Demand Food Delivery Platforms.* Unpublished MSc. (Digital Society) thesis, International Institute of Information Technology Bangalore.

Matthew A. Zook. 2007. Your urgent assistance is requested: The intersection of 419 spam and new networks of imagination. *Ethics, Place & Environment: A Journal of Philosophy & Geography.* 10(1):65-88.

Manuel Castells. 2010 (2nd edition). The perverse connection: The global criminal economy. Chapter 3 (pp.171-214) in Volume III: *The End of Millennium. The Information Age: Economy, Society, and Culture.* Blackwell.

Adil Najam, David Runnalls and Mark Halle. 2007. *Environment and Globalization: Five Propositions.* International Institute for Sustainable Development.

Ana Beatriz Hernandez and Gerard Ryan. 2011. Coping with climate change in the tourism industry: A review and agenda for future research. *Tourism and Hospitality Management.* 17(1):79-90.

Manuel Castells. 2010 (2nd edition). The Rise of the Fourth World: Informational Capitalism, Poverty, and Social Exclusion. Chapter 2 (pp.69-170) in Volume III: *The End of Millennium. The Information Age: Economy, Society, and Culture.* Blackwell.

Jagdish Bhagwati. 2004. Anti-globalization: Why? *Journal of Policy Modeling*. 26:439-463.

Amartya Sen. 2002. Globalization, Inequality and Global Protest. Development. 45(2):11-16.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Class participation 15%
Class presentation 10%
Mid-semester examination: 20%
Final examination: 20%
Term paper: 35%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Active participation in class discussions based on assigned readings	All COs
2.	In-class presentation of reading material (a few times a semester)	Potentially any CO
3.	For the term paper, a student is expected to write an essay (6000-8000 words) that draws on the theoretical frameworks in the course to explain why an industry or economic sector has come to play a dominant role in a region. The choice of region, industry/sector is left to the student.	Potentially any CO

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

No late submission of essays without prior instructor permission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Please refer https://owl.purdue.edu/owl/purdue_owl.html and follow any of the formats (eg. APA, MLA) described there.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	AI 512 / Maths for Machine Learning		
Course Instructor Name(s)	Prof. G. Viswanath, Prof. V. Ramasubramanian		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (3hr = 3 credit)	
	1	Tutorial (1hr = 1 credit)	
	L:T:P = 3:1:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
X	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
X	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

Basic mathematics and basic probability theory in undergraduate program (for MTech students) and earlier semesters (for iMTech students).

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	
Focus on skill development	Yes	
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

This course intends to provide the advanced mathematics background essential for Machine Learning and other advanced courses, and can be viewed as a combination of three main topics: Advanced Linear Algebra, Convex optimization, and Advanced Probability. This course is an essential prerequisite to advanced Machine Learning theory and practice, including domain specific areas such as visual-recognition, automatic speech recognition and natural language processing in subsequent semesters.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Solve linear regression problem using QR-decomposition and back substitution method on a given dataset by coding all basic matrix-vector operations in python.	PO4	Ap	C,P	8	3
CO2	Understand eigen decomposition and singular value decomposition in applications involving latent concept discoveries.	PO4	U	C,P	6	3
CO3	Solve constrained optimization problems using Lagrange multipliers.	PO4	Ap	C,P	8	2
CO4	Understand Random walk basics on graphs and properties related to stationarity and convergence.	PO4	U	C	3	

CO5	Understand Power-iterations and Perron-Frobenius theorem for stationarity convergence	PO4	U	C,P	4	2
CO6	Solve Page-rank and MCMC sampling problems using random walk theory	PO4	Ap	C, P	6	2
CO7	Understand latent-variable methods and EM framework	PO4	U	C,P	4	1
CO8	Solve unsupervised clustering and GMM parameter estimation using EM algorithm	PO4	Ap	C, P	6	2
					45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1 (Linear Algebra for ML)

Vector Operations, Linear functions, Regression Models -- Norms, Distances, Clustering -- Linear Dependence, Basis, Matrix -Vector Product -- Solving Linear Equations, Matrix Inverses - Least Squares, Data Fitting, Classification-- Eigen Analysis, SVD -- Positive/Negative Definiteness, Matrix Calculus--Python Exercises

Module 2 (Convex Optimization)

Convex Sets and Convex Functions--Conditions for Optimality, Equivalent Convex Problems --Primal and Dual Problems, KKT conditions - Linear and Quadratic Programming--Principal Component Analysis, Sparse PCA--Non-Negative Matrix Factorization, Topic Modeling--Python Exercises

Module 3 (Random Walks and Markov Chains)

Random Walks, Markov Chains – properties, stationarity, convergence. Applications – Page Ranking, MCMC Sampling

Module 4 (Latent Variable Models)

Expectation Maximization - Unsupervised clustering (K-means algorithm)- Gaussian Mixture Models (GMM)

Instruction Schedule

Learning Resources

Module 1 & Module 2:

1. *Introduction to Applied Linear Algebra, Lieven Vandenberghe, Stephen Boyd*

2. *Optimization Models, Giuseppe C. Calafiore, Laurent El Ghaoui*

3. *Boyd, Stephen, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.*

Module 3 & Module 4:

1. *John E Hopcroft and Ravindran Kannan, "Foundations of Data Science", 2013 © 2011*

2.. *Kevin Murphy, "Machine Learning A Probabilistic Perspective", The MIT Press, 2012*
3. *Jim Lambers, Power Iterations, 2009, Report.*
4. *Purnamrita Sarkar, Random Walks on Graphs An overview.*
5. *Robert Collins, Gaussian Mixtures and the EM Algorithm, Robert Collins*
6. *Jeff Bilmes, A gentle tutorial on EM algorithm and its application to Gaussian mixture*

Assessment Plan

Module1 & Module 2:

Continuous Assessment 1 : 10 Marks
Continuous Assessment 2 : 10 Marks
Continuous Assessment 3 : 10 Marks

Assignment -1: 10 Marks
Assignment -2: 10 Marks

Module3 & Module 4:

Continuous Assessment 5 : 25 Marks
Continuous Assessment 6 : 25 Marks

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Continuous Assessment 1	CO1
2	Continuous Assessment 2	CO2
3	Continuous Assessment 3	CO3
4	Assignment -1	CO1
5	Assignment -2	CO3
6	Continuous Assessment 5	CO4, CO5, CO6
7	Continuous Assessment 6	CO7, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	HSS 105 Introduction to Ethics		
Course Instructor Name(s)	Chetan Parikh		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3:0:0	**Total Credits = 3**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
X	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
	M.Tech
	M.Sc.

Branch:

	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

Ethics is difficult to teach. But developing the ability to think about and answer ethical questions in an objective and mature manner is an essential skill as a professional and a human being.

This course will expose students to the various aspects of the field of ethics, including philosophical, psychological, religious and appllied. Through readings, group discussions and reflections, the course will endeavour to develop in students the analytical and cognitive skills to think logically as well as intuitively about ethical issues, to engage in rational discussions, and to deduce their own conclusions.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Explain the various parts of a human psyche, which are at the root of all ethical conflicts, as described in the theories of Freud, and of the Bhagavad Geeta.		U, Ap, An	F, C, MC	3	0
CO2	Explain Maslow's theory of human motivation.		U, Ap	F, C, MC	3	0
CO3	Explain Lawrence Kohlberg's theory of human moral development, and apply it to real-life scenarios.		U, Ap, An	F, C, MC	3	
CO4	Explain, with examples, the theories of normative ethics, of Aristotle (Values Ethics), Immanuel Kant (Deontology) and Bentham-Mill (Utilitarianism).		U, Ap, An	F, C, MC	5	0
CO5	Explain the basic theories of ethics of Hinduism, Judaism, Christianity, Islam and the Baha'i Faith.		U, Ap, An	F, C, MC	7	0

CO6	Apply all of the above theories to the following social issues: Casteism in India, slavery, the abortion debate, the ethics of poverty. Also apply them to case studies pertinent to the life of students.		U, Ap, An, Ev	F, C, MC	8	0
CO7	Create and present a skit or a video that depicts moral courage, based on a real-life story.		C	MC	2	0

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Topic	No. of hours
Cases. What is moral?	1.5
Introduction. Origins of Ethics.	1.5
Human Psyche	3
Human psyche in the Bhagavad Geeta	1.5
Delayed gratification. The basic need for love (Harry Harlow).	1.5
Maslow's Theory of Human Motivation (& Needs)	3
Kohlberg's Theory of Moral Development	1.5
Aristotle - What is moral	3
Assignment videos on Moral Courage	1.5
Psychology of happiness	3
Jewish Ethics	1.5
Christian Ethics	1.5
Kant's Theory of Ethics	1.5
Utilitarianism	1.5
Video (about slavery): Birth of a nation	1.5
Documentary on casteism by Stalin	1.5
Manu Samhita. Discussion about caste.	1.5
Ethics in the Qur'an	1.5

Baha'i Faith: Promise of World Peace	1.5
What is moral. Abortion. Starvation & Morality.	1.5
Group discussions: Case studies	3
Presentations	4

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Ethics and the Discovery of the Unconscious, John Hanwell Riker. SUNY Press, 1997.
- Engineering Ethics: Concepts and Cases, Charles Harris, Jr., Michael Pritchard and Michael Rabins. 4th edition. Cengage Learning, 2012.
- Ethics and College Student Life, Kenneth Strike and Pamela Moss, Allyn and Bacon, 1997.
- Introducing Ethics: A Graphics Guide, by Dave Robinson, Chris Garret. 4th edition. Icon Books, 2005.
- Routledge Companion to Ethics, John Skorupski (ed.), Routledge, 2012.
- How Good People Make Tough Choices, Rushworth Kidder. Harper, 2003.
- Material from the internet, including:
    - http://www.newworldencyclopedia.org
    - http://plato.stanford.edu

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Test – 20%
Class work – 40%
Final exam – 20%
Assignment – 20%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Create and present a skit or a video that depicts moral courage, based on a real-life story.	CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of tests
- Manual evaluation of written class work
- Assessment of skit/video presentation

Students are provided the opportunity to view the evaluations done either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions are not accepted

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	DT211 Dynamics of the Information Technology Industry		
Course Instructor Name(s)	Balaji Parthasarathy		
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
		Tutorial (1hr = 1 credit)	
		Practical (2hrs = 1 credit)	
	L:T:P = 3:0:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**x**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

x	iMTech
	M.Tech
x	M.Sc.

Branch:

x	CSE
x	ECE
x	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
x	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

NONE (although exposure to DT385 will be useful)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development		
Focus on entrepreneurship	X	The course provides analytical insights into how changes in technology, public policies, and business strategies have provided an opportunity for new entrepreneurs in various parts of the world.
Provides value added / life skills (language, writing, communication, etc.)	x	The readings for the class, the discussions around the readings, and the term papers force students to articulate their ideas about how opportunities for entrepreneurship emerge with the forces that shape new technologies.

Course Context and Overview

[*Provide introduction to the course*]

Overview: This course is designed to analytically comprehend the institutional forces that have shaped the changes to the technical, social and spatial divisions of labour in the information technology (IT) industry. Such comprehension will help participants think about how changing social and economic conditions determine what technologies are developed in the industry and how they are produced, who produces them and where they are produced.

Format: All participants will be expected to read the assigned material and come prepared to discuss it in class. Since the course will follow a seminar format, active participation in class discussion will enhance the value of the class for everyone. One or two participants will be asked to take charge of the readings in every class and make a twenty-minute presentation. The presentations are not to be descriptive summaries; instead, they must synthesize the key ideas and concepts in the readings and raise issues for discussion.

Duration: 3 hours, once a week, 15 weeks

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)

CO1	Understand the historical evolution of computing (from the mainframe to the PC era), and networking (from local networks to the global internet).	PO3, PO5 (MSc) PSO3 (iMTech)	Understand, Analyze	Conceptual	9	
CO2	Identify economic characteristics of IT and how they distinguish it from other industrial sectors.	PO3, PO5 (MSc) PSO3 (iMTech)	Understand	Conceptual	3	
CO3	Understand the organisation of production in the global hardware industry, especially semiconductor segment in Silcon Valley	PO3, PO5 (MSc) PSO3 (iMTech)	Understand	Conceptual	3	
CO4	Understand the reasons behind the divergent trajectories of the Taiwanese and Indian hardware industries	PO3, PO5 (MSc) PSO3 (iMTech)	Understand, Analyze, Evaluate	Conceptual	6	
CO5	Identify the quality/productivity problems and the "software bottleneck" that have plagued software development.	PO3, PO5 (MSc) PSO3 (iMTech)	Understand	Conceptual	3	
CO6	Understand the organizational and institutional responses to the bottleneck, in the form of software services, packaged software and open source software.	PO3, PO5 (MSc) PSO3 (iMTech)	Understand, Analyze	Conceptual	6	
CO7	Understand the forces behind rise of the IT industry in emerging markets – Brazil, China, India, Ireland, Israel, Russia	PO3, PO5 (MSc) PSO3 (iMTech)	Understand, Analyze, Evaluate	Conceptual	12	
CO8	Understand the emerging international division of labour in the global IT industry	PO3, PO5 (MSc) PSO3 (iMTech)	Understand, Analyze, Evaluate	Conceptual	3	
				Total number of hours	45	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

See below in Instruction Schedule

Instruction Schedule

[Provide session-wise schedule]

Week 1: Introduction and Course Survey

Week 2: An Overview of the Computing Industry

Week 3: Laying the Foundations for a Networked World

Week 4: The Road to Convergence: The Digitization of Communications

Week 5: The Network Economy: Old or New?

Week 6: The Geography of the Computer/Semiconductor Industry in the US

Week 7: The Global Hardware Industry I: The Taiwanese Success Story

Week 8: The Global Hardware Industry II: India's Insignificance

Week 9: The Software Bottleneck and its Resolution I: Software Engineering

Week 10: The Limits to Software Engineering: Japan in the PC era

Week 11: The Software Bottleneck and its Resolution II: Software Products

Week 12: The Software Bottleneck and its Resolution III: Open Source Software

Week 13: The Globalization of the Software Industry I: Software Services in India and Russia

Week 14: Globalization of the Software Industry II: From Services to Products in Ireland and Israel

Week 15: Towards a Global Division of Labour in the ICT Industry; Wrapping up

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

John A.N. Lee. 1996. Those who forget the lessons of history are doomed to repeat it. *IEEE Annals of the History of Computing.* 18(2):54-62.

Martin Campbell-Kelly and William Aspray. 2004 (2nd ed.). *Computer: A History of the Information Machine.* Westview Press.

Janet Abate. 1999. *Inventing the Internet.* MIT Press.

Carl Shapiro and Hal Varian. 1999. *Information Rules: A Strategic Guide to the Network Economy.* Harvard Business School Press.

Annalee Saxenian. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128.* Harvard University Press.

John Mathews and Dong-Sung Cho. 2000. *Tiger Technology: The Creation of a Semiconductor Industry in East Asia.* Cambridge University Press.

Dan Breznitz. 2007*. Innovation and the State: Political Choice and Strategies for Growth in Israel, Taiwan and Ireland.* Yale University Press.

Eswaran Sridharan. 1995. *The Political Economy of Industrial Promotion: Indian, Brazilian, and Korean Electronics in Comparative Perspective 1969-1994.* Praeger.

Frederick P. Brooks. 1995 (2nd edition). *The Mythical Man-Month: Essays on Software Engineering.* Addison Wesley Longman.

Steve McConnell. 1999. *After the Gold Rush: Creating a True Profession of Software Engineering.* Microsoft Press. pp.1-97

Michael Cusumano. 1992. Shifting economies: From craft production to flexible systems and software factories. *Research Policy.* 21(5):453-480.

Marie Anchordoguy. 2000. Japan's software industry: A failure of institutions? *Research Policy.* 29(3):391-408.

Edmund A. Egan. 1997. *The Spatial Dynamics of the US Computer Software Industry.* Ph.D. Dissertation. University of California, Berkeley.

Yuko Aoyama and Hiro Izushi. 2003. Hardware gimmick or cultural innovation? Technological, cultural and social foundations of Japan's video-game Industry. *Research Policy.* 32(3):423-444.

Steven Weber. 2004. *The Success of Open Source.* Harvard University Press.

Josh Lerner and Mark Schankerman. 2010. *The Comingled Code: Open Source and Economic Development.* MIT Press.

Balaji Parthasarathy. 2004. India's Silicon Valley or Silicon Valley's India? Socially embedding the computer software industry. *International Journal of Urban and Regional Research.* 28(3):664-685.

Balaji Parthasarathy. 2010. The computer software industry as a vehicle of late industrialization: Lessons from the Indian case. *Journal of the Asia Pacific Economy*. 15(3):247-270.

Melanie Feakins. 2007. Off and out: The spaces of certification - offshore outsourcing in St. Petersburg, Russia. *Environment and Planning A.* 39(8):1889-1907.

Sean O'Riain. 2004. *The Politics of High-Tech Growth: Developmental Network States in the Global Economy.* Structural Analysis in the Social Sciences 23. Cambridge University Press.

Yuri Takhteyev. 2012. *Coding Places: Software Practice in a South American City.* MIT Press.

Dan Breznitz and Michal Murphree. 2010. *Run of the Red Queen: Government, Innovation, Globalization and Economic Development in China.* Yale University Press.

Balaji Parthasarathy and Bharath M Palavalli. 2011. The role of standards in technology-driven commodity chains: The information and communication technology services industry in Dalian, China, and Bangalore, India. In Morki Ohara, Manimegalai Vijayabaskar and Hong Lin (eds.). *Industrial Dynamics in India and China: Firms, Clusters and Different Growth Paths.* Palgrave Macmillan. pp.237-257

Annalee Saxenian. 2006. *The New Argonauts: Regional Development in a Global Economy.* Harvard University Press.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Class Participation: 25%
Class Presentation: 15%
Essay 1: 15%
Essay 2: 20%
Essay 3: 25%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	**Focus of Assignment / Project**	**CO Mapping**
1.	Active participation in class discussions	All COs
2.	In-class presentation of reading material (a few times a semester)	Potentially any CO
3	An essay (limit 2000 words) on the importance of standards in the information economy.	CO2
4	An essay (limit 2000 words) comparing the evolutionary trajectories of the Indian and the Taiwanese hardware industries.	CO3 CO4
5	An essay (limit 5000 words) on the software bottleneck and its transformation across the world.	CO5, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essays (for assignments listed above)

Students will be provided opportunity to view the evaluations done where possible either in person or onlin

Late Assignment Submission Policy
State any penalty policy for late submission

No late submission of essays without prior instructor permission.

Make-up Exam/Submission Policy
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)
[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]
Please refer https://owl.purdue.edu/owl/purdue_owl.html and follow any of the formats (eg. APA, MLA) described there.

Academic Dishonesty/Plagiarism
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs
[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	DT 202 The Digital and its Discontents/ ITS 602	
Course Instructor Name(s)	Janaki Srinivasan	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning		X	Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Teaches students how social divides shape the heterogeneous consequences of a technology initiative, and sensitises them to the importance of factoring this into the design, deployment and use of digital technologies for diverse populations
Focus on skill development	Yes	Teaches critical thinking and analytical skills
Focus on entrepreneurship	Yes	Highlights cases of development-focussed entrepreneurial ventures; teaches how to analyse the challenges and promise of such ventures
Provides value added / life skills (language, writing, communication, etc.)	Yes	Trains students in reading, writing and skills of constructing an evidence-based argument about the working of a technology initiative

Course Context and Overview

This course explores how the digital space shapes a multiplicity of social, economic, political and cultural inequalities in contemporary society. It will focus on two dimensions of such divides in the digital era: first, how classical inequalities and debates about them are reproduced in the digital space and, second, how the digital space might open up opportunities to challenge these divides. We will use the example of development theory and practice to introduce students to such divides and to understand how they have been conceptualized and addressed over time in the context of 'developing' countries. An important goal of the course will be to offer students the opportunity to think more critically about the possibilities and limits of ICT for Development (ICTD) projects.

'Development' has come to stand in for a variety of social, economic and political transformations in the past century, with its meaning and goals being redefined many times in that period. Our first step in this course will be to distinguish between the various senses of 'development' that prevail. We will trace the interplay of these different histories and meanings of development to understand why trajectories of social change have diverged dramatically in different geographies and times. Throughout, our focus will be on the central role accorded to technology in these theories and processes of social change.Subsequent modules will focus more narrowly on the contemporary production, deployment and use of novel digital technologies against the backdrop of this relationship between distinct senses of development. They will draw on examples of digital technology use in the domains of health, education, agriculture, governance and political advocacy in parts of Asia, South America and Africa. Our examples help us understand how the many kinds of development we studied shape digital spaces and, in so doing, open up possibilities for that space to be leveraged both to reinforce and to challenge existing inequalities and divides in different geographies.

In keeping with the larger goals of the Digital Society and other Masters programmes at IIITB, the lectures and assignments of the course are structured so as to encourage students to understand the socio-economic, cultural, and political factors that shape the implications of technology deployment in a development context and for various marginalised populations. They also encourage students to carry out independent secondary research of significant depth on a given geography, sector and ICTD initiative. Throughout, the course provides opportunities to students to apply their understanding of social divides to the reproduction and contestation of social divides in the design, deployment and use of digital technologies.

This course will be a foundation for students planning to take courses on e-governance, AI ethics or Social Media that examine technology use in the context of marginalised communities.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

	Course Outcome	**PO**	**CL**	**KC**	**Class (Hrs)**	**Tut (Hrs)**
CO1	Understand the types of social and digital divides and their roots in gender, class, caste, race, and region.	PO3	R, U	C	7.5	
CO2	Understand the evolution of development theories and their critiques, including contemporary debates on development metrics and goals,	PO3, PO5	R, U, An	F, C	9	3
CO3	Understand the role of technology in achieving developmental goals	PO3, PO5	R, U, An	F, C	3	
CO4	Understand the vision, ICT infrastructure and ICT policy environment that were developed and deployed in different parts of the globe since the 2000s	PO3	U, Ap, An, E	F, C	4.5	2
CO5	Understand the innovations in ICT that were developed and deployed in different parts of the globe since 2000 in education, healthcare, agriculture, finance, and governance,	PO3	U, Ap, An, E	F, C	7.5	2

CO6	Understand the innovations in ICT that were developed and deployed in different parts of the globe since 2000 in livelihood-related activities,	PO3	U, Ap, An, E	F, C	8.5	2
CO7	Analyze how social divides are reproduced and contested in the design, deployment, and use of digital technologies	PO3, PO4	Ap, E	C	2.5	5
CO8	Conduct secondary research of significant depth on the development trajectory of a given low-income geography, a sector (such as education, agriculture, finance, governance) in that region and an ICTD initiative in that sector and geography	PO1, PO2	Ap, An, C	C, MC	2.5	5
					45	**15**

***Legend:** PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1 (towards CO1, CO8): **Divides, Digital and Social** (4 lectures, 1 essay discussion session)
• Theories of information society and digital divides
• Introduction to studying divides using the example of development theory and practice

Module 2 (towards CO2, CO3, CO7, CO8): **Theories and critiques of Development** (8 lectures, 1 essay discussion session)
• Overview of the multiple meanings and goals of 'development' and how these have been contested by various actors at different points in history
• Differentiating between 'little d' and 'Big D' development, and how they shape each other
• Classical theories explaining capitalism (little d development) and the role of technology in each
• Outlining the eras of interventional Development since WWII (Big D development) and the role of technology in each: Modernization approach, Dependency Theory, Washington Consensus and the Neo-Liberal Turn, Post-Development Critiques
• Insights from history and a framework to study digital technologies in development:
  o identifying role of state vs. market
  o understanding efficiency vs. equity implications of various development models and metrics
  o learning to see role of structures and agency in how technological initiatives work

Module 3 (towards CO4, CO5, CO6. CO7, CO8): **ICT for D** (9 lectures, 1 essay discussion session)
• The role of devices, points of access and standards in ICTD interventions

• Cases of ICT deployment in education, finance, health, agriculture
• Analysing what is assumed and obscured, role of state and market, of structure and agency in each case

Module 4 (towards CO7, CO7, CO8): **ICTs in 'little d' development** (4 lectures, 1 essay discussion session)
• The commoditization of land, labour and knowledge as part of the capitalist development of ICT industries
• Dissent in the digital era

Module 5 (towards CO1): **Wrap-up** (1 lecture)
• Bring together threads from earlier modules to discuss alternative ways of thinking about the use of ICTs in the current conjecture of d/Development

Instruction Schedule

[Provide session-wise schedule]
Module 1
Session 1 Introduction to class
Session 2 Is the World Flat in the Age of Information?
Session 3 Living in an Information Society
Session 4 Theories of Digital Divides
Session 5 Discussion of Essay Rationale in class
Module 2
Session 6 The Many Definitions of Development
Session 7 Theories of Capitalist development I
Session 8 Theories of Capitalist development II
Session 9 Modernization and Dependency Schools of Development
Session 10 Challenges to the modernization approach (1970s)
Submission of Essay 1
Session 11Structural Adjustment and the Washington Consensus (1980s)
Session 12 Discussion of Essay 2 plan in class
Session 13 Post Development: Participatory and Sustainable Development?
Session 14 Post Development (contd.): Development through Markets?

MID-TERM: Submission of Essay 2

Module 3
Session 15 The Vision for ICTD in the 2000s
Session 16 ICT Infrastructures – Devices, Connectivity, Access and Algorithms
Session 17 ICT Policy Environment – Standards, Regulation and Ethics
Session 18 ICTs in Literacy, Education, and Learning
Session 19 ICTs in Finance
Session 20 Discussion of Essay 3 plan in class
Session 21 ICTs in Agriculture
Session 22 ICTs in Health, Nutrition and Disability
Session 23 ICTs in Governance and Social Protection
Session 24 What is Assumed and What is Obscured in ICTD interventions
Module 4
Session 25 Discussing Essay 3 outline
Session 26 Real Estate in a Virtual World?
Session 27 Digital Labour
Session 28 Knowledge in the Age of Information
Session 29 Digital Counter Movements?
Module 5

Session 30 Beyond Empowerment and Instrumental Use?

END TERM: Submission of Essay 3

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]
There is no single prescribed textbook for this course. Students will rely on lecture notes and assigned readings (excerpted from books or articles, a few of which are mentioned below). These will be made available on the institute LMS.

• Bhatia, A and Bhabha, J. 2017. "India's Aadhaar scheme and the promise of inclusive social protection." *Oxford Development Studies* Vol. 45 (1), pp. 64-79.
• Bonilla, Yarimar, and Jonathan Rosa. 2015. "# Ferguson: Digital protest, hashtag ethnography, and the racial politics of social media in the United States." *American Ethnologist* 42, no. 1: 4-17.
• Chan, Jenny, Ngai Pun, and Mark Selden. 2013. "The politics of global production: Apple, Foxconn and China's new working class." *New Technology, Work and Employment* 28, no. 2: 100-115.
• Easterly, William R. 2002. *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*. Reprint edition. Cambridge, Mass.: The MIT Press.
• Escobar, Arturo. 1995. "Imagining a Post-Development Era." In *Power of Development* edited by J. Crush. London: Routledge.
• Eubanks, Virginia. 2018. "A Child Abuse Prediction Model Fails Poor Families" *WIRED*, January 15.
Evans, Peter. 2010. "Is it labor's turn to globalize? Twenty-first century opportunities and strategic responses." *Global Labour Journal* 1, no. 3.
• Francis, E., Blumenstock, J., & Robinson, J. (2017). "Digital Credit: A Snapshot of the Current Landscape and Open Research Questions." *Working Paper 516*, The Bureau for Research and Economic Analysis of Development.
• Frank, Andre Gunder. 1966 'The Development of Underdevelopment,' *Monthly Review* (18): pp. 17-31.
• Gandhi, Rikin; Rajesh Veeraraghavan; Kentaro Toyama, and Vanaja Ramprasad. 2007. "Digital Green: Participatory video for agricultural extension." In *IEEE Proceedings of Information and Communication Technologies and Development*, 2007: 1-10.
•Jensen, Robert. 2007. "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector." *The Quarterly Journal of Economics* 122 (3): 879–924.
• Jessop, Bob. 2007. Knowledge as a fictitious commodity: Insights and limits of a Polanyian perspective. In *Reading Karl Polanyi for the twenty-first century: Market economy as political project*. Palgrave, Basingstoke, pp. 115-134.
• Morawczynski, O. 2009. "Exploring the usage and impact of ''transformational'' mobile financial services: the case of M-PESA in Kenya." *Journal of Eastern African Studies* 3(3): 509-525
• Upadhya, Carol. 2007. "Employment, Exclusion and 'Merit' in the Indian IT Industry." *Economic and Political Weekly*, pp. 1863-1868.
• Vie, Stephanie. 2014. "In defense of "slacktivism": The Human Rights Campaign Facebook logo as digital activism." *First Monday* 19, no. 4.
• W. W. Rostow, 1960. *The Stages of Economic Growth: A Non-Communist Manifesto.* Cambridge: Cambridge University Press.
• Warschauer, Mark and Morgan Ames. 2010. "Can One Laptop Per Child Save the
• Webster, Frank. 2006. Theories of the Information Society. London; New York: Routledge. inclusive social protection." Oxford Development Studies Vol. 45 (1), pp. 64-79. World's Poor?" *Journal of International Affairs* 64(1)

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]
Assessment criteria:

1. Class participation - 5%
2. Reading responses – 10%
3. Leading class – 10%
4. Essays (3) – 75%
    a. Examining a chosen country's development models – 15%
    b. Examining the development planning and priorities of a specific sector in that country- 25%
    c. Examining an ICT initiative targeted at above sector in chosen country – 35%

The evaluation criteria for each essay will be based on:

- Depth of country research
- Argument and linking to readings/concepts from class
- Clarity and structure in your writing

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
	Class participation: Throughout the semester, in lecture-based and discussion sessions. Your participation grade will be based on the extent to which you engage with the material and in our discussions in class - you will find it very hard to do either if you have not read the material for class.	CO1-CO6
	Leading class: Once or twice in the semester **(**depending on class size) You will be required to make a 15-minute presentation to the class at least once in the semester. Your presentation will be evaluated for its ability to summarize the main arguments of the readings assigned for that session and to raise questions.	CO4, CO5, CO6
	Reading responses: 10 reading responses to be submitted through semester You are required to post your reading responses (150 – 250 words) by midnight the day prior to the session whose readings you are responding to. Individual responses will not be graded (but if you don't submit, that will reflect in your grade). You will be graded overall for your ability to engage with, connect and challenge the concepts introduced in your readings. Module 2: You will respond to the readings assigned for a class session and post responses for all 8 lecture-based sessions in the module. Module 3 and 4: Reading responses for these modules will be Module-level i.e., you will be expected to respond to one question that we pose in each module. You may use readings from any one class from that module to answer that question.	CO3-CO6
	Essays: 3 essays in the semester You will be required to write a sequence of three essays for this course. The essays will build on each other, and you will engage with them through the semester. Closer	CO7, CO8

	to the submission date of the essays, there will be an in-class discussion session where you will be required to discuss your essay plan with your classmates in groups. You will pick a country that the World Bank currently lists as low or low-middle income and that is of interest to you. In your first essay, you will trace the history of development in that country since the early 20th century, paralleling the theories and histories we will discuss in class. For the second essay, you will pick a domain that has been the target of Development activity in that country (eg., governance, health, education) and trace its history, again paralleling class discussions. For your final essay, you will build on your previous essays and once again leverage discussions in class to analyse an ICT-based project currently underway in the country and domain you picked. In each case, you will use your essay to engage with the arguments of a relevant reading from class.	

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided an opportunity to view their graded essays over email or in person. They will also have an opportunity to view other components of their score and enquire about them.

Late Assignment Submission Policy

State any penalty policy for late submission

Students will not be allowed to submit their essays or other assignments later than the deadline other than for valid medical reasons.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Students may follow any recognized citation standard such as APA, or Chicago, as long as they do so consistently.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

This class has a zero-tolerance policy towards plagiarism. Every time you plagiarize (even if you argue that it is merely quoting someone without citing them), and starting from the first such instance, you will receive a zero for that assignment. Please clear any citation queries you may have ahead of time

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

All readings and grading comments are made available in a digital format that is accessible for visually challenged students. Other accommodations will be as per institute policy.

Course Syllabus

Course Code / Course Name	**Smart Cities: Urban Labelling and Beyond**	
Course Instructor Name(s)	Anjali Karol Mohan	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
		Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
	M.Tech
X	M.Sc.

Branch:

	CSE
	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		Equips students to design and develop digital technologies within the frame of urban governance
Focus on skill development		Allows students to grasp sectoral, institutional and digital dimensions of what constitutes smart cities and train students to assess the impact of digital technologies on diverse urban population
Focus on entrepreneurship		NA
Provides value added / life skills (language, writing, communication, etc.)		Teaches critical thinking and analytical writing

Course Context and Overview

[*Provide introduction to the course*]

Globally, urbanization, urban development and management debates are increasingly influenced by the “smart city” idea – an idea that has emerged fashionable both in policy and practice. Its main focus appears to be on the role of Information and communication technology (ICT) infrastructure, although related socio-economic as well as political factors have also been discussed. In November, 2011, the trademark ‘smarter cities’ was officially registered as belonging to IBM. This constitutes an important milestone not just for IT companies attempting to gain visibility and legitimacy in the smart city market, but also for the ‘other’ stakeholders that have historically been a part of the debates on cities, namely planners, architects, policy makers, governments, politicians and citizens. Proponents of the smart city idea are of the view that smart cities are a way forward in making cities truly the ‘engines of national growth’. ICT driven reforms, projects and programmes envisaged as part of the smart cities idea are envisaged as effective tools to steer and manage the ongoing urban development and management processes.

Critiques on the other hand, believe that the smart city is nothing but a phase in the ‘urban labelling’ phenomenon, (much like the livable city, techno-city, sustainable city, ubiquitous city or the intelligent city) and, is largely about rendering hitherto unconcerned stakeholders and technologies key to the development and implementation of specific forms of urban management solutions. This labelling, while acknowledged (albeit often with skepticism) a part of the ‘contemporary language games’ around urban management, however makes a difference in the manner in which cities and related urbanization policies are understood,framed, conceptualized and planned. Yet, semantics of a smart city are not clear. Rather, definitional impreciseness has led to numerous assumptions of what constitutes a smart city or what makes a city smart.

Furthermore, while debates around the smart cities idea are fast evolving, these emerge as fragmented and call for further exploration. This elective aims to unpack the smart cities discourse to understand the ‘smart’ in context of the ‘city’. It doing so, the course covers definitional components, critical insights, and sectoral, institutional and digital dimensions of what constitutes smart cities.

The elective is divided into four broad sections. Section I (classes 2-7) starts with the ideation of the city to then understand how cities are imagined/ viewed in the 21st century. In particular, this section focuses on the impact of globalization on the urban. Section II (classes 8-18) focuses on the origins of the smart city conceptualization and the debates around the semantics of smart city. In particular, this section the emergence of the smart cities discourse as a case of “corporate story telling”. Section III (Classes 19-22) provides an overview of the smart cities debate in India with a focus on definitions, features, strategy, challenges, financing and implementation mechanisms. In particular, this section aims to provide an understanding of the Smart City as a political construct in India. The concluding section (classes 23-30) focuses on various elements of the smart city debate: e-governance; mobility and intelligent transport systems; big data; participatory planning; smart communities; control and surveillance.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand theories of urbanization and discourses on cities	PO1, PO4	Un	C,F	9	
CO2	Understand role of technology in urban planning and infrastructure	PO1, PO5	Un	C	6	2
CO3	Understand the semantics of smart cities	PO5	Un	F,C	6	2
CO4	Understand what constitutes smart cities	PO4, PO5	Un	F,C	9	4
CO5	Apply concepts of Smart Cities in the Indian contexts	PO1, PO3, PO5	Ap	F, C	9	4
CO6	Assess the impact of Smart Cities on urban communities and institutions	PO1,PO5	An	F, C	6	3
	Total				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom’s Taxonomy); KC: Knowledge Category (from Revised Bloom’s Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

- Introduction and discussion on the course outline and anticipated outcomes
- Popular imaginations of the city: An exercise in interpretation of ideation of a city
- Urbanization, Urban Theory and Cities
- Cities in the Global South: Past imaginations of the Future
- Globalization and cities: Emerging Perspectives
- Globalization and speculative urbanization
- The emergence of the Smart City Discourse
- Cities: Efficiency Versus Sufficiency
- Semantics of a Smart City
- Critical Perspectives on Smart Cities
- Intelligent cities and smart cities
- Planning for (Smart) Cities
- Smart to Smarter Cities – A case of Corporate Story telling
- Smart Cities: Case Studies
- From Global to National: The Urban in India
- Smart Cities in India: From Corporate storytelling to political narratives
- Smart Cities in India: Debating Centralization and Decentralization
- India's experiments with Smart Cities: Critical Insights
- Smart Cities and Provincial Visions in India
- From Policy to Action: Democratisation and/or Corporatisation
- Smart Cities and e-Governance
- Smart Cities: Planning for Intelligent Transport Systems
- Smart Cities: Importance of Big Data
- Smart Cities: Participatory Planning
- Smart Cities: Smart Citizens and communities
- Smart Cities: Urban Control and surveillance

Instruction Schedule

[Provide session-wise schedule]

Class1: Introduction and discussion on the course outline and anticipated outcomes What is a city? Class 2: Popular imaginations of the city: An exercise in interpretation of ideation of a city. Class 3: Urbanization, Urban Theory and Cities Class 4: Urbanization, Urban Theory and Cities Class 5: Cities in the Global South: Past imaginations of the Future Class 6: Globalization and cities: Emerging Perspectives. Class 7: Globalization and speculative urbanization Class 8: The emergence of the Smart City Discourse Class 9: Cities: Efficiency Versus Sufficiency Class 10: Semantics of a Smart City

Class 11: Semantics of a Smart City
Class 12: Critical Perspectives on Smart Cities
Class 13: Intelligent cities and smart cities
Class 14: Planning for (Smart) Cities
Class 15: Smart to Smarter Cities – A case of Corporate Story telling
Class 16: Smart to Smarter Cities – A case of Corporate Story telling (Contd).
Class 17 : Smart Cities: Case Studies
Class 18: From Global to National: The Urban in India
Class 19: Smart Cities in India: From Corporate storytelling to political narratives
Class 20: Smart Cities in India: Debating Centralization and Decentralization
Class 21: Smart Cities in India: Debating Centralization and Decentralization
Class 22: India's experiments with Smart Cities: Critical Insights
Class 23: Smart Cities and Provincial Visions in India
Class 24: From Policy to Action: Democratisation and/or Corporatisation
Class 25: Smart Cities and e-Governance
Class 26: Smart Cities: Planning for Intelligent Transport Systems
Class 27: Smart Cities: Importance of Big Data
Class 28: Smart Cities: Participatory Planning
Class 29: Smart Cities: Smart Citizens and communities
Class 30: Smart Cities: Urban Control and surveillance

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Film: http://www.theatlantic.com/video/index/380650/what-isa-city/
- Hollis, L. (2013). Cities are Good for You: The Genius of the Metropolis. A&C Black. (8-30)
- Cities and Urbanism. Heroic Urbanism: 13 Ultra-Cool Comic
- Book Cities: http://weburbanist.com/2010/09/20/heroic-urbanism-13-coolcomic-
- book-cities/
- The Story Behind DC Comics' Famous Gotham City Map: http://www.eliotrbrown.com/wp/gotham-city-map.html
- The Cartographer Who Mapped Out Gotham City: http://www.smithsonianmag.com/arts-culture/cartographergotham-city-180951594/?no-ist
- The Architecture of Superman: A Brief History of The Daily Planet: http://www.smithsonianmag.com/arts-culture/the-architectureof-superman-a-brief-history-of-the-daily-planet-22037/?no-ist
- City Lab: World's Largest Urban Simulator Spans 26 Square Miles: http://weburbanist.com/2015/08/27/city-lab-worlds-largesturban-simulator-spans-26-square-miles/
- The Capital: Egypt Plans Largest From-Scratch City in History: http://weburbanist.com/2015/03/19/the-capital-egypt-planslargest-from-scratch-city-in-history/

- Dubai to Build New 50 Million Sq Ft Climate-Controlled City: http://weburbanist.com/2014/07/12/dubai-to-build-new-50-million-sq-ft-climate-controlled-city/
- Film: Metropolis by Fitz Lang
- Parker, S. (2015). Urban theory and the urban experience: Encountering the city. Routledge.
- Soja, E. W. Putting Cities First: Remapping the Origins of Urbanism. A Companion to the City, 26-34.
- Peattie, L. (1990). Planning: Rethinking Ciudad Guayana. In Planning: rethinking Ciudad Guayana. Ann Arbor (selected pages)
- Scott, J. C. (1998). Seeing like a state: How certain schemes to improve the human condition have failed. Yale University Press. Pp. 103-146
- Bharne, V. (2012). Anointed Cities. The Emerging Asian City: Concomitant Urbanities & Urbanisms, 17-26
- The Emerging Asian City: An Interview with Vinayak Bharne | Planetizen: The Urban Planning, Design, and Development Network.
- Harvey, D. (1989). The urban experience (p. 312). Baltimore: Johns Hopkins University Press. Pp. 165-199
- Amin, A. (2000). The economic base of contemporary cities. A Companion to the City, 115-129.
- Goldman, M (2011), "Speculative urbanism and the making of the next world city", International Journal of Urban and Regional Research, Vol 35(3), 555−581.
- Lees, L., & Demeritt, D. (1998). Envisioning the Livable City: The Interplay of "Sin City" and "Sim City" in Vancouver's Planning Discourse. Urban Geography, 19(4), 332-359.
- Lambertz, K.A. There's A Lesson in Spain's Surreal, Unfinished Cities.: http://www.huffingtonpost.com/entry/spain-emptycities_us_56ba6221e4b0b40245c47dff?section=india
- Townsend, A. M. (2013). Smart cities: Big data, civic hackers, and the quest for a new utopia. WW Norton & Company (1-18)
- Greenfield, A. (2006). No Boundaries: The challenge of ubiquitous design. Adobe Design Center, 1-5: http://uwforum.org/upload/board/No_Boundaries.pdf
- Vezzoli, C. A., & Manzini, E. (2008). Design for environmental sustainability. Springer Science & Business Media. (Chapters 1&2)
- Lein, J. K. (2008). Integrated Environmental Planning: A Landscape Synthesis. John Wiley & Sons (Chapter 4)
- 'A monster crawls into the city' – an urban fairytale by Saskia
- Sassen: http://www.theguardian.com/cities/2015/dec/23/monster-cityurban-
- fairytale-saskia-sassen
- Cstep (2015): Reconceptualising Smart Cities: A Reference Framework for India. Compendium of Resources. (1-39)
- Vanolo, A. 2014. Smartmentality: The smart city as disciplinary strategy. Urban Studies 51, no 5: 883-898
- Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?. City, 12(3), 303-320
- Wolfram, M. (2012). Deconstructing smart cities: an intertextual reading of concepts and practices for integrated urban and ICT development. na.
- Kukka, H., Ylipulli, J., Luusua, A., & Dey, A. K. (2014,October). Urban computing in theory and practice: towards a transdisciplinary approach. In Proceedings of the 8th

Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational (pp. 658-667). ACM.

- The stupefying smart city. Richard Sennett LSE Cities, LondonSchool of Economics, Eds.: Burdett Ricky, Rode Philipp. London, 16-17, 2012. https://lsecities.net/media/objects/articles/the-stupefying-smartcity/en-gb/
- Nissenbaum, H. F., & Varnelis, K. (2012).Modulated cities: Networked spaces, reconstituted subjects. Architectural League of New York.
- Komninos, N. (2009). Intelligent cities: towards interactive and global innovation environments. International Journal of Innovation and Regional Development, 1(4), 337-355.
- Kirkland, A. (2015). The Terrifying "Smart" City of the Future http://www.alternet.org/civil-liberties/terrifying-smart-cityfuture
- Throgmorton, J.A. 2003. Planning as persuasive storytelling in a global-scale web of relationships. Planning Theory 2, no 2: 125-51
- Van Hulst, M. 2012. Storytelling, a model of and a model for planning. Planning Theory 11, no 3: 299-318
- Healey, P. (2000). Planning in relational space and time: responding to new urban realities. A Companion to the City, 517-530.
- Söderström, O., Paasche, T., & Klauser, F. (2014). Smart cities as corporate storytelling. City, 18(3), 307-320.
- Townsend, A., & Norton, W. W. (2013). Smart cities. Places Journal https://placesjournal.org/article/smart-cities/
- Robinson Rick (2015). From Concrete to Telepathy: Building Cities as if People Mattered. TEDxBrum https://www.youtube.com/watch?v=o_yRJOg8yY8
- Halpern, O., LeCavalier, J., Calvillo, N., & Pietsch, W. (2013). Test-bed urbanism. Public Culture, 25(2 70), 272-306.
- Falconer, G. & Mitchell, S. (2012). Smart City Framework: A Systematic Process for Enabling Smart+Connected Communities: (http://www.cisco.com/c/dam/en_us/about/ac79/docs/ps/motm/Smart-City-Framework.pdf)
- Shwayri, S. T. (2013). A model Korean ubiquitous eco-city? The politics of making Songdo. Journal of Urban Technology, 20(1), 39-55.
- Cugurullo, F. (2013). How to build a sandcastle: An analysis of the genesis and development of Masdar City. Journal of Urban Technology, 20(1), 23-37
- Sennett, R. (2012). No one likes a city that's too smart. The guardian
- http://www.theguardian.com/commentisfree/2012/dec/04/smart-city-rio-songdo-masdar
- Parker, P. (1998). The Multi-Function Polis 1987-97: An International Failure or Innovative Local Project?. Australia-Japan Research Centre, Crawford School of Public Policy, The Australian National University.
- Mohan, A.K (2014). From Hierarchy to Heterarchy in the Information Age: The State and the Municipal Reforms Programme in Karnataka, India. Unpublished Dissertation, International Institute of Information Technology, Bangalore (65-73, 78-95)
- Mahadevia, D. (2011). Branded and renewed? Policies, politics and processes of urban development in the reform era. Economic and Political Weekly, 46(31), 56-64.
- Government of India (2014): Sivaramakrishna Committee Report on Study of Alternatives for the New Capital of Andhra Pradesh http://www.cprindia.org/sites/default/files/policybriefs/

- ExpertCommittee_CapitalAP_Final.pdf: Chattaraj, S. (2015). Are 100 New Smart Cities Smart Policy?http://www.outlookindia.com/website/story/are-100-newsmart-cities-smart-policy/293100
- Smart Cities: Mission Statement and Guidelines. 2015. Ministry of Urban Development, Government of India.
- Cstep (2015). Reconceptualizing Smart Cities: A Reference Framework for India.
- Dutta, A. (2016): Will India's experiment with smart cities tackle poverty – or make it worse?: https://theconversation.com/will-indias-experiment-withsmart-cities-tackle-poverty-or-make-it-worse-53678
- Sinha, D. (2015) Is Amravati really a 'capital' choice? In India Together http://indiatogether.org/articles/amravati-as-thecapital-of-andhra-states
- Amravati: Proposed Smart Capital for Andhra Pradesh https://www.youtube.com/watch?v=-RahriAP3vg
- Datta, A. (2012). India's ecocity? Environment, urbanisation, and mobility in the making of Lavasa. Environment and Planning C: Government and Policy, 30(6), 982-996
- Datta, A. (2015). New urban utopias of postcolonial India 'Entrepreneurial urbanization'in Dholera smart city, Gujarat. Dialogues in Human Geography, 5(1), 3-22
- Studying the selected 20 Smart City Proposals in India: https://secure.mygov.in/home/35421/discuss/
- Ministry of Urban Development, Government of India. http://smartcities.gov.in (strategy; selection process; implementation and monitoring and financing modalities)
- Odendaal, N. (2003). Information and communication technology and local governance: understanding the difference between cities in developed and emerging economies. Computers, Environment and Urban Systems, 27(6), 585-607.
- Mohan, A. K., Cutrell, E., & Parthasarathy, B. (2013,December). Instituting credibility, accountability and transparency in local service delivery?: helpline and Aasthi in Karnataka, India. In Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers-Volume 1 (pp. 238-247). ACM
- Government of India (2006). National urban transport policy 2006: http://www.indiaenvironmentportal.org.in/files/TransportPolicy.pdf
- Suzuki, H., Dastur, A., Moffat, S., Yabuki, N., & Maruyama,H. (2010). Ecological Cities as Economic Cities. Eco2 Cities: Ecological Cities as Economic Cities, 13-28 (169-182)
- Vinay Venkatraman (2014). Mobility beyond transport in smart cities. TEDx CopenhagenSalon https://www.youtube.com/watch?v=z5O4Yl6ZB4k
- Kitchin, R. (2014). The real-time city? Big data and smart urbanism. GeoJournal, 79(1), 1-14.
- Mischa Dohler (2013). Smart Cities – The Untold Story: TEDx London City 2.0
- https://www.youtube.com/watch?v=xUFUp-ylfC4
- Choi, J. H. J., & Greenfield, A. (2009). To connect and flow in Seoul: Ubiquitous technologies, urban infrastructure and everyday life in the contemporary Korean city. Handbook of research on urban informatics: The practice and promise of the real-time city, 21-36.
- Bunnell, T. (2003). Malaysia's high-tech cities and the construction of intelligent citizenship. Theorizing the southeast Asian city as text, 109-133.

- Saunders, T., & Baeck, P. (2015). Rethinking Smart Cities from the Ground Up. London: Nesta. (selected pages)
- Crang, M., & Graham, S. (2007). Sentient cities ambient intelligence and the politics of urban space. Information, Communication & Society, 10(6), 789-817.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

- Class Participation--- 20%
- Group Activities and Presentations – 40%
- Writing Assignments (Mid-term and End-term) – 20%
-

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Class Participation	CO 1-6
2.	Group Activities and Presentations	CO 1-6
3	Writing Assignments	CO 1-6

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Students will not be allowed to submit their essays or other assignments later than the deadline other than for valid medical or other emergencies.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Students may follow any recognized citation standard such as APA, or Chicago, as long as they do so consistently.

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

All readings and grading comments are made available in a digital format that is accessible for visually challenged students. Other accommodations will be as per institute policy.

Course Syllabus

Course Code / Course Name	NC-501 / Networking and Communication	
Course Instructor Name(s)	Prof. Debabrata Das and Prof. Jyotsna Bapat	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	4	Lecture (3 hr = 3 credit)
	0	Tutorial (1hr = 1 credit)
	0	Practical (0 hrs = 0credit)
	L:T:P = 4:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		X	Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
X	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
X	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The deep understanding of functioning of network stacks will help the students be eligible for employability in R&D companies.
Focus on skill development	Yes	The course assignments and examinations help students to approach as well as solve computer networking problems in logical manner.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

World is moving towards more digitization. The success of digitization depends mainly on communication of digital information between human and devices, efficient storage of it and computation. With respect to above communication of digital information is one of the major requirements for dissemination of required information. However, as we know the user equipments (like, Personal computers, mobile, laptops, servers etc.), routers/switches, and medium (optical, wireless etc.) are not uniform between two users or devices. Hence, the above digital information communication has to pass through heterogeneous systems/medium making it an extremely complex system with respect to fast as well as successful transmission. With respect to above, this course reveals the complexity to the students and its solution for fast as well as reliable communication over heterogeneous network architecture, referred as Internet.

With respect to above, the course first covers, the types of network topologies possible and its properties. Which topology, one should select with respect to requirements for better performance. Secondly, it covers the application protocols and why different protocols required for various applications. In third step it teaches socket programing to make the student understand the connection between application layer to transport layer for reliable, congestion as well as flow control of information over the Internet. In fourth step, it covers the routing algorithms concepts for information. In fifth step it covers medium access control protocols and how an information moves steps by step to reach destination. During the last part of the course, it covers the channel capacity and physical medium concept for less erroneous transmission between the nodes.

The above structure of courses and mode of interactive teaching not only clears their concepts but also logical thinking for research base for the post graduate students. As the course proceeds the students are given assignments to solve critical thinking problems. Moreover, they are also taught of theoretical model and simulation of protocols along with systems understanding. These help them develop problem solving capacity as well as give them ability to recognize unnoticed problems.

The students who have taken this course have joined R&D companies in the areas of networking and communication as their understanding of the subjects along with research blend of mind. Furthermore, the students have also pursued higher studies (PhD).

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)
CO1	Understand the challenges in digital information flow over a heterogeneous computer network;	PO4	U	F, C	8
CO2	Analyze the interoperability between the protocols for the different layers of network stack	PO4	An	F, C, P	14
CO3	Understand the functioning of web browsing, FTP, e-mail and real time network applications	PO4	U	F, C	6
CO4	Determine the appropriate routing protocols for efficient routing for given topological conditions and router abilities	PO4	Ap	F, C, P	6
CO5	Understand role of flow control and congestion control algorithms to avoid congestion over Internet.	PO4	U	F, C, P	6
CO6	Understand the evolution of IPv6 from IPV4 for real time and non-real time communication over Internet.	PO4	U	F, P, C	6
CO7	Determine the appropriate medium access control protocol to avoid collision during transmission of information in the given medium.	PO4	Ap	F, C, P	6
CO8	Understand the functioning of Physical layer and new advances in technologies used in Physical layer.	PO4	U	F, C	8

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

- Introduction to Computer Networking and Communication → why it is important to study this with respect to larger picture of digitization?

- Types of Network Topology and each topology properties
- Application protocols
- Socket programing
- Transport Layer protocols: Multiplexing and De-multiplexing of information in a node; TCP protocol: Reliable transmission algorithm, Congestion and flow control algorithms, UDP protocol,
- Network Layer protocols: routing algorithms - link state and distance vector, IP headers, IP mobility,
- Data link layer: concepts of medium access control protocol, error detection and correction, frame structure,
- Physical layer: Theoretical foundations of Digital Communication: Introduction to decision theory, AWGN channel, Bandlimited channel, colored noise channel, channel capacity for selected channel.

Instruction Schedule

[Provide session-wise schedule]

Lectures 1-3:

The first lecture is to make the students oriented towards the subjects to be covered in this course and why? The grading system and the books referred. Logical and physical topologies and why we need so many topologies?

Lecture 4:

Client, Server, Connection oriented and connectionless services, Layered architecture, Internet protocol layer, Concepts on – why packet switching will take over circuit switching? □ leads to understand importance of Internet.

Lectures 5-8

Need of services by application layer protocols, HTTP, FTP, SMTP, DNS

Lecture 9-10

DNS, Socket concepts for TCP and UDP

Lecture 11

Relationship of transport layer with application and network layer, Multiplexing and De-multiplexing, UDP

Lecture 12-13

Why Go Back N, Selective Repeat of TCP connection invented? Channel utilization, segment structure,

Lecture 14-15

Reliability in Internet,

Lecture 16-18

Flow control, and Congestion control algorithms

Lecture 19-21

Link-state routing algorithm, Distance-vector routing algorithm, fragmentation

Lecture 22-24

Intra-autonomous system routing: RIP, OSPF, Inter-autonomous system routing: BGP

Lecture 25

IPv4 and IPv6 packet format and basic differences and alignments,

Lecture 26

IP-based Mobility at network layer,

Lecture 27 -29
Error detection and correction techniques; multiple access protocols in LAN: channel portioning, taking turn
Lecture 30-32
Random Access MAC protocol in distributed system (Wired and Wireless LAN medium access Control Protocol, concepts on throughput increase and why (Pure/Slotted ALOHA, CSMA, CSMA/CD: Ethernet,)
Lecture 33
Address resolution protocol
Lecture 34
With respect to all the concepts in previous classes, in these two class we stitch all the concepts from application to data link layers to explain -- how a digital information packets moves from source to destination in an internet,

Lecture 35
Software Define Network Architecture, Control plane functions, Data plane functions,
Lecture 36-37
Theoretical foundations of Digital Communication: Introduction to decision theory, AWGN channel, Bandlimited channel, colored noise channel, channel capacity for selected channel.
Lecture 38-39
Error Correcting and Detecting Codes: Block codes, cyclic block codes, convolutional codes
Lecture 40
Orthogonal Frequency Division Multiplexing, MIMO systems. Typical application in 4G and 5G.

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Computer Networking: Top Down Approach, by Kurose and Ross
2. Local Area Network, by G. Keiser
3. Performance Analysis of the IEEE 802.11 Distributed Coordination Function, by G. Bianchi, IEEE Journal of Selected Areas in Communications, Vol. 18, No. 3, March 2000.
4. B. Sklar, “Digital Communications: Fundamentals and applications”, Prentice Hall
5. J. G. Proakis and M. Salehi, “Communication Systems Engineering”, Prentice Hall

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

1. Two Class Tests/Quizzes: 20%
2. Mid Term Exam: 30%
3. Assignments: 10%
4. Project: 10%
5. Final Exam: 30%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Why MIME format important in email protocol? (assignment)	CO1, CO2, CO3
2	Design and implementation of socket programing (project)	CO3, CO4
3	IPV4 and IPV6 header structures and how an information moves from IPV4 network to IPV6 network and vice versa. (Assignment)	CO6, CO7
4	Why Go-Back-N was invented? How selective repeat works (Assignment)	CO5

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- **Manual evaluation of essay type / descriptive questions**

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Student is allowed to submit within 1 day after deadline. Exceptions are made if prior permission is taken.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	Wireless Communication (NC-827)	
Course Instructor Name(s)	**Prof. Priyanka Das and Prof. Jyotsna Bapat**	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	45	Lecture (3hrs = 3 credit)
		Tutorial (0hr = 0 credit)
		Practical (2hrs = 0 credit)
	L:T:P = 3:0:0	**Total Credits = 3**

Grading Scheme *(Choose by placing X against appropriate box)*		
	X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		X	Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

X	iMTech
X	M.Tech
	M.Sc.

Branch:

X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

- Digital Communication (EC-306)
- Probability, Random Variables, and Random Processes

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The conceptual understanding of this course helps the students to get jobs in information technology and communication system design industry
Focus on skill development	Yes	The course content, assignments, and project develop the student skills in applications of advanced wireless communication systems
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

- **Course category**: Engineering Science

- **Offered in**: Fall semester

- **Aim of the course**: The primary goal of this advanced research course is to introduce students to the underlying theory, design techniques, and analytical tools for understanding and improving the performance of modern wireless communication systems. This course intends to cover the fundamentals of wireless channel models, impact of fading, various channel coding schemes for error control, multi-carrier modulation techniques, and the multiple-input multiple-output (MIMO) systems, which are several key 4G/5G wireless technologies. It also includes Matlab coding assignments and a mini project.

- **Course Overview**: Wireless communication has witnessed revolutionary developments in the last decade. These advances have led to implementation of 3G, 4G, and 5G wireless technologies, which can support data rate in excess of 100 Gbps. Most of the future data-intensive applications handling a massive number of connected devices will demand high data rates with low latency. To deliver these demands and customer expectations, current 5G technologies must be further developed in line with the 6G concepts. The 6G system will increase the performance and maximize the user quality of service (QoS) several folds more than 5G along with some additional benefits. Major 6G use cases include enhanced mobile broadband (eMBB), ultra-reliable low latency communication (URLLC), and massive machine type communications (MMTC).

  The course is designed to help students get an in-depth grasp of the fundamentals of wireless technologies, and gain a better understanding of modern 5G wireless communication systems from physical layer perspective, and its extension towards 6G. While the potential benefits of such technologies are promising, there are numerous challenges in the design and implementation of such wireless systems. The course will address the following topics: wireless channel modeling, fading and its countermeasures, diversity techniques, channel coding schemes, orthogonal frequency division multiplexing (OFDM), space-time coding, and MIMO systems. This will also lay the foundation for advanced wireless communication techniques such as Cooperative Communication, Massive MIMO, and Millimeter Wave Communication. Finally, students are expected to prepare a mini project that will focus on an in-depth study and analysis of any cutting-edge wireless technology of their choice.

- **The importance of the course to the profession**: The field of digital communication has evolved rapidly in the past few decades, with commercial applications proliferating in wireline communication networks (e.g., digital subscriber loop, cable, fiber optics), wireless communication (e.g., cell phones and wireless local area networks), and storage media (e.g., compact discs, hard drives). After course completion, the students should be well equipped for research or cutting-edge development in communication systems in either industry or academia. Specifically,
    - There are myriads of job opportunities in the manufacturing industry and service establishments such as broadcasting, data communication, entertainment, consulting, research and development including system support.
    - The students might get a chance to work in multimedia service organizations that are engaged in real-time information transfer via video conferencing/internet broadcasting.
    - Scope to work in different sectors such as Defence, DRDO, ISRO, Civil Aviation, Indian Telephone Industries, Development Centers in various states, NPL, A.I.R, Post and Telegraph Department, Railways, Software Engineering/IT, Hardware Manufacturing, VLSI Design, Telecommunication, Power Sector, Television Industry, Research & Development, and Home Appliances.

- **Related Courses**
    - Next Generation Wireless Systems: Design and Performance Analysis
    - Recent advances in 5G and Beyond

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Upon the successful completion of the course, students will be able to:

	Course Outcome	PO	CL	KC	Class (Hrs)
CO1	Model wireless time-varying channel and its impact on received signal quality through simulations using Matlab	PO1	Ap	C, F, P	9
CO2	Analyze the BER performance under frequency-flat Rayleigh fading channel with verification using Matlab	PO1	Ap	C, F, P	3
CO3	Understand the principles of diversity techniques including time, frequency, and antenna diversity through simulations using Matlab	PO1	U	C, F, P	3
CO4	Determine the appropriate transceiver design of multi-antenna systems and evaluate the data rate, diversity order, and coding gain performance metrics	PO1	Ap	C, F, P	9

CO5	Understand the impact of channel encoding/decoding schemes including linear block codes, cyclic, and convolutional codes on output bit error probability through simulations using Matlab	PO1	U	C, F, P	9
CO6	Design wireless communication system with key 4G (OFDM) technology through simulations using Matlab	PO1	Ap	C, F, P	9
CO7	Describe and differentiate four generations (2G/3G/4G/5G) of wireless standards for cellular network with more emphasis on 5G through a Mini Project implementation	PO1	Ap	C, F, P	3

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Lab (Hrs): Number of hours of Lab session (where applicable)*

Course Competencies:

- Understand the challenges in wireless communication system design.
- Model wireless fading channel and understand its impact on received signal-to-noise ratio.
- Compute cell coverage area and outage probability under combined pathloss and shadowing.
- Calculate coherence time and coherence bandwidth and classify the type of small-scale fading for given system parameters.
- Analyze BER performance under Rayleigh fading with coherent and non-coherent detection.
- Analyze BER vs SNR for repetition coding with L time-diversity branches.
- Understand the effect of various multi-antenna schemes including MRC and MRT on improving error performance and the requirement for receiver and transmitter-side channel state information.
- Determine the criteria for designing good space-time codes of MIMO transmissions.
- Compare the diversity order, coding gain, and data rate for Alamouti, Repetition coding, and V-BLAST space-time coding schemes.
- Determine capacity-optimal power allocation policy for MIMO channel through its singular value decomposition.
- Understand channel encoding/decoding schemes including linear block codes, cyclic codes, and convolutional codes, and demonstrate their impact on system performance.
- Study the Orthogonal Frequency Modulation techniques and their advantages/disadvantages.
- Understand key technologies used in 2G-5G wireless standards and the roadmap towards 6G.
- Conduct a mini project which can be a literature survey, in-depth study and analysis, simulations, or experiment from the cutting-edge wireless research topics as discussed in Module-6 of Course Content.

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Module 1 – Physical modeling of wireless channels and challenges

- Transmit and receive signal models
- Free-space and simplified path loss models
- Shadowing effect

- Small scale fading
- Coherence time vs coherence bandwidth
- Statistical multipath channel modeling
- Rayleigh, Rician, and Nakagami-m fading models
- Higher frequency channel modeling (> 60 GHz)

Module 2 – Point-to-point communication: detection, diversity and channel uncertainty

- Bit error rate performance for Rayleigh fading channel
- Realization of independent fading paths- Diversity techniques
- Time diversity
- Antenna diversity
- Frequency diversity
- Channel estimation

Module 3 – MIMO

- Narrowband MIMO system model
- MIMO receivers
- Parallel decomposition of MIMO model
- Diversity gain, spatial multiplexing of MIMO
- Rank and determinant criteria
- MIMO channel capacity
- Alamouti code and its BER performance
- Nonlinear MIMO receiver: V-BLAST
- MIMO beamforming

Module 4 – Coding for wireless channel

- Linear block codes, Generator matrix
- Parity check matrix and syndrome testing
- Convolutional code
- The Viterbi algorithm

Module 5 – Multicarrier modulation

- Data transmission using multiple carriers
- Mitigation of subcarrier fading
- OFDM, its FFT/IFFT implementation, cyclic prefix
- Challenges in OFDM: PAPR
- OFDMA

Module 6 – Recent trends in wireless communications (Project Topic Discussion)

- Millimeter wave wireless communication
- Massive MIMO
- Non-orthogonal multiple access (NOMA)
- Full-duplex wireless technology
- Cooperative communication
- Cognitive radio systems
- Intelligent Reflecting Surface (IRS)

Instruction Schedule

[Provide session-wise schedule]

Schedule	Topic	Exam
Week 1	Introduction to the course: Evolution of wireless communication technology	
Week 2	Wireless channel models, Ray tracing, Delay and Doppler spread, Coherence time and bandwidth, Jakes Model	
Week 3	Linear time-varying wireless channel, Fading channel distribution	
Week 4	BER performance for AWGN and Rayleigh fading wireless channels, Deep Fade Phenomenon	Quiz-1
Week 5	Principle of Diversity: Time and Antenna diversity, MRC technique	
Week 6	Introduction to MIMO, System Model	
Week 7	MIMO Receivers, Introduction to Singular Value Decomposition (SVD) and MIMO Channel Capacity	
Week 8	MIMO Diversity-Alamouti, Orthogonal Space-Time Block Codes (OSTBC), MIMO Beamforming-Maximal Ratio Transmission (MRT) technique	Mid-term
Week 9	Channel Codes: Linear block codes	
Week 10	Cyclic codes	
Week 11	Convolution codes and Viterbi Algorithm	Quiz-2
Week 12	Introduction to Multicarrier Modulation (MCM) and OFDM	
Week 13	OFDM System Model, IFFT/ FFT Transceiver Model	
Week 14	OFDM PAPR, Multi user OFDM	
Week 15	Introduction to 5G Wireless Technologies – Massive MIMO, mmWave, NOMA, Full Duplex technology, Cooperative Communication, Cognitive radio, IRS	End-term, Mini Project

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- **Text Books**

  1. David Tse and P. Viswanath, “Fundamentals of Wireless Communication”, Cambridge University Press
  2. Andrea Goldsmith, “Wireless Communication”, Cambridge University Press
  3. Aditya K. Jagannatham, “Principles of Modern Wireless Communications Systems: Theory and Practice”, Mc Graw Hill Education

- **Reference Books**
  1. Theodore Rappaport, “Wireless Communications: Principles and Practice”, Prentice Hall
  2. Other research papers for state-of-the-art wireless technologies for 5G and beyond

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Two Quizzes (15%), Mid-term (25%), End-term (25%), Matlab Programming Assignments (10%), Mini Project (20%), and Class Activity (5%)

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Simulate a wireless channel considering simplified path loss and log-normal shadowing model and find the outage probability using Matlab.	CO1
2	Plot BER vs SNR for (i) AWGN channel without fading and (ii) Rayleigh fading under coherent detection through simulations using Matlab.	CO2
3	Plot BER vs SNR for (i) Repetition Coding with L-diversity branches and (ii) SIMO system with N receive antennas under Rayleigh fading, and obtain diversity order in each case through simulations using Matlab.	CO3
4	Understand the impact of channel coding on system performance, specifically BER using simulations.	CO5
5	Understand the principle of multicarrier modulation using simulation.	CO6
6	Conduct a mini project which can be a literature survey, in-depth study and analysis, simulations, or experiment from the cutting-edge wireless research areas focusing on the depth and clarity in your description with a system model and performance analysis.	CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools
- Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Student is allowed to submit within 1 day after deadline. Exceptions are made if prior permission is taken.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Appropriate citation of references as per the standard IEEE format is mandatory in assignments and course project.

Academic Dishonesty/Plagiarism

[State if any specific policy derived from institute policy is applicable. Otherwise leave it as given]

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	SM 602 / Introduction to nonlinear dynamical systems	
Course Instructor Name(s)	B. Ashok	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	4	Lecture (1hr = 1 credit)
	-	Tutorial (1hr = 1 credit)
	-	Practical (2hrs = 1 credit)
	L:T:P = 4:0:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)

(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
x	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

X	CSE
X	ECE
	Digital Society

x	iMTech
x	iM.Tech
	M.Sc.

Course Category

Select **one** from the following:
(Place X appropriately)

X	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	Yes	Enables application of analytical tools to practical engineering as well as scientific problems
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Problem solving skills, logical reasoning

Course Context and Overview

Dynamical systems theory seeks to explain the behaviour of systems evolving in time. Though deterministic in nature, classical systems can often show behaviour that can be very unpredictable or chaotic.
The course introduces the language and basic tools of nonlinear dynamics through a mixture of lectures, computer-lab work, assignments, self-reading and project-work. Everyday examples and applications showing nonlinear behaviour are discussed, and analysis of the same is undertaken.

The subject has applications over diverse fields, ranging from the behaviour of various physical, mechanical and biological systems, chemical reactions and fluid systems to climate systems, ecological systems & economics, etc.

The course begins with a discussion of nonlinear ordinary differential equations (flows) and their structure. The concept of linear stability analysis is then introduced, starting with a stability matrix and the Jacobian, finding eigenvalues and eigenvectors for one, two or more dimensions, and the direction of flow of the dynamical system. Geometrical concepts of fixed points, sources & sinks, saddle, etc. explained. Classification of fixed points is learnt.

This is followed by explanation and analysis of limit cycles, when these can exist and the conditions required to be satisfied for these. The Poincare-Bendixson theorem is introduced, showing how a trajectory must approach a closed orbit if confined to a closed, bounded region in a two-dimensional phase-space, in the absence of fixed points. The concept of nullclines are introduced and used in analysis of limit cycles. Lienard systems and Lienard's equation for the the existence of stable limit cycles are introduced.

Potential functions, Lyapunov functions and Dulac's criterion are introduced as tools for investigating stability and absence of closed orbits.

Relaxation oscillations are then discussed with examples, and analysis of relaxation oscillators is done. Physical examples of relaxation oscillations and multiple time-scales are also introduced to enhance comprehension. The van der Pol oscillator is discussed in detail, and slow and fast manifolds discussed.

Bifurcations are then introduced, explaining the concept of local and global bifurcations.
Various local bifurcations, in particular: saddle-node, transcritical, pitchfork and Andronov-Hopf bifurcations are discussed and analyzed and their normal-form equations understood. Plotting of and understanding bifurcation diagrams is done concurrently.

Integrable and Hamiltonian systems are discussed and the equations defining such systems are introduced. Gradient systems are investigated.
KAM theorem is introduced. Concepts of Poincare section are explained. Liouville's theorem and implications are discussed.

Dissipative systems are then introduced. The Lorenz equations are discussed in detail, along with the Lorenz attractor. Volume contraction of the phase space, related bifurcations and stable and unstable manifolds are discussed in detail.

The concept of chaos is introduced and means of detecting it explained. Lyapunov exponents are defined and studied. Strange attractors are discussed.

Discrete nonlinear dynamical systems are then introduced, starting with simple maps. The logistic map is discussed in detail, as an example of a unimodal map. Cycles are discussed. Cobweb diagrams are introduced as a graphical method for investigating stability of fixed points, and used for various examples of maps.
Period-doubling is introduced, and investigated in simple maps like the logistic and sine maps. Calculation of Feigenbaum constants is done and the concepts of qualitative and quantitative universality are discussed.

Lastly, fractals are introduced with examples of simple fractals and the measures of fractal dimension discussed. Self-similar fractals are discussed. Box, similarity, pointwise, correlation dimensions are studied.

All of the above content in the course are accompanied with assignment problems that students have to solve.
An end-term project is assigned individually that is aimed to allow each student to apply what they have learnt to a particular problem. Students are encouraged to show originality in working on their project problem, in extending it and using concepts learnt in class.

The aim of the course is to give the fundamental background necessary for students to apply the methods of dynamical systems to areas of their interest in future, and is open to all students (iMTech / MTech / MS / PhD).

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)
CO1	Apply linear stability analysis & geometrical concepts to to nonlinear differential equations to classify fixed points into spirals, centers, nodes, stars & saddle points based on eigenvalues & eigenvectors.	PO1	Ap	F, C, P	5
CO2	Construct and use potential functions, Lyapunov functions, Dulac's criterion to show the absence of closed orbits for a system	PO1	Ap	F, C, P	3
CO3	Apply Poincare-Bendixson theorem & Lienard's equation to determine existence of limit cycles	PO1	Ap	F,C,P	3
CO4	Understand the concept of relaxation oscillations, multiple time-scales and slow and fast manifolds, using the van der Pol oscillator as an example	PO1	U	F,C,P	5
CO5	Use normal form-equations to classify local bifurcations as saddle-node, transcritical, pitchfork and Adronov-Hopf and plot bifurcation diagrams of such systems.	PO2	Ap	F,C,P	5
CO6	Understand the concepts of integrable and Hamiltonian systems, and their conservation of phase space volume as formulated through Liouville's theorem	PO1	U	F,C,P	2
CO7	Analyze the Lorenz equations and its bifurcations and stable and unstable manifolds in detail, as an example of a dissipative system.	PO1	U	F,C,P	5
CO8	Understand the concept of chaos and how it is detected and quantified by means of Lyapunov exponents	PO1	U	F,C, P	4
CO9	Perform stability analysis and plot bifurcation diagrams for discrete dynamical systems showing existence of cycles and period-doubling.	PO1	Ap	F,C,P	6
CO10	Understand concepts of qualitative and quantitative universality and obtaining Feigenbaum constants	PO1	U	F,C,P	2
CO11	Understand the concepts of self-similarity, fractals and measures of fractal-dimensions	PO1	U	F,C,P	2
					Total hours: 42

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Course Content

Structure of nonlinear ODEs, linear stability analysis.

Zero & one dimensional attractors- limit cycles, higher dimensional attractors, Poincare-Bendixson theorem.

Null-cline method for the analysis of limit cycles, relaxation oscillations, slow and fast manifolds, introduction to local bifurcations: saddle-node, transcritical, pitchfork, Andronov-Hopf; bifurcation diagrams.

Integrable systems: KAM theorem, Poincare surface of section, Hamiltonian systems, Lyapunov functions & direct method for stability.

Dissipative systems: Lorenz equations, chaos, Lyapunov exponents, strange attractors.

Fractals & their dimensions.

Discrete dynamical systems: simple maps, cycles, cobweb diagrams, logistic map, period doubling, Feigenbaum constants, universality.

Instruction Schedule

Pre Mid sem: CO1 to CO6
Post Mid sem: CO7 to CO12
Weekly 2 classes of 1.5 hours each.

Learning Resources

1. Steven Strogatz, “Nonlinear Dynamics & Chaos”, Westview Press / Levant Books (2007).

2. Robert Hilborn, “Chaos & nonlinear dynamics: an introduction for scientists & engineers”, Oxford University Press (2001).

3. K. Alligood, T. Sauer & James A. Yorke, "Chaos: an introduction to dynamical systems", Springer-Verlag (1996).

4. Various pedagogical papers from, e.g., The American Journal of Physics.

Assessment Plan

3 to 4 Assignments: 30% weightage
Mid term Assessment : 30%,

End-term project Assessment: 40%

Grading :
For an A grade, an absolute score of 75%-80% is expected.
Other grades are set relatively based on the highest mark obtained by any student in the class and the lowest pass mark that instructor decides. In this band of marks, all the grades starting from A to D are typically spread equidistantly. Students who get lower than the set pass marks are given F grade.

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Stability analysis, fixed point classification, closed orbits	CO1, CO2, CO3
2.	Relaxation oscillations, Limit cycles, Bifurcation diagrams: generation and analysis	CO3, CO4, CO5
3.	Hamiltonian and dissipative systems	CO6,CO7
4.	Chaos, discrete dynamical systems (maps)	CO8, CO9, CO10, CO11
5.	Project covering use of concepts taught throughout the semester	CO1-CO10

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of numerical & analytical problems in assignments to be solved based on topics covered in class.
- Evaluation through midterm-assessment based on an exam or progress in project.
- Evaluation based on end-semester evaluation based on a written exam or project assigned individually to students.

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Make-up Exam/Submission Policy

As per institute policy

Citation Policy for Papers (if applicable)

For papers allotted for presentation or project-work, students are expected to cite that and other supporting papers they may refer to. Citation format expected is: Author names, Title of paper, Journal name, Journal Volume, pages (Year of publication).

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs

As per institute policy

Course Syllabus

Course Code / Course Name	AI 836 / Advanced Visual Recognition	
Course Instructor Name(s)	Prof. Dinesh Jayagopi, Prof. G. Viswanath	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (3hr = 3 credit)
	1	Tutorial (1hr = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
X	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	Visual Recognition

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Paper presentations help in progressing for a research career in industry or academia
Focus on skill development	Yes	Reading research papers in depth and being able to present the main ideas, helps in innovating in the future
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)	Yes	Paper presentations helps improve communication skills

Course Context and Overview

This course is an advanced version of the visual recognition course (AI 825). In this course, students are expected to learn advanced topics – Generative Adversarial Networks (which can help generate images), specialize recognition to human centered problems – Face, Body and Hand analysis, sequence modeling problems – Object tracking and scene text recognition, transformer models for language and vision, deeper visual understanding beyond object detection - Scene graph modeling and visual question answering.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the theory of Generative Adversarial Networks	PO4	U	F, C	6	0
CO2	Understand visual recognition for human centered problems	PO4	U	F, C	8	0
CO3	Understand visual recognition for sequence modeling problems	PO4	U	F, C	8	0
CO4	Present research papers in human centered and sequence modeling domains	PO4	Ap	F, C	8	0
CO5	Understand theory of Transformers and Language Modeling	PO4	U	F, C	6	2

CO6	Understand Scene Graph Modeling and Visual Grounding	PO4	U	F, C	6	2
CO7	Apply Transformers and Language Modeling techniques to Visual Question Answering	PO4	Ap	C,P	5	1
CO8	Analyze the Image-Language modality fusion techniques	PO4	Ap	C, P	6	2

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Part-1

Generative Adversarial Networks, Human centered visual recognition (Face, Body and Hand modeling), Sequence Modeling (Object tracking in video and Scene Text recognition)

Part-2

Transformers- Language Modeling – Scene Graph Prediction – Visual Grounding- Visual Question Answering – Techniques for Image Language Fusion

Instruction Schedule

Learning Resources

Assessment Plan

Part 1:
Assignment 1: 10 marks
Paper presentation 1: 20 marks
Paper presentation 2: 20 marks

Part 2:

Assignment 2 : 10 Marks

Assignment 3 : 15 Marks
Assignment 4 : 10 Marks
Assignment 5 : 15 Marks

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Part 1: Assignment 1	CO1
2	Part 1: Paper presentation 1	CO2, CO4
3	Part 1: Paper presentation 2	CO3, CO4
4	Part2 : Assignment 2	CO5
5	Part2 : Assignment 3	CO6
6	Part2 : Assignment 4	CO7, CO8
7	Part2 : Assignment 5	CO5, CO6

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	EC503 Digital CMOS VLSI Design	
Course Instructor Name(s)		
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
X	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
X	M.Tech
	M.Sc.

Branch:

	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Digital Design, Basic Electronics Theory and Lab, Electronic devices and Circuit lab

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The basic CMOS transistor working and design techniques towards improving performance is highly useful for todays SoC Design employability.
Focus on skill development	Yes	The design techniques, and layout understanding are the skills developed in the course.
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

This is the first graduate level course in VLSI design. This course introduces students to CMOS circuits, develops first-order current-voltage and capacitance-voltage models for transistors, transfer characteristics of CMOS inverter, performance estimation for circuits through logical effort, combinational circuit design, and circuit families.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand NMOS and PMOS current equations and determine the relation with respect to size of transistors.	PO3	U	F	3	
CO2	Apply and observe CMOS Inverter transfer characteristics and Noise margin using current equations and compare the same using LTSpice tool.	PO3, PO1	Ap	F,C	4	4
CO3	Evaluate the propagation delay for a unit inverter and compare the same using LTSpice tool.	PO3, PO2, PO1	E	C,P	7	4
CO4	Understand the Elmore delay model and apply the same for higher order NAND and NOR gates.	PO3	U	PC, P, F	6	
CO5	Understand the design methodology for multi stage digital circuits.	PO3, PO1	U	PC, C&S, D-I	6	

CO6	Understand different combinatorial logic families, and compare them in terms of logical effort and parasitic delay.	PO3	U	F, C	8	
CO7	Apply stick diagram for higher order digital compound gates and determine the footprint.	PO3, PO2, PO1	Ap	P, PC	4	4
CO8						
CO9						
CO10						

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

NA

Course Content

[Provide list-wise topics]

Course contents includes CMOS logic, pass transistors, Transfer characteristics of Inverter, Noise Margin, Long channel current model, short channel current model, Design of Inverter, gate capacitances, parasitic capacitances, C-V characteristics for a MOS transistor, CMOS stick diagram, and layout, CMOS Delay Estimation, Delay optimization, Elmore delay model, Linear delay model, logical effort, Design for multi-stage and compound circuits, Decoder gate level design, Combinational CMOS Logic Styles, Dynamic Combination CMOS Logic styles, Pseud NMOS, Asymmetric gates, and Domino logic. The course also includes Schematic and layout of Digital circuits using Electric tool.

Instruction Schedule

[Provide session-wise schedule]

NMOS Transistor	2 hours
MOS Capacitor Model, Short-Channel	3 hours
Short Channel, and DC Characteristics	3 hours
Skewed Inverter, Transistor Dimensions	4 hours
CMOS Buffer, Noise Margin	5 hours
Delay	5 hours
Parasitic delay	2 hours
Logical Effort	3 hours
Electrical effort and branching	3 hours
Decoder design	2 hours
Combinational circuit families	5 hours
Stick Diagram	3 hours
Ratioed circuit	3 hours

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Neil H. E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th edition, 2011.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Midterm exam-30%
Final exam-30%
Quizzes-20%
Assignments-20%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	I-V and C-V characteristics using Long channel current equations and verify the same in LTSpice tool.	CO1
2	Transfer characteristics of Inverter and Transmission gate and verify the same in LTSpice.	CO2
3	Optimize the performance of a digital circuit by identifying critical paths and determine the gate and transistor size.	CO4,CO5
4	Draw stick diagram and layout in Electric Tool for a compound logic gate.	CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Unless medically approved excuse, all late submissions are not considered for grading.

Make-up Exam/Submission Policy
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)
[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism
State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs
[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	VL 504 System Design using FPGA	
Course Instructor Name(s)	Nanditha Rao	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	24	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:1	**Total Credits = 2**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
X	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch: ECE*

X	iMTech
X	M.Tech
	M.Sc.
	CSE
X	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Digital design, architecture

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	
Focus on skill development	Yes	
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

This course covers the use of the hardware description language- Verilog for the design of digital integrated circuits and covers in detail the programming of the design on to the field programmable devices (FPGA).

Applications: High performance computing, acceleration, image and DSP applications, automative, defense, hardware emulation and prototyping, medical applications etc https://www.xilinx.com/applications/

Verilog:
We will first review in brief the basics of Verilog programming which includes: structural and behavioral styles of programming. This is done as part of the preparatory semester for Mtech students.

FPGA architecture overview:
Second, we focus on the basic building blocks of PLDs and FPGA architectures, design methodologies and the Xilinx Vivado based programming methodology.

FPGA programming methodologies:
We will simulate/verify the design with testbenches and implement the design on to an FPGA development board (Xilinx). We discuss the major interfaces on the board, using the IP blocks, debugging with Logic Analyser as part of the FPGA design flow. We will then briefly discuss the Embedded System design flow with Zynq boards, High level synthesis design flow (HLS) and if time permits, the partial reconfiguration design flow.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Overview of Design methodology: ASIC vs FPGA Design flows, FPGA architecture, Xilinx 7 Series FPGA architecture Overview, Basys3-Introduction, Schematics. Introduction to standard FPGA design flow using Xilinx Vivado Design Suite	PO1, PO3, PSO1	U	C	3	
CO2	Handson/ Labs- Mux/FSM/Sequence detector design.Use of Integrated Logic Analyzer (ILA), Virtual input output (VIO)	PO1, PO3	Ap	C,P	3	
CO3	Design using IP blocks: clock wizard, Block RAM memory	PO1, PO2	U, Ap	C, P	3	
CO4	Overview of timing analysis, layout and power. Programming the 7-segment display	PO2, PSO1	U, Ap	P	3	
CO5	Interfacing: (UART, DSP blocks)	PO2, PO4, PSO1	U, Ap	C, P	3	
CO6	Zynq architecture overview: Concept of Programming System (PS), programmable logic (PL), AXI interface, Embedded System design flow, Programming using SDK	PO1, PO4, PSO1	U, Ap	C, P	4	
CO7	High-level Synthesis design flow, Partial reconfiguration flow	PO4	Ap, Cr	C, P	5	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*
KC: factual, conceptual, procedural, or metacognitive knowledge

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]
Topic 1: Design methodology, Vivado design methodology, Design of digital circuits
Topic 2: Design with IP blocks, interfacing, timing and power analysis
Topic 3: Zynq architecture overview
Topic 4: High-level Synthesis design flow, partial reconfiguration

Instruction Schedule

[Provide session-wise schedule]

Preparatory semester: Week 0a - 0b: Overview of Verilog HDL, structural and behavioral design. The concept of synthesisable Verilog code, Blocking and non-blocking statements, delays.

Week 1: Overview of Design methodology: ASIC vs FPGA Design flows, FPGA architecture, Xilinx 7 Series FPGA architecture Overview, Basys3-Introduction, Schematics.

Introduction to standard FPGA design flow using Xilinx Vivado Design Suite and Basys3

Xilinx University program and Intel FPGA program course materials and labs are used for the following content.

Week 2- Handson/ Labs- Mux/FSM/Sequence detector design.Use of Integrated Logic Analyzer (ILA), Virtual input output (VIO)

Week 3- IP blocks: clock wizard, Block RAM memory

Week 4- Overview of timing analysis, layout and power. Programming the 7-segment display

Week 5: Interfacing: (UART, DSP blocks) – **limited to demos if it is in online mode.**
Alternative: Explore more IP blocks: Floating point add/mult IPs, Microblaze soft core processor.
Lab examples: Memory design, floating point multiplier co-processor

Assignments: Explore usage of IP Blocks: FFT, Error correction, MAC, Adders, Multipliers

Plan for project, literature survey presentations

Week 6: Zynq architecture overview: Concept of Programming System (PS), programmable logic (PL), AXI interface, Embedded System design flow, Programming using SDK
Online mode: Demo using Xilinx: Zedboard/Zybo.
Alternate 1: Connection through VPN to lab machines for access to these boards.
Alternate 2: Work with Microblaze Soft IP Core as a replacement to Zynq boards.

Week 7: High-level Synthesis design flow,
Week 8: Partial reconfiguration flow

Tools:
Xilinx Vivado development Suite – to program the Xilinx FPGA
Xilinx Basys 3 Artix-7 FPGA Board, Zybo, Zedboard

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

- Ian Kuon , Russell Tessier and Jonathan Rose, FPGA Architecture: Survey and Challenges
- Palnitkar, Samir, *Verilog HDL, Second Edition*, Prentice Hall.
- Verilog HDL: A Guide to Digital Design and Synthesis, By Samir Palnitkar
- Xilinx University program:
  Course material: https://www.xilinx.com/support/university/vivado/vivado-teaching-material/hdl-design.html
    Workshop material: https://www.xilinx.com/support/university/vivado/vivado-workshops/Vivado-embedded-design-flow-zynq.html
    Microblaze: https://xilinx-wiki.atlassian.net/wiki/spaces/A/pages/18842560/MicroBlaze

- Partial Reconfiguration Flow, Udemy course
- Verilog® HDL Quick Reference Guide – by Sutherland
- Vivado Design Suite Tutorial, [suggested readings - handbook]
- *Vivado Design Suite User Guide [suggested readings - handbook]*

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

	% of Total Grade
Quiz, exams	60%
Assignment, Presentations, Projects	40%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Design the digital circuits on FPGA, ILA, VIO, memory	CO3
2.	Design the interfacing on the FPGA	CO5
3.	Zynq programming	CO6
4.	High level synthesis design flow, examples	CO7
5.	Examples with Partial Reconfiguration flow	CO7

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools
- Demo for assignments/projects

Students will be provided opportunity to view the evaluations done either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission:
10% penalty for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention “Not applicable” if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

- **All assignments/codes/reports will be run through a plagiarism check tool**
- **Cheating – 0 marks for the assignments**
- **Repeat offense/Cheating in exam – Zero marks + Grade penalty**

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	VL 506 / System Software	
Course Instructor Name(s)	Prof. B. Thangaraju	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 2:0:0	**Total Credits = 2**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
x	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Linux Basics, Shell Scripting and basic knowledge of operating systems.

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Engineers trained on Linux System Programming are sought for. This course provides a strong foundation for the same.
Focus on skill development		
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

System Software course covers all the fundamentals of Operating Systems including Linux Kernel subsystems and Inter Process Communication Mechanisms. Lab session focused on Linux System Programming.

Course Outcomes and Competencies

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand the importance of operating systems, kernel subsystems, types of kernel used for GPOS, embedded and real time systems.	PO1, PSO1	R	F,C	1	0
CO2	Managing files and file locking synchronization mechanisms using file related system calls.	PO1, PSO1	Ap	P	5	0
CO3	Implement process scheduling policy and signaling mechanisms for real time and non-real time processes.	PO1, PSO1	Ap	C,P	5	0
CO4	Understand soft real time features as per POSIX standards.	PO1, PSO1	U	F,C	1	0
CO5	Perform Linux Inter Process communication mechanisms including pipe, FIFO, message queues, shared memory and socket programming.	PO1, PSO1	Ap	P	12	0
	TOTAL				**24**	**0**

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

This course will cover the following topics:
1. Computer Architecture
2. Kernel Architecture
3. System Internals
4. Inter Process Communication Mechanisms
4. Implementation of Soft Real Time Systems

Instruction Schedule

[Provide session-wise schedule]

Week	Topics
1	Computer Architecture a. Basic structure of computer hardware and software b. Process, Memory and I/O systems: CPU, RAM, Virtual Memory, I/O devices c. Types of System - Server, Desktop, Embedded and Real Time d. Operating System Vs Kernel
2	Kernel Architecture a. Kernel Subsystems (computing resource management) b. Types of Kernel: Monolithic, Micro and Hybrid Architecture c. Monolithic - Server and Desktop d. Microkernel - Embedded and Real Time systems e. Hybrid - Handle both RT and Non-RT tasks
3-4	System Internals: Implementation of - process, file, memory and signal management
5-7	Inter Process Communication Mechanisms - pipe, FIFO, message Q, shared memory, semaphore and socket programming
8	Implementation of Soft Real Time Systems - as per POSIX standard Application Program Vs Kernel Module

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Operating System Concepts by Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Eighth edition, John Wiley & Sons. Inc, 2009.
2. Linux System Programming by Robert Love, O'Reilly Media, 2013.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

System Software (2 credit)	Marks (%)
Mid Term Exam	50
Lab Exercises	20
Mini Project	30
Total	100

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	64 Lab exercises on Linux System Programming	CO2, CO3, CO5
2	Project: Design and Development of online ticket booking system. Use: only UNIX system calls.	CO2, CO5

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions
- Manual evaluation of programming questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission
A penalty of 10% of the Lab assignment/ project marks will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	VL 601: Testing and Design For Testability	
Course Instructor Name(s)	Subir Kumar Roy	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems X			Cyber Security
	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:CS and ECE*

X	iMTech
X	M.Tech
	M.Sc.
	CSE
X	ECE
	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* None – only basic knowledge of digital design assumed

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	In the area of Si chip fabrication to enhance yield and reliability where a complex digital system design is realized physically on a Silicon IC chip.
Focus on skill development	Yes	The course has very high focus on using test automation tools from leading EDA vendors properly to result in high yielding fabricated Silicon chips.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

[*Provide introduction to the course*]

Course overview:

Fabrication of Silicon chips with current generation sub-nanometer technologies is an extremely complex and expensive process. Even though a design to be implemented on Silicon is fully verified the manufacturing process introduces it own set of errors during the fabrication of the chip. To be able to improve yield of Silicon chips it is necessary to understand the manufacturing related defects introduced in a chip and identify them post fabrication to not only sort out the good chips from the bad chips but also to reduce the number of bad chips by improving the design. This is made possible by defining abstract electrical and logical fault models and detecting them in fabricated chips.

This course aims to provide an understanding of such fault models and design of algorithms to detect them through specially designed test vectors applied to the input output pins of chips through specialized Automated Test Equipments (ATE) to distinguish bad chips from good chips and also to improve yield.

Why is it important?

VLSI integrated circuits have revolutionized the industrial world. They are ubiquitous and are being deployed in every conceivable engineering systems – from the simplest to the most complex. It is imperative to have the right skill sets amongst our graduating students to render these extremely complex chips efficiently and with minimum number of re-spins as the Silicon processing steps to realize them have very high cost.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand VLSI Testing Process and Automated Test Equipment, Test Economics and Silicon chip quality.	PO1, PSO1	U	F	3	1
CO2	Understand different Silicon fabrication related fault models.	PO1, PSO1	U	F, C	6	2
CO3	Understand different approaches to testing methods based on logic and fault simulation.	PO1, PSO1	U	C, P	6	2
CO4	Understand testability measures to metric the effectiveness of designed test vectors	PO1, PSO1	U, An	C, P	6	1
CO5	Understand and use different combinational circuit automated test pattern generation algorithms and tools implementing them in different digital circuit designs for test vector generation	PO1, PO5, PSO1	U, Ap	C, P	8	3
CO6	Understand and use different memory system automated test pattern generation algorithms and tools implementing them in different digital memory circuit designs for memory test vector generation	PO1, PO5, PSO1	U, Ap	C, P	8	3
CO7	Understand and use different built in self test (BIST) structures for integration with implemented digital circuit design so that testing can be done in-situ in Silicon using automated tools for creating and integrating BIST structures in different digital circuit designs	PO1, PO5, PSO1	U, Ap	C, P	8	3
	Total hours				45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Topic 1 VLSI Testing Process and Automated Test Equipment, Test Economics and Silicon chip quality.

Topic 2 - Silicon fabrication related fault models.

Topic 3 - Logic simulation and Fault simulation..
Topic 4 - Testability measures
Topic 5 - Combinational circuit automated test pattern generation (ATPG) algorithms
Topic 6 - Memory Testing
Topic 7 - Built In Self -Test and Design For Testability

Instruction Schedule

[Provide session-wise schedule]

Topic 1 (3 hours) - VLSI Testing Process and Automated Test Equipment, Test Economics and Silicon chip quality.

- Testing Philosophy / Role Of Testing / VLSI technology trends & their effects on testing / Types of Testing
- ATE – LTX Fusion / Advantest T6682 ATE / Multisite Testing
- Defining costs / Production / Benefit-Cost Analysis / Economics of Testable Design / Yield / Defect Level as a Quality Measure – Test data analysis & defect level estimation

Topic 2 (6 hours) - Silicon fabrication related fault models.

- Defects / Faults / Error
- Functional versus Structural Testing
- Levels of Fault Models & their glossary
- Single Stuck-at Fault (SSAF) – Fault Equivalence for SSAF / Fault Collapsing / Fault Dominance / Checkpoint Theorem

Topic 3 (6 hours) - Logic simulation and Fault simulation

- Difference between Simulation for Design Verification and Simulation for Test Evaluation
- Modeling circuits for simulation
- True Value Event Driven Simulation
- Algorithms for Fault Simulation – Serial / Parallel / Deductive / Concurrent
- Statistical methods for fault simulation – fault sampling

Topic 4 (6 hours) - Testability Measures

- SCOAP controllability and observability – Combinational SCOAP measures / Sequential SCOAP measures / High Level Testability Measures

Topic 5 (8 hours) - Combinational circuit automated test pattern generation (ATPG) algorithms

- ATPG algebras
- Testing as a global problem
- Different Test Generation Approaches – Random / Deterministic / Algebraic / Fault oriented / Fault Independent / Single Path / Multiple Path
- D-Calculus and D-Algorithm
- 9-Valued Algorithm
- Path Oriented Decision Making (PODEM) Algorithm
- Fanout Oriented (FAN) Test Generation algorithm

Topic 6 (8 hours) - Memory Testing

- Memory Faults and failure mechanisms
- Memory Test Levels

- March Test Notations
- Functional RAM testing with March Tests
- Testing for Neighbourhood Pattern Sensitive Faults
- RAM Layout related faults – Inductive Fault Testing
- RAM Fault Hierarchy
- Cache RAM Testing
- Functional ROM Testing
- Electrical Parametric Testing

Topic 7 (8 hours) - Built In Self -Test and Design For Testability

- Digital DFT and Scan Design
- Random Logic BIST
- Theory and Operation of Linear Feedback Shift Registers using Galois Fields – LFSRs as Random Test Pattern Generators / LFSRs as Signature Analyzers / Multiple Input Signature Registers
- Memory BIST
- Design For Testability Sub-Systems – Hierarchy in System On Chips

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. M. Abramovici, M. Breuer and A. Friedman, "Digital Systems Testing and Testable Designs", Jaico Publishing House, 2013.
2. V. D. Agrawal and M. Bushnell, "Essentials of Electronic Testing For Digital, Memory and Mixed Signal VLSI Circuits", Springer, 2000.
3. H. Fujiwara, "Logic Testing and Design For Testability", Computer Systems Series, The MIT Press, 1990.

Assessment Plan

% of Total Grade
Mid Term 25%
Assignments 20%
Presentations 20%
End Term 35%

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Take home theory assignments (Two) to solve testability related problems for different categories of digital circuits.	CO2, CO3, CO4, CO5, CO6 and CO7

2.		
3.		

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic plagiarism check using tools
- Demo for assignments/projects

Students will be provided opportunity to view the evaluations done either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission:
10% penalty for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

- **All assignments/codes/reports will be run through a plagiarism check tool**
- **Cheating – 0 marks for the assignments**
- **Repeat offense/Cheating in exam – Zero marks + Grade penalty**

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	VL801 Analysis and design of VLSI subsystem	
Course Instructor Name(s)		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
X	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:		*Branch:*	
	iMTech		CSE
X	M.Tech	X	ECE
	M.Sc.		Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
VL503 / EC503 Digital CMOS VLSI Design

Additional Focus Areas-

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The design techniques of VLSI system in terms of Power, performance improvement, and timing analysis is highly useful for today's SoC Design and a direct focus on today's VLSI employability.
Focus on skill development	Yes	The design implementation and understanding of VLSI subsystem in Cadence software is an important tool skill developed in the course.
Focus on entrepreneurship	No	Mostly the students taking this course are interested in getting recruitment in multinational VLSI companies such as INTEL, Qualcomm, Samsung.
Provides value added / life skills (language, writing, communication, etc.)	No	The group project presentation ensures that student develops the necessary communication skills and value added team working skills.

Course Context and Overview

[*Provide introduction to the course*]

This is the second graduate level course in VLSI design. The course introduces students to subsystem level design techniques and estimate power, performance and area of the circuit in detail. Timing parameters for designing sequential circuit designs followed by different adder architecture will also be explained. Interconnect analysis is also included in this course.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the most evolved and robust Latch and flipflop designs in VLSI and demonstrate the understanding to the Instructor.	PO2, PO3	U, Ap	C, P	4	5
CO2	Apply the static timing constraints to design sequential datapath without any timing violations for higher order adder circuit in a sequential flow using CADENCE tool.	PO2, PO3	Ap	F,C, P	6	6
CO3	Evaluate the dynamic and static power for higher order and multistage designed circuit using CADENCE tool.	PO2	E, Ap	C,P	6	6
CO4	Design approximate computing / flip flop/ SRAM for higher order bits using state of art literature design.	PO1, PO2, PO3	Ap	C&Sp, P	6	6

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

NA

Course Content

[Provide list-wise topics]

Course contents includes interconnect engineering, static timing analysis, sequential circuit design, circuit design using latches and flipflops, datapath subsystems includes adders, and multiplier designs, power estimation including static and dynamic power estimations. The course also requires students to design circuits and layout in Cadence software.

Instruction Schedule

[Provide session-wise schedule]

Design of Latches and Flipflops	4 hours
Control signals for latch and flipflop designs	2 hours
Static timing analysis for latches, pulsed latches and flipflops	6 hours
Introduction Power estimation	2 hours
Switching Probability	2 hours
Driving factor to estimate power	2 hours
Level converters	2 hours
DVFS technique	3 hours
Leakage currents	5 hours
Adder design	3 hours
Carry Ripple, Carry Skip, Carry Look ahead adders	6 hours
Interconnects	3 hours
Repeaters	5 hours

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Neil H. E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th edition, 2011.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Exam#1-20%
Exam#2-20%
Project-35%
Assignments-25%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Draw the layout of Klass Semidynamic flipflop in Cadence and determine the setup and hold time for the flipflop. Use 45 nm technology node.	CO1
2	Demonstrate Power and Energy of parasitic load capacitance and Vdd power supply connected to unit inverter with respect to time domain for three different ramp input (3 different slope) in Cadence. Use 45 nm technology node. Verify the delay of both level converter circuits in Cadence tool. Use 45 nm technology node	CO3
3	Design the layout of a sequential circuits involving flipflops with a computation for 8 bit adder circuit. Make sure that the adder circuit is designed in a view that maximum and minimum delay constraints are satisfied for the flipflops designed. Use 45 nm technology node.	C02
4	Project on Approximate Computing/ Memory design / Flipflop design	CO4

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission
Unless medically approved excuse, all late submissions are not considered for grading.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Syllabus

Course Code / Course Name	VL 818 Virtual Machines	
Course Instructor Name(s)	K K Subramaniam	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:0	**Total Credits = 4**

Grading Scheme *(Choose by placing X against appropriate box)*	**4**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
X	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	Engineers trained in virtual machines are sought after by leading IT companies dealing in cloud computing, mobile application and industrial automation
Focus on skill development	Yes	Students are exposed to real-life open source products to develop practical skills
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

Widespread adoption of high-speed internet and 64-bit computing poses a challenge to emerging engineers on building the next generation computing machines. While operating systems insulate applications from variations in hardware configurations, a virtual machine insulates applications from variations in processor ISA also. It is this abstraction that makes it possible to deploy applications across billions of smartphones and web browsers.

This course will cover the concepts behind virtual machine architecture, design and implementation on a modern multi-core computer board. It will cover abstraction of computational objects and systematic composition of a virtual machine from these objects. It will also cover algorithms for object memory management and automatic garbage collection. Lab sessions will expose students to the practical aspects of building, operating and tuning a virtual machine on a modern multi-core processor board.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the architecture of virtual machines and their instruction sets	PO1, PSO1	U	C	12	
CO2	Understand bootstrapping a virtual machine into existence and extending its functions on the fly	PO1, PSO1	U	F, C	12	

CO3	Understand object memory management and automatic garbage collection	PO1, PSO1	U	F, C	12	
CO4	Configure, build, and operate a virtual machine from scratch	PO1, PSO1	Ap	C	6	
CO5	[Optional] Conduct performance measurements to assess impact of incremental improvements to an open source VM	PO1, PSO1	Ap	F, C	3	
	Total Hours				45	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Architectural Overview of Virtual Machines
2. Object Message Model
3. Virtual Machine and Image
4. Specification of a Virtual Machine
5. Virtual Machine Bytecode ST-80
6. Primitive Methods
7. Specification of Object Memory
8. Automatic Memory Management
9. Garbage Collectors
10. Building Open Smalltalk VM
11. Performance Measurements and Tuning

Lab Activities:

1. Simple Virtual Machine
2. Virtual Machine with persistent image

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Smalltalk-80: The Language and its Implementation by Adele Goldberg
2. A Little Journey in a Virtual Machine (4 parts) by Igor Stasenko, https://www.youtu.be/FJQmjhOvjUs
3. LISP 1.5 Programmer's Manual by John McCarthy (Chapters 1 & 2)
4. The Garbage Collection Handbook: The Art of Memory Management by Richard Jones

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assessment type	Percentage distribution
Assignments	25
Quizzes	20
Class Participation	5
Written Exam	50

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	**Focus of Assignment / Project**	**CO Mapping**
1	A1 Build a bootloader for a virtual machine	CO2
2	A2 Extend a virtual machine function using a primitive	CO4
3	A2 (alternative) Configure and build Open Smalltalk VM	CO4

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

A penalty of 10% of the assignment marks will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	VL 855 Device Driver Development	
Course Instructor Name(s)	K K Subramaniam	
Credits (L:T:P) (Lecture : Tutorial : Practical)	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
		Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:0:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**4**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
X	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

X	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

EG301 Operating Systems
VL818 Virtual Machines (desirable)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**
Direct focus on employability	Yes	The course tracks the current state of art in driver development and helps student in becoming productive at work immediately
Focus on skill development	Yes	Students work on LInux kernel which is used by over 80% of embedded systems today
Focus on entrepreneurship	Yes	Innovative smart digital products use device drivers extensively.
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

For CSE and EC students who are interested in building device drivers for I/O devices and controllers in embedded systems and computers, this course teaches the latest principles and concepts involved in modular live extensions to open source kernel to manage existing and newly developed I/O devices and controllers.

This course trains students in the latest process of developing device drivers for industrial domains like robotics, data acquisition and control, automotive control, telematics and infotainment. Lab sessions will be interwoven with lectures to help students develop practical skills on popular embedded system boards.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Configure, build and install GNU/Linux mod-ules in a cross-compilation environment	PO1, PSO1	Ap	C	9	
CO2	Understand the current device driver model and its components	PO1, PSO1	U	F, C	9	
CO3	Understand kernel support for memory management, interrupts and timers	PO1, PSO1	U	F, C	9	
CO4	Design, build and test a modular driver for a sample device	PO1, PSO1	Ap	C	9	

CO5	Use Device Tree files for live detection and configuration of devices	PO1, PSO1	Ap	F, C	9	
CO6	Modify an existing device driver to practice real-life scenarios	PO1, PSO1	Ap	C	9	
	Total Hours				45	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

1. Linux Kernel Architecture
2. Kernel Configuration
3. Kernel Modules
4. Memory Management
5. Types of Device Drivers
6. New Device Driver Model
7. SYSFS and UDEV
8. Kernel Services - Memory, Interrupt, Device Resource Management
9. GPIO subsystem
10. Industrial I/O subsystem
11. Clocks and Timers
12. Power Management
13. Practical Device Drivers

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. *Linux Kernel Documentation, https://www.kernel.org/doc/html/latest/*
2. Proceedings of Embedded Linux Conference, Linux Plumbers Conference.
3. *Linux Device Drivers, (3rd Ed)* by Jonathan Corbet, Alessandro Rubini, Greg-Kroah Hartman

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assessment type	Percentage distribution
Assignments	25
Quizzes	20
Class Participation	5
Written Exam	50

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	A1 Build and install latest kernel on Raspberry Pi board	CO1
2	A2 Control an external device (projector/light) using IR from RPi	CO6

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

A penalty of 10% of the assignment marks will be paid for late submission.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]
Not Applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Syllabus

Course Code / Course Name	VL 502 Analog CMOS VLSI Design		
Course Instructor Name(s)	Chetan Parikh, Subhajit Sen		
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**	
	3	Lecture (1hr = 1 credit)	
	0	Tutorial (1hr = 1 credit)	
	0	Practical (2hrs = 1 credit)	
	L:T:P = 3:0:0	**Total Credits = 4**	
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)	
		Satisfactory/Unsatisfactory (S / X)	

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
X	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
X	M.Tech
	M.Sc.

Branch:

	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
X	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	No	
Focus on skill development	No	
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

In this course students will learn to analyze and design CMOS amplifiers, which are building blocks of a vast number of analog and mixed-signal VLSI systems. At every stage of the course the students will design, on paper as well as in simulation, the circuits they analyze.

The course contents will include MOS transistor physics and models, single-stage amplifiers, differential amplifiers, current mirrors, frequency response of amplifiers, operational amplifiers, stability and frequency compensation of amplifiers.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Explain the basic physics of operation of a MOSFET, including the concepts of off and inversion modes, triode and saturation regions of current flow, and threshold voltage.	PSO1, PO1	U	C	2	0
CO2	Describe the square-law I-V model of MOSFETs	PSO1, PO1	U	F, C	2	0
CO3	Explain the body effect, velocity saturation and vertical field-dependence of mobility.	PSO1, PO1	U, An	F, C, M	1	0
CO4	Use Spice to simulate and design MOSFET circuits.	PSO1, PO5	R, U	F, C	1	0
CO5	Extract basic MOSFET Spice parameters given the parameter set for an advanced model such as BSIM3.	PSO1, PO5	U, Ap, An	C, P	1	0
CO6	Analyse a variety of simple MOSFET circuits at dc and for small-signals.	PSO1, PO3	U, Ap, An	C, P, M	3	0

CO7	Analyse and design MOSFET amplifier configurations – common-source, common-gate, common-drain, telescopic and folded cascodes, differential amplifiers, two-stage amplifiers.	PSO1, PO3	U, Ap, An, E, C	C, P, M, FDP, C&S, PC, D	14	0
CO8	Analyse and design MOSFET amplifiers at high frequencies.	PSO1, PO3	U, Ap, An, E, C	C, P, M, FDP, C&S, PC, D	4	
CO9	Analyse and design various CMOS operational amplifier configurations: Single-stage cascodes, two-stage amplifiers, gain-boosted amplifiers.	PSO1, PO3	U, Ap, An, E, C	C, P, M, FDP, C&S, PC, D	11	
CO10	Calculate the slew rate of amplifier circuits.	PSO1, PO3	U, Ap, An	C, P, M	1	
CO11	Determine the frequency stability of high-gain amplifiers, and devise appropriate frequency compensation networks.	PSO1, PO3	U, Ap, An, E, C	C, P, M, FDP, C&S, PC, D	4	

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Topic Name	No. of hours
MOSFET physics	2
MOSFET I-V models and characteristics	2
Some second order effects in MOSFETs	1
Spice & parameter extraction	1

MOSFET circuits at dc	3
Small-signal approximation	1
AC analysis of MOSFET amplifiers: CS, CG, CD, cascode, etc.	7
Current mirrors	2
Differential amplifiers	5
Frequency response	4
CMOS operational amplifiers	12
Stability and compensation	4
TOTAL	44

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. B. Razavi, Design of Analog CMOS Integrated Circuits, 2nd edition, Tata-McGraw-Hill, 2018.
2. R.J. Baker, H.W. Li and D.E. Boyce, CMOS: Design, Layout and Simulation, 4th edition, Wiley, 2019.
3. T.C. Carusone, D. Johns and K. Martin, Analog Integrated Circuit Design, 2nd edition, Wiley, 2013.
4. P.E. Allen and D.R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford, 2002.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Tests – 55%
Final exam – 20%
Assignments – 25%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Knowing MOSFETs	CO5
2	Design of a common-source CMOS amplifier	CO7
3	Design of a telescopic cascode differential amplifier	CO7, CO8
4	Design of a 2-stage operational amplifier	CO9, CO11

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of circuit analysis and design problems

Students are provided the opportunity to view the evaluations done either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions are not accepted

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

Course Proposal Template

Course Name	Advanced Data Visualization
Course Proposer Name(s)	Jaya Sreevalsan Nair
Course Instructor Name(s)	Jaya Sreevalsan Nair
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Special Topics
Credits	Four
Grading Scheme	4-point scale: (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CSE** – Computer Science and Engineering **DS** – Data Sciences **NCS** – Networking & Communication and Signals **ES** – Embedded Systems **SoC** - System on Chip	DS, CSE
Semester	Term: II Academic Year: 2018-19
Pre-Requisites (where applicable, specify exact course names)	
Data Visualization (CS732/ DS732)	
Course Description	
This course builds upon the syllabus covered in the Data Visualization course (CS732/ DS732). Here, we focus on multiple aspects of data science which enable data visualization as well as incorporate visualizations. The course will have four modules. In the first module of the course data management and data processing that prepares data for building visualizations. In the second part, we focus on data visualizations in an analytics pipeline for a combination of specific data types, e.g. spatio-temporal datasets, tabular datasets, grid datasets, unstructured data, etc. In the third module, we focus on evaluations of data visualizations. In the fourth module, we learn about how to study the uncertainty in the visual analytics pipeline. The outcome of the course is to enable the student to learn the state-of-the-art in the aforementioned modules as well as build visual analytics tools for large-scale datasets.	

Course Content
Module 1: Data management and preprocessing for visualizations • Integrating databases with visualizations • Handling large-scale data of specific types – networks, tables, grids, etc. • Building levels of detail • Reformatting datasets to specific data types/structures, e.g. matrices, tables, networks, tensors, for exploiting the same for visualization Module 2: Composite Visualizations • Design space of composite visualizations • Hybrid vs composite visualizations Module 3: Evaluations of Visualizations • Designing user studies • Domain expert vs user studies • Quantifying metrics Module 4: Uncertainty analysis • Measuring uncertainty in visual analytics • Case studies on uncertainty analysis in visualizations
Assessments (optional for Special Topics courses)
Project, seminars, class participation.
Text Book / References
Papers, articles, lecture notes and other material provided during the course.

***Prep Term**: July; **Term I**: Aug – Nov; **Term II**: Jan – Apr; **Term III**: Jun – July;*

<AI 826: DEEP LEARNING FOR AUTOMATIC SPEECH RECOGNITION (DL-ASR)>

GENERAL COURSE INFORMATION

Course Name	Deep Learning for Automatic Speech Recognition (DL-ASR)
Term	Term I (Aug 2020)
Instructor(s)	Dr. V. Ramasubramanian
Course credits	4
Pre-requisite(s)	Automatic Speech Recognition DS/SP 823

COURSE OVERVIEW AND OBJECTIVES

This is a specialized course focusing exclusively on deep learning (DL) techniques and algorithms for automatic speech recognition (ASR), focusing on developments over the last 10 years till date, subsequent to conventional ASR approaches (which were covered in the “ASR” course (DS/SP 823) during Jan-May 2020). The course will cover topics such as DNN-HMM, RNN, LSTM, CTC, CNN, end-to-end models, encoder-decoder architectures, attention-based models etc – all as specifically applied to ASR.

COURSE CONTENTS

1. Review of conventional GMM-HMM ASR systems.
2. Deep learning techniques for ASR:
    a. ASR based on Deep Neural Network architecture (DNN-HMM hybrid systems): Basics of MLP, DNN, training, pre-training, RBM, stacked RBM/DBN, contrastive divergence, DNN sequence discriminant training.
    b. ASR based on i) Recurrent neural networks (RNN), ii) Long short-term memory (LSTM), iii) Connectionist temporal classification (CTC), iv) Convolutional neural networks (CNNs), and
    c. ASR based on i) End-to-end approaches, ii) Encoder-decoder architectures, iii) Attention-based approaches

GRADING

- Continuous Assessments (Quiz/Assignment/MCQ fortnightly or monthly): 100 marks

TEXT BOOK AND REFERENCES

1. Dong Yu and Li Deng, "Automatic speech recognition: A deep learning approach", Springer-Verlag London, 2015. (Both authors are from Micorsoft Research, Redmond).
2. Li Deng and Dong Yu, "Deep Learning: Methods and Applications", NOW publishers, 2014.
3. Ian Goodfellow, Y. Bengio, A. Courville, "Deep learning", MIT Press, 2016.
4. Other recent published papers / thesis.

Course Proposal

Course Name	**Reinforcement Learning**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS / SP-PR
Semester	Fall (Aug-Dec) - 2019

Pre-Requisites (where applicable, specify exact course names)

At least one of the following:

- Maths for ML
- Machine Learning – I
- Introduction to Text Processing and Information Retrieval
- Machine Perception
- ASR

Course Description

This course is intended to be an intense, in-depth course in Reinforcement Learning. The focus will be on setting up the formal foundations for RL and giving a flavour of the recent developments in Deep Reinforcement Learning, the amalgamation of deep neural networks and RL that has propelled what remained an obscure field of study till as late as a decade ago into the forefront of machine learning / AI research. The primary references for this course would be:

1. Dmitri P. Bertsekas, **Dynamic Programming and Optimal Control – Vol I & II**, 4th Edition, Athena Scientific, Belmont, Massachusetts, 2017.
2. Dimitri P. Bertsekas and John N. Tsitsiklis, **Neuro-Dynamic Programming**, Athena Scientific, Belmont, Massachusetts, 1996.

3. Richard Sutton, **Reinforcement Learning – An Introduction**, MIT Press, 2017, ISBN 978-0-521-51814-7. http://incompleteideas.net/book/bookdraft2017nov5.pdf

   The '**Suggested Reading**' Lists given for the modules detailed below, refer to material other than what you can expect to be covered in these books mentioned above.

Course Content

1. **Module 0 (Some Math Preliminaries)**: *(2-3 Lectures)*
   - Markov Chains and MDPs
   - Kalman Filters
   - Linear Stochastic Systems
   - Importance Sampling

   Suggested Reading:

   a) Greg Welch and Gary Bishop, An Introduction to the Kalman Filter, ACM SIGGRAPH Course 8, 2001 [pdf]
   b) Art B. Owen, Monte-Carlo Theory, Methods and Examples – book Manuscript, Chapter 9: Importance Sampling, [pdf]. The other chapters of the book can be accessed from [html]
   c) P.R. Kumar and Pravin Varaiya, Stochastic Systems: Estimation, Identification and Adaptive Control, Prentice Hall, 1986. Chapters 2-3. [pdf]

2. **Module 1 (Psychology & Neuroscience Motivation)**: *(1-2 Lectures)*
   - Pavlovian conditioning, Operant / Instrumental Conditioning
   - Neuroscience Basics, Dopamine, Basal Ganglia
   - Neural Actor-Critics

   Suggested Reading:

   d) Florentin Worgotter and Bernd Porr, Temporal Sequence Learning, Prediction, and Control - A Review of different models and their relation to biological mechanisms [pdf]
   e) Bar-Gad, I., Morris, G., Bergman, H.: Information processing, dimensionality reduction, and reinforcement learning in the basal ganglia. Progress in Neurobiology 71, 439–473 (2003)
   f) James Knierim, Basal Ganglia, [html]
   g) Brandon, S.E., Vogel, E.G., Wagner, A.R.: Computational theories of classical conditioning. In: Moore, J.W. (ed.) A Neuroscientist's Guide to Classical Conditioning, ch. 7, pp. 232–310. Springer, New York (2002)
   h) E. James Kehoe and Michaela Macrah, Fundamental Behavioural Models and Findings in Classical Conditioning, in "A Neuroscientist's Guide to Classical Conditioning", Ed John W. Moore, Springer 2002 [pdf]
   i) Yael Niv, The Neuroscience of Reinforcement Learning, ICML Tutorial 2009 [pdf]

3. **Module 2 (Introduction, Overview)**: *(1-2 Lectures)*
   - Basic Concepts and Terminology: Environment, Agent, State, Value Function, Actions and Policy, Reward, Prediction vs Control, Finite (Episodic) vs Infinite Horizon Tasks, Bandits, ...
   - Sequential Decision Making, MDP, RL vs Dynamic Programming
   - Model-Free RL Methods and Model-based RL Methods
   - Role of Function Approximators and Deep Learning in RL
   - RL Resources; Simulation Platforms; Practical Considerations

4. **Module 3 (Problem Formulation & Solution Taxonomy)**: *(3-4 Lectures)*
   - RL Problem Formulation, Bellman Equations, Optimality Criterion
   - Existence of Optimal Solutions; Shrinkage/Contraction, Monotonicity Arguments
   - Discounting and its implications
   - Solution Approaches

→→→→

Dynamic Programming	**Reinforcement Learning**
Exact Methods for Known/Small Environments	Approximate Methods for Unknown/Large Environments
Finite Horizon	Infinite Horizon
Deterministic	Stochastic
Model-based (Known/Assumed model of the world)	Model-free (Learning from Simulations)

5. **Module 4 (Exact Dynamic Programming)**: *(3-4 Lectures)*
   - Value Iteration; Policy Iteration; Hybrids
   - Convergence Properties
   - Stochastic DP and other variants
   - Infinite Horizon DP --- Stochastic Shortest Path problems, Discounted Cost MDPs

6. **Module 5 (Approximate DP / Reinforcemcnt Learning)**:
   - *Tabular Methods*: Monte-Carlo and Temporal Difference Methods, Eligibility Traces, Sarsa, Q-Learning, Rollout Algorithms (5-6 Lectures)
   - *Batch RL*: experience replay mechanisms; Least Square methods for policy iteration *(5-6 Lectures)*
   - *Using Function Approximators*: DQN, Policy Gradients --- REINFORCE / TRPO / PRPO, Actor-Critic Methods *(5-6 Lectures)*

Suggested Reading:

a) Csaba Szepasvari, Algorithms for Reinforcement Learning – Lecture published in the "Synthesis Lectures on Artificial Intelligence and Machine Learning" series by Morgan & Claypool Publishers. June 2009. [html]
b) Playing atari with deep reinforcement learning (2013), V. Mnih et al. [pdf]
c) Prioritized experience replay (2015), Tom Schaul et. al., [pdf]
d) Deep Reinforcement Learning with Double Q-Learning (2016), H. Hasselt et al. [pdf]
e) Deep Reinforcement Learning: An Overview (2017), Y. Li, [pdf]
f) V. Mnih et. al.,, Asynchronous Methods for Deep Reinforcement Learning [pdf]
g) John Schulman, Optimizing Expectations from Deep Reinforcement Learning to Stochastic Computation Graphs, Ph.D Thesis, University of California, Berkeley, 2016 [pdf]
h) John Schulman et. al.,, Proximal Policy Optimization Algorithms [pdf]

7. **Module 6 (Topics in Deep Reinforcement Learning)**: *(3-4 Lectures)*
   - Bayesian Reinforcement Learning
   - Reinforcement Learning in Continuous State-Action Spaces --- DDPG
   - Game Theory and Multiagent RL
   - Partially Observable MDPs

Suggested Reading:

a) Mohammad Ghavamzadeh et. al., Bayesian Reinforcement Learning: A Survey [pdf]
b) ICML-07 Tutorial on Bayesian Methods for Reinforcement Learning [html]
c) Nikos Vlassis et. al., Bayesian Reinforcement Learning, Technical Report [pdf]
d) Timothy P. Lillicrap et. al., Continuous Control with Deep Reinforcement Learning [pdf]
e) Thanh Thi Nguyen et. al., Deep Reinforcement Learning for Multi-Agent Systems: A Review of Challenges, Solutions and Applications [pdf]
f) L. Busoniu, R. Babuska, and B. De Schutter, A comprehensive survey of multi-agent reinforcement learning, IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, vol. 38, no. 2, pp. 156–172, Mar. 2008 [pdf]
g) State of the Art Leaderboards for Multiagent RL [html]
h) Tony's POMDP Page [html]
i) Kevin P. Murphy, A Survey of POMDP Solution Techniques, September 2000 [pdf]

Assessments

The evaluation will include four components –- the weightage out of 100 for each component is shown in brackets.
• 3 Assignments (**30**)
  ○ *Tentative Dates for the start of the assignments*: **Sep 16**, **Oct 21**, **Nov 25**
  ○ *Time*: **1 Week**
 	
• RL project --- theory or implementation (**30**)
  ○ *Start*: Asap
  ○ *Submission*: **Dec 4**
 	
• 3 Online Quizzes (**30**)
  ○ *Tentative Dates for the quizzes*: **Sep 4**, **Oct 16**, **Nov 27**
 	
• Paper Reading Report/Presentation (**10**)
  ○ *Start*: **Sep 2**
  ○ *Submission*: **Between Nov 9 and Nov 20**

CC 102 Computer Architecture and Organisation

Objectives

The objectives of this course are to provide the student with an understanding of the internal organisation of a modern computer. The student will know of the principal blocks that constitute a processor, its organisation and instruction set.

Proposed Course Contents

- Von Neumann Machine, computer components, functions, bus inter connection, PCI, ALU, integer arithmetic, addition, subtraction, multiplication and division, floating point arithmetic.

- Machine instruction set, types of operands, types of operations, addressing modes, instruction formats, processor organization, register organization, instruction cycle, instruction pipelining, pentium processor, power-PC processor, RISC.

- 8085 Microprocessor organization, assembly language programming of 8085, processor control unit, operation, micro-operations, hardwired control, micro program control, horizontal and vertical micro instructions, micro instruction sequencing and execution, nanoprogramming, Applications of microprogramming.

- Internal memory, semiconductor main memory, cache memory, DRAM organization, associate memory organization, magnetic disk, CDROM, magnetic tape, memory management, memory hierarchy, partitioning, paging, virtual memory, demand paging scheme, segmentation.

- Input/Output, external devices, I/O modules, I/O addressing, programmed I/O, Interrupt driven I/O, priority, arbitration, DMA, I/O channel, I/O processor.

The recommended textbooks for the course are as follows:

- “Computer Organization and Architecture,” by William Stalling, 4th Edition, PHI.

- “Computer Architecture and Organization,” by Hayes, MH.

- “Introduction to Microprocessors,” by Mathur.

CC 108/CC 108A IT Infrastructure

From the ACM IT Curriculum

- **IAS. Fundamental Aspects**
- **IAS. Security Mechanisms (Countermeasures)**
- **IAS. Operational Issues**
- **IAS. Policy**
- **IAS. Attacks**
- **IAS. Security Domains**
- **IAS. Forensics**
- **IAS. Information States**
- **IAS. Security Services**
- **IAS. Threat Analysis Model**
- **IAS. Vulnerabilities**

Fundamental Aspects

- History and terminology
- Security mindset (reasoned paranoia)
- Design principles (defense in depth)
- System/security life-cycle
- Security implementation mechanisms
    - Gates, guards, guns; cryptography
- Information assurance analysis model
    - MSR model*; threats; vulnerabilities; attacks; countermeasures
- Disaster recovery (natural and man-made)
- Forensics

Core Learning Outcomes

1. Briefly describe the history of the field of *Information Assurance and Security.*
2. Explain the relationship between threats, vulnerabilities, countermeasures, attacks, compromises and remediation.
3. Give examples of how IT system components (e.g. servers, routers, people, software) can be countermeasures, vulnerabilities, and also threats.
4. Explain the security mindset and the role of "paranoia" in that mindset.

5. Explain and give examples of why information assurance and security must be "built in" to design and architecture from the beginning to be most effective.
6. Outline the system life-cycle and its relationship to security.
7. Describe the Security Services as defined by the MSR model.
8. Describe the Information States as defined by the MSR model.
9. Describe the Countermeasures as defined by the MSR model.
10. Given the MSR model, explain how the components interrelate to categorize threats, vulnerabilities and attacks.
11. Describe a disaster recovery scenario.
12. Define forensics.
13. Describe a situation where a forensic investigation would be necessary.

Vulnerabilities

- Perpetrators
- Inside attacks
- External attacks
- Black hat
- White hat
- Ignorance
- Carelessness
- Network
- Hardware (design, implementation, installation, etc.)
- Software (design, implementation, installation, etc.)
- Physical access

Core Learning Outcomes

1. Define white hat, black hat, hacker and cracker.
2. Explain how culture, community, tools, and technologies contribute to compromising systems.
3. Describe the role of the user in information assurance and how they fit into an overall information assurance plan for an organization.
4. Explain to a non-security community of users what measures they must follow and why, in a situation where their jobs are not security-related.
5. Give an example of how inside and external attacks are similar and are different.

6. List and explain the typical threats and vulnerabilities for an organization's network.

Attacks

- Social engineering
- Denial of service
- Protocol attacks
- Active attacks
- Passive attacks
- Buffer overflow attacks
- Malware (viruses, Trojan horses, worms)

Core Learning Outcomes

1. Explain and give examples of the social engineering techniques used to gain access to computing and network assets in an organization.
2. Explain how a Denial of Service attack works against an organization's network.
3. List some different protocol attacks to which TCP/IP is susceptible.
4. Explain how the different protocol attacks (e.g. TCP/IP) work against an organization's network.
5. Explain some techniques used during an active attack.
6. Explain some techniques used during a passive attack.
7. Explain how an active attack might use information from a passive attack to compromise a system.
8. Describe and explain how a Buffer Overflow Attack might be used to compromise a system.
9. Identify and distinguish between the different types of Malware (viruses, Trojan horses, worms).

Security Mechanisms

- Cryptography
  - Cryptosystems
  - Keys: symmetric & asymmetric
  - Performance (software/hardware)
  - Implementation
- Authentication
  - "Who you are, what you have, what you know"

- ◉ Bio-authentication (use of biometrics)
- Redundancy
- Intrusion detection

Core Learning Outcomes

1. Explain the three key factors involved in authentication and how they are used to verify identity and grant access to a system.
2. Explain the process and value of two-factor authentication.
3. Explain the characteristics of an effective password to end-users.
4. Describe and compare physical access control to logical access control.
5. Identify the key types of biometric information utilized in authentication from the perspectives of accuracy, intrusiveness and efficiency.
6. Explain the differences between symmetric and asymmetric cryptosystems, e.g., number of keys required, the types of algorithms used, etc.
7. Explain what is meant by integrity, confidentiality, and authentication.
8. Explain how cryptosystems offer integrity, confidentiality and authentication.
9. Explain digital signatures and certificates.
10. Explain how public key infrastructure (PKI) works.
11. Use a PKI-based application to demonstrate how public-key cryptography works.

Operational Issues

- Trends
- Auditing
- Cost / benefit analysis
- Asset management
- Standards
- Enforcement
- Legal issues
- Disaster recovery (natural and man-made)

Core Learning Outcomes

1. Describe legal and ethical considerations related to the handling and management of enterprise information assets.
2. Specify what constitutes admissible evidence in a legal proceeding and how to acquire and maintain this information.

3. Describe the importance of and key elements involved in incident tracking to develop an incident handling and reporting process.
4. Identify risks associated with disasters or disruptions and specify key mitigation strategies.
5. Identify the types of company assets to be protected by a security plan.
6. Specify the key aspects of physical site security.
7. Describe the elements contributing to the cost of an organization's security management and operations process and their relation to risks and losses associated with information assurance or security related issues and incidents.
8. Describe and evaluate employment policies and practices that are relevant to safeguarding an organization's information assets.
9. Describe the importance of utilizing standards and key standard processes currently utilized in information assurance and their areas of relevance (i.e. DES – Data Encryption Standard).
10. Describe the purpose and elements of the key types of security audits. Discuss how various security standards (i.e. ISO 177799) impact the direction of these audits.

Policy

- Creation of policies
- Maintenance of policies
- Prevention
- Avoidance
- Incident response (forensics)
- Domain integration (physical, network, internet, etc.)

Core Learning Outcomes

1. Describe the role of policy and procedure in the IAS Model.
2. Explain why policy and procedure are listed as countermeasures.
3. Explain how poorly defined and executed policies can be a vulnerability.
4. Explain how an organization might develop a policy to defend against password vulnerabilities.
5. Explain why a password policy might need to be modified due to changing circumstances.
6. Explain why security policies must consider all aspects of an organization in order to be effective.
7. Give an example of how vulnerability in one area of an organization might enable a compromise in another area. (Example: weak physical security allows sniffer access to the LAN which allows a password to be read from a POP3 packet. The password is used to gain access to a corporate server. Login access to the server allows a root-kit to be applied and the bad guy has total access to the server).

8. Describe a situation in which an incident would require a full forensic approach including evidence gathering, full chain of custody auditing and expert analysis.
9. Explain how failure to follow good forensic procedures could make prosecution of an attacker impossible.

Reference Books

1. Computer Security Principles and Practice, Stallings
2. Principles of Information Security, Whitman and Mattord

CC 108 IT Infrastructure
TERM I (2016-17)

GENERAL COURSE INFORMATION

Course Name	CC 108 IT Infrastructure
Instructors	Chandrashekar R Tricha Anjali
TA	TBD
Course credits	4
Pre-requisite	a) Knowledge of Linux operating system

COURSE OVERVIEW

IT professionals will encounter a variety of computing platforms in their careers. One of the roles of the IT professional is to select, deploy, integrate and administer platforms or components to support the organizations IT infrastructure. This knowledge area includes the fundamentals of hardware and software and how they integrate to form essential components of IT systems.

Since IT systems are increasingly under attack, knowledge of Information Assurance and Security (IAS) is of paramount importance to the profession of IT. The IT professional must understand, apply, and manage information assurance and security in computing, communication, and organizational systems. It is also important for the IT professional to provide users with a framework to be sufficiently security aware to be an asset to the organization rather than a liability. IAS includes operational issues, policies and procedures, attacks and defense mechanisms, risk analyses, recovery, and information security.

- PT. Computing infrastructures.
- PT. Enterprise deployment software.
- IAS. Fundamental aspects.
- IAS. Security mechanisms (countermeasures).
- IAS. Operational issues.
- IAS. Policy.
- IAS. Attacks.
- IAS. Vulnerabilities.
- IM. Managing the database environment.
- SA. Applications.
- SA. Administrative activities

COURSE OUTCOMES

At the end of the course, the student is expected to have obtained proficiency in the following (tagged with Bloom's taxonomy of learning):

- (REMEMBER) Get familiar with the vocabulary and terminology associated with infrastructure management
- (UNDERSTAND) Understand the various concepts of technologies employed in data centers
- (UNDERSTAND) Understand the information assurance security concerns
- (APPLY) Learn how to apply infrastructure design principles to create deployment architecture for a multi-tier software applications
- (ANALYZE) Ability to study a set of requirements and analyze the strengths and weakness of the architectures

COURSE CONTENTS

Stand alone computing devices

Topics covered around fundamentals of computing systems-operating system roles-mobile devices, laptops, PCs, work stations, branch offices devices-windows/Linux operating systems on stand-alone devices.

Server centric computing

Meaning of servers-roles of servers- server types(databases, e-mail, ERP, File servers, application servers, Web servers, network service servers ect)- Server clustering- data center technlogies

Cloud and virtualization

Fundamentals of virtualization technologies – Theories of Virtual machines- type of VMs-VmWare, Citrix, Xen/KVM -pros and cons of virtualization. Fundamentals of cloud services – multi-tenancy-provisioning-QoS- types of clouds – public-private-hybrid-community- SaaS-PaaS-IaaS-Staas-security aspects of cloud. Cloud computing models.

Enterprise Networking

Enterprise networking fundamentals – switches-routers-security gateways-software defined networking – NFVs

Storage

Fundamentals of storage technologies – DAS-NAS-SAN-file systems -storage networking protocols-cloud storage technologies -cloud storage -object-storage-gateways-storage security-server-SANs-converged Storage-storage devices technologies-SMR-helium filled drives-Flash based storage.

PT Enterprise deployment

Main frame -client server-3-tier architecture -n-tier architecture.

Non-functional

Reliability-availability-serviceability aspects

Managing database environments

Topics TBD

Securing the IT Infrastructure

- IAS Fundamental aspects
  - History and terminology
  - System/security life-cycle
  - Information assurance analysis model
  - MSR model; threats; vulnerabilities; attacks; countermeasures

- IAS Vulnerabilities
  - Perpetrators
  - Inside attacks
  - External attacks
  - Black hat / White hat
  - Ignorance
  - Carelessness
  - Network

- IAS Attacks
  - Social engineering
  - Denial of service
  - Protocol attacks
  - Active attacks
  - Passive attacks
  - Buffer overflow attacks
  - Malware (viruses, Trojan horses, worms)

- IAS Security mechanisms (countermeasures)

- Cryptography
  - Cryptosystems
  - Keys: symmetric & asymmetric
  - Performance (software/hardware)
  - Implementation
- Authentication
  - "Who you are, what you have, what you know"
  - Bio-authentication (use of biometrics)
- Redundancy
- Intrusion detection

IAS Operational issues
- Standards
- Enforcement
- Legal issues

IAS Policy
- Creation of policies
- Prevention
- Avoidance

GRADING

20%: Quizzes
30%: Mid-Term Exam
30%: End-Term Exam
20%: IT Infrastructure Design and Implementation Project

REFERENCE MATERIAL

- IT Infrastructure Architecture by Sjaak Laan

CHEATING AND PLAGIARISM

This course has zero tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor.

DEADLINES

Unless noted otherwise, all deadlines are due at **10:00 AM** on the date indicated

LATE POLICY

- 4 - 24 hours late submission: 25% penalty
- 24 - 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

ANNEXURE

What is Plagiarism

Many people think of plagiarism as copying another's work, or borrowing someone else's original ideas. But terms like "copying" and "borrowing" can disguise the seriousness of the offense:

According to the *Merriam-Webster OnLine Dictionary*, to "plagiarize" means

1) to steal and pass off (the ideas or words of another) as one's own
2) to use (another's production) without crediting the source
3) to commit literary theft
4) to present as new and original an idea or product derived from an existing source.

In other words, plagiarism is an act of fraud. It involves both stealing someone else's work and lying about it afterward. But can words and ideas really be stolen?

According to U.S. law, the answer is yes. In the United States and many other countries, the expression of original ideas is considered intellectual property, and is protected by copyright laws, just like original inventions. Almost all forms of expression fall under copyright protection as long as they are recorded in some media (such as a book or a computer file).

All of the following are considered plagiarism:

- turning in someone else's work as your own
- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)

Attention! Changing the words of an original source is not sufficient to prevent plagiarism. If you have retained the essential idea of an original source, and have not cited it, then no matter how drastically you may have altered its context or presentation, you have still plagiarized

Most cases of plagiarism can be avoided, however, by citing sources. Simply acknowledging that certain material has been borrowed, and providing your audience with the information necessary to find that source, is usually enough to prevent plagiarism.

CC 108 IT Infrastructure
TERM I (2016-17)

GENERAL COURSE INFORMATION

Course Name	CC 108 IT Infrastructure
Instructors	Chandrashekar R Tricha Anjali
TA	TBD
Course credits	4
Pre-requisite	a) Knowledge of Linux operating system

COURSE OVERVIEW

IT professionals will encounter a variety of computing platforms in their careers. One of the roles of the IT professional is to select, deploy, integrate and administer platforms or components to support the organizations IT infrastructure. This knowledge area includes the fundamentals of hardware and software and how they integrate to form essential components of IT systems.

Since IT systems are increasingly under attack, knowledge of Information Assurance and Security (IAS) is of paramount importance to the profession of IT. The IT professional must understand, apply, and manage information assurance and security in computing, communication, and organizational systems. It is also important for the IT professional to provide users with a framework to be sufficiently security aware to be an asset to the organization rather than a liability. IAS includes operational issues, policies and procedures, attacks and defense mechanisms, risk analyses, recovery, and information security.

- PT. Computing infrastructures.
- PT. Enterprise deployment software.
- IAS. Fundamental aspects.
- IAS. Security mechanisms (countermeasures).
- IAS. Operational issues.
- IAS. Policy.
- IAS. Attacks.
- IAS. Vulnerabilities.
- IM. Managing the database environment.
- SA. Applications.
- SA. Administrative activities

COURSE OUTCOMES

At the end of the course, the student is expected to have obtained proficiency in the following (tagged with Bloom’s taxonomy of learning):

- (REMEMBER) Get familiar with the vocabulary and terminology associated with infrastructure management
- (UNDERSTAND) Understand the various concepts of technologies employed in data centers
- (UNDERSTAND) Understand the information assurance security concerns
- (APPLY) Learn how to apply infrastructure design principles to create deployment architecture for a multi-tier software applications
- (ANALYZE) Ability to study a set of requirements and analyze the strengths and weakness of the architectures

COURSE CONTENTS

Stand alone computing devices

Topics covered around fundamentals of computing systems-operating system roles-mobile devices, laptops, PCs, work stations, branch offices devices-windows/Linux operating systems on stand-alone devices.

Server centric computing

Meaning of servers-roles of servers- server types(databases, e-mail, ERP, File servers, application servers, Web servers, network service servers ect)- Server clustering- data center technlogies

Cloud and virtualization

Fundamentals of virtualization technologies – Theories of Virtual machines- type of VMs-VmWare, Citrix, Xen/KVM -pros and cons of virtualization. Fundamentals of cloud services – multi-tenancy-provisioning-QoS- types of clouds – public-private-hybrid-community- SaaS-PaaS-IaaS-Staas-security aspects of cloud. Cloud computing models.

Enterprise Networking

Enterprise networking fundamentals – switches-routers-security gateways-software defined networking – NFVs

Storage

Fundamentals of storage technologies – DAS-NAS-SAN-file systems -storage networking protocols-cloud storage technologies -cloud storage -object-storage-gateways-storage security-server-SANs-converged Storage-storage devices technologies-SMR-helium filled drives-Flash based storage.

PT Enterprise deployment

Main frame -client server-3-tier architecture -n-tier architecture.

Non-functional

Reliability-availability-serviceability aspects

Managing database environments

Topics TBD

Securing the IT Infrastructure

- IAS Fundamental aspects
  - History and terminology
  - System/security life-cycle
  - Information assurance analysis model
  - MSR model; threats; vulnerabilities; attacks; countermeasures

- IAS Vulnerabilities
  - Perpetrators
  - Inside attacks
  - External attacks
  - Black hat / White hat
  - Ignorance
  - Carelessness
  - Network

- IAS Attacks
  - Social engineering
  - Denial of service
  - Protocol attacks
  - Active attacks
  - Passive attacks
  - Buffer overflow attacks
  - Malware (viruses, Trojan horses, worms)

- IAS Security mechanisms (countermeasures)

Cryptography
- Cryptosystems
- Keys: symmetric & asymmetric
- Performance (software/hardware)
- Implementation

Authentication
- "Who you are, what you have, what you know"
- Bio-authentication (use of biometrics)

Redundancy

Intrusion detection

IAS Operational issues
- Standards
- Enforcement
- Legal issues

IAS Policy
- Creation of policies
- Prevention
- Avoidance

GRADING

20%: Quizzes
30%: Mid-Term Exam
30%: End-Term Exam
20%: IT Infrastructure Design and Implementation Project

REFERENCE MATERIAL

- IT Infrastructure Architecture by Sjaak Laan

CHEATING AND PLAGIARISM

This course has zero tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor.

DEADLINES

Unless noted otherwise, all deadlines are due at **10:00 AM** on the date indicated

LATE POLICY

- 4 - 24 hours late submission: 25% penalty
- 24 - 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

ANNEXURE

What is Plagiarism

Many people think of plagiarism as copying another's work, or borrowing someone else's original ideas. But terms like "copying" and "borrowing" can disguise the seriousness of the offense:

According to the *Merriam-Webster OnLine Dictionary*, to "plagiarize" means

1) to steal and pass off (the ideas or words of another) as one's own
2) to use (another's production) without crediting the source
3) to commit literary theft
4) to present as new and original an idea or product derived from an existing source.

In other words, plagiarism is an act of fraud. It involves both stealing someone else's work and lying about it afterward. But can words and ideas really be stolen?

According to U.S. law, the answer is yes. In the United States and many other countries, the expression of original ideas is considered intellectual property, and is protected by copyright laws, just like original inventions. Almost all forms of expression fall under copyright protection as long as they are recorded in some media (such as a book or a computer file).

All of the following are considered plagiarism:

- turning in someone else's work as your own
- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)

Attention! Changing the words of an original source is not sufficient to prevent plagiarism. If you have retained the essential idea of an original source, and have not cited it, then no matter how drastically you may have altered its context or presentation, you have still plagiarized

Most cases of plagiarism can be avoided, however, by citing sources. Simply acknowledging that certain material has been borrowed, and providing your audience with the information necessary to find that source, is usually enough to prevent plagiarism.

VL 855 - Device Driver Development

15 weeks, 30 Sessions [18 sessions (lecture), 10 Sessions (lab), 2 (Assessment)]

Course Objective

For CSE and EC students who are interested in building device drivers for I/O devices and controllers in embedded systems and computers, this course teaches the latest principles and concepts involved in modular live extensions to open source kernel to manage existing and newly developed I/O devices and controllers. It trains students in the process of developing device drivers for industrial domains like robotics, data acquisition and control, automotive control, telematics and infotainment. Lab sessions will be interweaved with lectures to help students develop practical skills on popular embedded system boards.

At the end of the course, students will be able to:

- Configure, build and install GNU/Linux modules in a cross-compilation environment
- Understand the current device driver model and its components
- Understand kernel support for memory management, interrupts and timers
- Design, build and test a modular driver for a sample device
- Use Device Tree files for live detection and configuration of devices
- Modify an existing device driver to practice real-life scenarios.

Credits	4
Specialization	VLSI (see section 5 in Course Handbook)
Pre-requisites	Programming Languages, Operating Systems
Skills	Advance C/C++ programming on GNU/Linux with make, gcc and gdb
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)

Topics

Linux kernel architecture, kernel configuration, modules, memory management, physical and virtual memory, types of device drivers, examples of each type, Pat Morchel's new Linux Driver Model, sysfs, udev. Kernel services like memory pools, input subystem, device resource management, IRQs, i/o and memory map registers and GPIO, managing concurrent access to resources, memory allocation, interrupt contexts and management, clocks and timers, power management in kernel, clock management, suspend and resume, frequency and voltage scaling.

Recommended Reading

Linux Kernel Documentation, http://lxr.linux.no/linux+/Documentation*
Proceedings of Embedded Linux Conference, Linux Plumbers Conference
Linux Device Drivers, (3rd Ed) by Jonathan Corbet, Alessandro Rubini, Greg-Kroah Hartman

Compilers in Software Engineering (succeeds *Compilers*)– Course Handbook

1 General Course Information

Course Name	CS XXX Compilers in Software Engineering
Instructor	Sujit Kumar Chakrabarti `sujitkc@iiitb.ac.in` Office: 205-A
TA	TBD
Course Credits	4

2 Pre-requisite

1. Programming Languages course (desirable) or Introductory Compilers
2. Proficiency in programming with at least a couple of programming languages (e.g. C++, Java, OCaml, Haskell, Python etc.)
3. Data-structures and algorithms
4. Automata Theory/Theory of Computation

3 Course Overview

Compiler design continues to be a growing field of engineering and research as newer computing platforms (cloud, GPUs, mobile, edge computing devices) emerge with their own specific needs and demands. Technology developed over the last few decades in the area of compiler design have found applications in a variety of software engineering applications, e.g. bug finding, debugging, software quality measurement, static verification, testing, software development environments, profiling, reverse engineering etc. There has been a proliferation of tools – both commercial and free – based on this technology. Most of these tools are a regular part of most software engineers' toolkit today.

This course is an introduction to the application of programming language engineering (i.e. compiler design etc.) in software engineering.

The course starts with a review of basic compiler design concepts. It then proceeds to survey a variety of software engineering tools which are a useful addition to a programmer's toolkit. Each tool will be surveyed from a user's perspective introducing the student of its capability and application. Then, we will take a look at the internal details of the tool: the algorithms, data-structures and mathematical basics as applicable.

4 Course Outcome

As an outcome of doing this course the student will be able to design and implementation a compiler (lexical analyser through to optimising code generator). The student will also be able to understand the internal working of related language processing and program analysis tools, e.g. debuggers like gdb, bug-finding tools like lint and valgrind, PolySpace etc.

At the end of this course, the student is expected to:

- **Know**
  1. The overall structure of a compiler
  2. The concepts and tools useful in implementation of a compiler and all its phases
  3. Mathematical underpinnings of static program analysis and formal verification
  4. A set of software engineering tools which are based primarily on program analysis techniques
- **Be able to**
  1. Implement a compiler end to end for a modern programming language.
  2. Implement static analysis tools that find bugs, do automatic quality review, simulators, virtual machines, symbolic execution engines etc.

5 Course Contents

- Overview of compilers
- Front end - Lexical analysis, Syntax analysis, Semantic analysis
- Back end - Runtime organisation, Machine independent optimisation, Code generation basics

- Data flow analysis and its mathematical foundations
- Survey of modern program analysis techniques and software engineering tools based on them

6 Grading

Mid-term	20
End-term	30
Case-studies/project	50

7 Reference Material

1. Compilers: Principles, Techniques, and Tools – Alfred V. Aho,Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman
2. Modern Compiler Implementation in Java – Andrew Appel
3. Relevant literature

Course - Modern Operating Systems

15 weeks, 30 Sessions [18 sessions (lecture), 10 Sessions (lab), 2 (Review and Assessment)]

Course Description

This course will cover the principles of operating system design and implementation on a modern multi-core computer board. It will cover the abstractions of processes, threads and their scheduling algorithms, efficient memory management through use of virtualization, segmentation, paging and swapping. The concept of using namespaces to stitch together a virtual filesystem on top of physical storage devices will also be covered including protection mechanisms to ensure privacy while allowing controlled sharing of data amongst multiple users. Lab sessions will expose students to the practical aspects of building and operating and tuning a kernel on a modern multi-core board.

Course Objectives

Upon completion of this course, the student will be able to:

- Understand how different software abstractions are built layer by layer on a modern computer through a process of bootstrapping and extending its functions on the fly.
- Understand the various design tradeoffs in algorithms used in scheduling processes, tasks, clocks, memory.
- Understand the importance of inter-processes communication and its implications for building large systems.
- Configure, build, install and operate a modern kernel on a computer board through a cross-compilation process
- Learn to monitor a live operating system and tune its performance.

Pre-requisites

Advanced C/C++ programming skills including use of command-line, shell-based commands and GNU C/C++ toolchain commands like gcc and make. Knowledge of Object-oriented programming.

Topics

Structure of modern OS, Tasks and Scheduler, Memory management, Namespaces and filesystems, User authentication and security, process synchronization, inter-process communications, network stacks, device management, power management

Recommended Reading

- Understanding Linux Kernel (3rd Edition) by Jonathan Corbet et. al
- Operating Systems - Concept-based Approach by Dhamdhere
- Operating Systems Concepts (7th Edition) by Silberchatz

CS 302: Introduction to Automata Theory and Computability
Fall 2020

Syllabus

- **Instructor**:

  Prof. Shrisha Rao <srao@iiitb.ac.in>

- **TAs**:

  Aayush Grover <aayush.grover@iiitb.org>
  Aditya Gulati <aditya.gulati@iiitb.org>
  Akshi <akshi.025@iiitb.org>
  Gopalakrishnan Venkatesh <gopalakrishnan.v@iiitb.org>

- **Class Time**:

  Tue & Thu: 13:30 PM – 15:00 PM

  Discussion sessions:

  Friday: 11 AM – 12 PM, OR 2 PM to 3 PM

- **Course Objectives**:

  (i) To understand the basic concepts in the theory of computation and automata theory.

  (ii) To understand the formal description of a computer as a Turing Machine.

  (iii) To understand the formal equivalence of formal languages and problems, and results like the Halting Problem.

  Note: This class has prerequisites—specifically, knowledge of discrete mathematics (especially proofs, basic set theory, and elementary logic), and possibly one programming language as well. Please work on firming up the prerequisites if necessary.

- **Suggested Texts:**

  (i) *Computability: Computable Functions, Logic, and the Foundations of Mathematics*, 2nd ed., by Epstein and Carnielli, Wadsworth/Thomson Learning, ISBN 0-534-54644-7.

  (ii) *Introduction to Automata Theory, Languages, and Computation*, 2nd ed., by Hopcroft, Motwani, and Ullman, Addison-Wesley, ISBN 0-201-44124-1.

  (iii) *Introduction to the Theory of Computation*, by Sipser. Thomson Learning, ISBN 981-240-226-8.

  (iv) *Languages and Machines*, 2nd ed., by Sudkamp. Addison-Wesley, ISBN 0-201-82136-2.

- **Letter Grade Distribution**: (Subject to change)

  A = 80th percentile and above
  B = 50th–80th percentile
  C = 10th–50th percentile

- **Course Outline**: Major Topics (take this as a plan, not a contract)

  - General mathematical background
  - Finite Automata, Regular Expressions
  - Turing Machines
  - Computability
  - Church's Thesis
  - Primitive Recursive Functions
  - Partial Recursive Functions
  - Undecidability

  We will cover chapters 1–5 and 8 of Hopcroft, *et al.*, and chapters 1–6 and 8–20 of Epstein, *et al.*

- **Policies and Hints**:

  ACADEMIC HONESTY

  1. Students are advised to look at `http://www.plagiarism.org/` and other such resources carefully to educate themselves in this important aspect of academic honesty.
  2. Other misconduct includes, but is not restricted to, copying in an assignment or examination. In case a student gives inappropriate help to another, both will suffer the same penalty.

Homework

1. All written work (assignments, project documents, papers) done as part of this course must be typeset neatly in Latin Modern Roman size 12 using LaTeX 2ε with the standard classes `article, report, memoir`, and with the default settings for margins, spacings, and other things. (Adding the line `\usepackage{lmodern}` in the preamble will cause the document to be typeset in Latin Modern.) Other TeX-based document systems like XeTeX, or IDEs like LyX, may be used, with the same classes and defaults. The use of MS Word, Libre Office, etc., is not permitted, and documents prepared using them will not be accepted.
2. There will be several homework assignments. Homework submission *must be on time*. An exception can only be made when there is previous notice given of a need, and when there is just reason for an extension—in the instructor's judgment, not the student's. Late submissions otherwise will attract a penalty, and may also be rejected. Homework is to be submitted on paper, and will not be accepted by electronic mail or other means. Missed assignments are grounds for a failing grade (even if there are enough points from other work to earn a passing grade).
3. It is strongly recommended that a start on homework be made early, as soon as it is assigned (or made available on LMS). The problems are meant to foster thinking, and working on solving them is an integral part of learning. As such, rushed work will not suffice. Homework assignments will generally take at least ten hours of effort each to complete.
4. A student may orally collaborate to understand homework problems, but may not share any written solutions. On each problem that is handed in, the names of the others with whom the student has had discussions concerning the solution must be stated. The student must indicate whether (s)he gave help, received help, or worked something out together. Failure to do this will be considered cheating.
5. The class is geared toward fostering excellence in a core area of computer science, and every student is expected to make a committed effort at meeting the challenge. It is expected that there will not be many mediocre results in this class. Either a student will do very well (i.e., get an A or a high B) or fail completely (withdraw or F). A student who works hard for an A in this class will probably get it, but a student who attempts to get a mere passing grade will probably not.

- **Students' Responsibilities**:

  - Attend classes as far as possible and participate actively in them.
  - Complete all assigned homework satisfactorily.

- **Grading**: Letter grade of A–D, F, I.

Course Syllabus

Course Code / Course Name	CS 512 / Discrete Mathematics and Computability
Course Instructor Name(s)	Meenakshi D'Souza and Srinivas Vivek

<table>
<tr>
<td>Credits (L:T:P)

(Lecture : Tutorial : Practical)</td>
<td>Select <u>one</u> from the following:

(Place X appropriately)

<table>
<tr><th>Hours</th><th>Component</th></tr>
<tr><td>3</td><td>Lecture (1hr = 1 credit)</td></tr>
<tr><td>1</td><td>Tutorial (1hr = 1 credit)</td></tr>
<tr><td>0</td><td>Practical (2hrs = 1 credit)</td></tr>
<tr><td>L:T:P = 3:1:0</td><td>Total Credits = 4</td></tr>
</table>
</td>
</tr>
</table>

Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable) *(Choose by placing X in box against not more than two areas from the list)*				
X	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
X	General Elective			

<table>
<tr><td>Programme / Branch</td><td>Course is restricted to the following programmes / branch(es):

(Place X appropriately. More than one is okay)

Programme: Branch:

<table>
<tr><td></td><td>iMTech</td></tr>
<tr><td>X</td><td>M.Tech</td></tr>
<tr><td></td><td>M.Sc.</td></tr>
</table>

<table>
<tr><td>X</td><td>CSE</td></tr>
<tr><td></td><td>ECE</td></tr>
<tr><td></td><td>Digital Society</td></tr>
</table>
</td></tr>
<tr><td>Course Category</td><td>Select <u>one</u> from the following:

(Place X appropriately)

<table>
<tr><td></td><td>Basic Sciences</td></tr>
<tr><td></td><td>CSE Core</td></tr>
</table>
</td></tr>
</table>

	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites (where applicable, specify exact course names)
Design and Analysis of Algorithms, Theory of Computation (both at undergraduate level).

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas are covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	**Yes / No**	**Details**

Direct focus on employability	No	
Focus on skill development	Yes	This course provides exposure to mathematical rigour and helps students build skills for formal reasoning.
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview
This course will provide an introduction to topics from Discrete Mathematics and Computability theory towards pursuing further electives in Computer Science (Theory) and research electives in this area. The course will cover many topics in Combinatorics and also discuss Turing machines, computability and complexity theory, especially Class-P, Class-NP, NP-complete problems and class PSPACE.
Concept Map of the Course (Optional)
Course Outcomes and Competencies

Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand propositional logic, the laws, concepts including satisfiability, validity, and predicate logic.	PO4	U	C	6	2
CO2	Prove basic results in propositional logic, elementary number theory and combinatorics using direct proofs, proofs by contradiction and mathematical induction.	PO4	Ap	C	6	2
CO3	Understand discrete mathematical structures including sets, functions, relations, partial orders, graphs and trees, based on their definitions.	PO4	U	C	8	3
CO4	Solve counting problems by using counting techniques including permutations, combinations, inclusion-exclusion, generating functions and their associated mathematical principles.	PO4	Ap	C,P	6	2
CO5	Understand Turing machines as mathematical models of computation, variants of Turing machines and equivalent models.	PO4	U	C	6	2

CO6	Understand notion of undecidability, reductions and Rice's theorem on a necessary condition for undecidability.	PO4	U	C,P	5	2
CO7	Solve problems on classes P, NP and NP-completeness using the notions of polynomial-time reductions.	PO4	Ap	C,P	8	2
	Total				**45**	**15**

** PO/PSO - Programme Outcome / Programme Specific Outcomes*

** CL - Cognitive Level*

** KC - Knowledge Category*

Course Content (List of Topics)

Discrete Mathematics:

- Propositional logic, sets, functions, relations, partial orders, countability.
- Combinatorics: sum rule, product rule, permutations and combinations, inclusion-exclusion principle, pigeon-hole principle, recursion, generating functions, number of onto functions, partitions and Stirling numbers of second kind.

Computability:

- Computability: Turing machines, equivalent models of Turing machines, decidable and undecidable problems, reductions, Rice's theorem.
- Complexity theory: Class P, Class NP, NP-complete problems, PSPACE completeness, Savitch's theorem.

Instruction Schedule

Provide session-wise schedule

Learning Resources

Mention textbooks, reference books and other learning resources required as part of the course

- Kenneth Rosen, Discrete Mathematics and its applications, 7th edition, McGraw Hill, 2012.
- Ronald L. Graham, Donald E. Knuth, and Oren Patashnik, Concrete Mathematics: A Foundation for Computer Science, 2nd edition, 1994.
- Ralph P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th edition, 2003
- Dexter C. Kozen, Automata and Computability, Springer, 1997.

- Michael Sipser, Theory of Computation, Cengage Learning, 2007.

Assessment Plan

List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)

Two class tests - 2 x 20% = 40%

Mid-term exam - 30%

Final exam - 30%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

NA

S. No.	Focus of Assignment / Project	CO Mapping
	NA	

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

NA

Make-up Exam/Submission Policy *State if any specific policy derived from institute policy is applicable. Otherwise leave it as given*
[As per institute policy]
Citation Policy for Papers
NA
Academic Dishonesty/Plagiarism *State if any specific policy derived from institute policy is applicable. Otherwise leave it as given*
[As per institute policy]
Accommodation of Divyangs *State any special action taken to accommodate Divyangs*
[As per institute policy]

Course Proposal Template

Course Name	Advanced Algorithms
Course Proposer Name(s)	Muralidhara V N
Course Instructor Name(s)	Muralidhara V N
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	• Elective
Credits	Four
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F) •
Area of Specialization (if applicable) **CSE** – Computer Science and Engineering **DS** – Data Sciences **NCS** – Networking & Communication and Signals **ES** – Embedded Systems **SoC** - System on Chip	Computer Science and Engineering (Theory and Systems)
Semester	Term: (I / II / III / Prep) Academic Year:
Pre-Requisites (where applicable, specify exact course names)	
CS 511 Algorithms or equivalent courses	
Course Description	
The course is covers advanced topics in the area of algorithms which were not covered in the basic course on Algorithms. The main focus of the course is problem solving and programming. .	
Course Content	
The topics include 1. Advanced Dynamic Programming. 2. Network flow and applications. 3. Strings algorithms - KMP, suffix arrays. 4. Geometry, Special (geometric) Data Structures-Analytical Geometry computation on geometric shapes Representation and manipulation of Geometric primitives point, line, shapes, simple 3-D objects, etc. Popular geometric constructions Operations on geometric objects intersections, union, envelopes (convex hull), vornoi diagrams Interval trees, k-d trees, range trees Typical geometric problems range search, point location, path finding, nearest neighbor.	

5. Number Theory:Prime numbers GCD and LCM Integer Factorization Euler's Totient (Phi) function Extended Euclid Algorithmic Modular Arithmetic and Congruence Fibonacci Numbers.
Assessments (optional for Special Topics courses)
Two class tests, one mid-term exam and one final exam. There will be one term paper presentation.
Text Book / References
• None.

CS709
Geometric Modeling
Term II, 2017-18

Instructors

Prof. Amit Chattopadhyay, Prof. Jaya Sreevalsan Nair, Prof. T. K. Srikanth
{a.chattopadhyay, jnair, tk.srikanth}@iiitb.ac.in

Pre-requisites

- Good understanding of linear algebra and geometry
- Good object oriented programming skills (C++ preferable)
- Computer Graphics and use of OpenGL (desirable)

Course Description:

This course introduces the basics of geometric Modeling, specifically curve, surface and solid Modeling, as relevant to Computer Graphics, medical visualization, and engineering. With the increased availability of 3D data in the form of scanned points images, there is strong need for synthesizing 3D models from such data, and performing computations with and on these objects. The course explores computational and representational techniques for geometric objects in these domains, as well as geometric algorithms involving such objects, covering traditional solid Modeling as well as data-driven surface and volume Modeling. The course focuses on mesh (piecewise linear) geometries, and includes implementation of geometric algorithms, programmatic design of geometric models using 3D Modeling tools, and 3D printing.

This course is open for the **MTech 2nd Semester and the IMTech 6th and 8th Semester.**

Course Contents

A Brief Introduction to Computational Geometry:

Point containment, Convex Hulls, Voronoi Diagrams and Delaunay Triangulation.

Geometry of Curves and Surfaces:

Basics of differential geometry: tangents, normals, curvature, continuity; Parametric Surfaces and Curves: Beziers, B-splines

Topology:

Simplexes and Simplicial complexes; Manifold and non-manifold topology. Boundary, connectivity, connected regions; Mixed dimensional and non-manifold objects

Mesh Representation and Operations:
Data structures for mesh objects. Mesh simplification and refinement: Subdivision surfaces, decimation, progressive meshes, mesh smoothing/fairing

Data-driven surface and volume Modeling:
Mesh surfaces from point data and point clouds -- line fitting, surface fitting, outlier removal; Volumetric models and voxels; Interpolation schemes, iso-surface extraction, Marching Cubes.

Solid Modeling -- Representations
Half-spaces, neighbourhoods, bounded geometries. CSG and B-rep representations.

Basic Operations on Geometric Models:
Point containment, closest distance; Boolean operations: generalized classification, union/intersection/difference of solids, surfaces, curves and combinations

Geometric Algorithms on Surfaces and Solid Models:
Mass properties, collision detection, Contour generation/sharp feature extraction.
Spatial data structures

Miscellaneous (optional):
Machine learning for geometric modeling/ Shape matching; 3D printing

Assessments:

The course includes 3 programming assignments, and written mid-term and final examinations. All assignments will be evaluated based on a demo and code review.

The assignments involve implementation of geometric algorithms and the use of modeling tools and packages. The final assignment includes creating physical models using a 3D printer.

The weightage of these for the final grade are as follows:

- Mid-term and Finals: 20% each
- Assignments: 3 assignments, 20% each

References:

- C. M. Hoffmann, *Geometric and Solid Modeling*: *An Introduction.* San Mateo, CA: Morgan Kaufmann, 1989.
- Joe Warren, and Henrik Weimer. *Subdivision methods for geometric design: A constructive approach*. Morgan Kaufmann, 2001.
- Herbert Edelsbrunner**,** *Geometry and Topology for Mesh Generation,* 2001.
- Toth, Csaba D., Joseph O'Rourke, and Jacob E. Goodman, eds. *Handbook of discrete and computational geometry*. CRC press, 2004.
- Farin, Gerald, and Dianne Hansford. *The geometry toolbox for graphics and modeling*. CRC Press, 2017.
- Selected papers from top-tier journals and conferences on recent advances in geometric Modeling

Course Syllabus Template

Course Code / Course Name	CS/DS 720: Topics in Artificial General Intelligence (AGI)	
Course Instructor Name(s)	Srinath Srinivasa	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	40	Lecture (1hr = 1 credit)
	8	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 10:8:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	IIITB scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
X	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: *Branch:*

	iMTech
X	M.Tech
	M.Sc.
X	CSE
	ECE
	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

- First level course in Discrete math and logic
- First level course in Graph Theory
- First level course in Probability and Statistics

	• First level course in AI/ML Students wishing to take this course on credit, should have secured at least B+ or higher grade in the pre-requisite courses.

Additional Focus Areas

None

Course Context and Overview

The field of AI started off with a quest for mechanized general intelligence. But much of present day AI may be termed "narrow" or "weak" AI. They represent models created for specific domains or problems, and require specialised knowledge structures, or training data. In contrast to this, the original goal of AI which is now called Artificial General Intelligence (AGI), is to explore computational models representing intelligence of a general nature. This entails some element of "common sense" ability that can be applied across domains, as well as be useful for acquiring specialised intelligence on the fly.

Given the several false starts and "AI winters," some experts believe that AGI may never be realised, and its quest is somewhat like the quest for perpetual machines, which can never be possible. Nevertheless, the grand quest for understanding general intelligence has resulted in a number of interesting computational models that have variegated and versatile applications.

This course explores some such topics relevant to the overarching goal of AGI.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the history of Artificial Intelligence--its various phases and the resulting "winters" and the predominant paradigm in each wave					
CO2	Build formal conceptual models for textual descriptions					
CO3	Understand epistemological constructs of common knowledge and Frames, and non-monotonic reasoning paradigms					
CO4	Understand ethical concerns around the design, training, and deployment of AI					

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions

- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Course Handbook: CS821 Privacy-preserving Machine Learning

Course Name	CS821: Privacy-preserving Machine Learning
Course Proposer Name(s)	Ashish Choudhury and Srinivas Vivek
Course Instructor Name(s)	Ashish Choudhury and Srinivas Vivek
Course Type	Special topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS
Semester	Term II, Academic Year 2019-20

Pre-Requisites (where applicable, specify exact course names)

We are planning to offer this course on a **regular basis** during the **second semester** of every academic year (Jan-May semester). This course is available as an elective **only** for the 3rd , 4th year iMTech, 1st year M. Tech students **(the final year iMTech and final year M. Tech students are not allowed to register for this course),** and MS (Research) and Ph.D. students working on machine learning, cryptography or security.

Anyone with a IIITB affiliation **can audit** the course, without any eligibility criteria. Anyone who wants to **credit** the course **should be familiar** with the basic ML algorithms and these **will not be covered** as part of the course. Hence, it is **compulsory** that a student should have **credited** the **GEN512 (Mathematics for Machine Learning)** course. **Prior knowledge of Cryptography/Security is <u>not</u> required.**

Course Description

The growing influx of data makes machine learning (ML) a promising applied science, touching human life like never before. Its potential can be leveraged to advance areas such as medicine, facial recognition, banking, recommendation services, threat analysis, and authentication technologies. Many technology giants such as Amazon, Microsoft, Google, Apple are offering cloud-based ML services to their customers both in the form of training platforms that train models on customer data and pre-trained models that can be used for inference, often referred as `ML as a Service (MLaaS)'. However, these huge promises can only be unleashed when rightful privacy concerns, due to ethical, legal or competitive reasons, can be brought to control via privacy-preserving techniques. This is when privacy-preserving techniques such as secure multi-party computation (MPC) and homomorphic encryption (HE) schemes meet ML, with the former serving extensively in an effective way both for secure training and prediction.

Informally, the goal of privacy-preserving ML (PPML) is to ensure mutually-distrusting parties to perform ML tasks in a privacy-preserving fashion, by maintaining the privacy of individual data. Though MPC techniques and HE schemes allow to carry out any kind of distributed computation in a privacy-preserving fashion, of late customizing these techniques to efficiently carry out ML tasks in a privacy-preserving fashion has received tremendous attention by the research community. A clear witness of this is the increasingly growing number of research papers getting published in flagship avenues in the area of security like CCS, Oakland S&P, Usenix Security, NDSS as well as flagship avenues in ML like NeurIPS (formerly known as NIPS), ICML, etc.

This course aims to discuss basic paradigms of MPC and HE used for privacy-preserving ML. The students will be exposed to the state-of-the art research results in the domain of PPML. To complement the study of privacy-preserving applications, we will also explore the cryptanalytic applications of ML. It is expected that at the end of the course, students will be able to read advanced level research papers in the area of PPML and pursue research in this exciting area. To the best of our knowledge, this will be the first course of its kind to be offered in any Indian university, bridging the gap between two fascinating research topics in computer science.

Course Content

The course will be divided into **three parts**, the first part discussing MPC techniques for PPML (covered by Prof. Ashish Choudhury), while the second part will discuss how to do PPML using HE techniques (covered by Prof. Srinivas Vivek). The third part on cryptanalysis using ML will be offered by Prof. Srinivas Vivek. The **tentative topics** for each part are as follows.

- **(Tentative) Topics for the first part**: secret-sharing, replicated secret-sharing, secure 2-party, 3-party, 4-party and 5-party computation, Yao's garbling, Oblivious transfer, framework for secure mixed computation, privacy-preserving training and prediction using MPC, privacy-preserving neural network using MPC.
- **(Tentative) Topics for the second part**: Linearly homomorphic encryption schemes: RSA, multiplicative/additive ElGamal, Paillier. Somewhat/fully homomorphic encryption schemes: Gentry's blue print including bootstrapping, integer-based schemes (DGHV), ideal-lattice based schemes (BGV, FV), LWE-based schemes (GSW). Plaintext encoding techniques. Privacy-preserving SVM classification using HE. Privacy-preserving prediction using (Deep) Neural Network + HE.

- **(Tentative) Topics for the third part**: Improving side-channel attacks using deep learning.

Assessments
The **tentative** assessment plan is as follows: • Practical project (30 marks) • Paper presentation (30 marks) • Research assignments (40 marks) A small set of exceptional students may be given the option of working on some open research problem, in place of project, paper presentation and research assignments.
Text Book / References
There is no text book covering all the topics. We will be covering various topics from various resources, which will be discussed as and when a particular topic will be covered.

Course Proposal Template

Course Name	Approximation Algorithms
Course Proposer Name(s)	Muralidhara V N
Course Instructor Name(s)	Muralidhara V N
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	• Elective
Credits	Four
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F) •
Area of Specialization (if applicable) **CSE** – Computer Science and Engineering **DS** – Data Sciences **NCS** – Networking & Communication and Signals **ES** – Embedded Systems **SoC** - System on Chip	Computer Science and Engineering (Theory and Systems)
Semester	Term: (I / II / III / Prep) Academic Year:
Pre-Requisites (where applicable, specify exact course names)	
CS 511 Algorithms or equivalent courses	
Course Description	
There are several problems, that arise in computer science and have applications in various fields which are NP-hard, which means that optimal solutions to these problems cannot be computed in polynomial-time unless P equal NP. There are no practical techniques known to compute the optimum solutions to for most of these problems. This course is on the design of polynomial-time approximation (near optimal) algorithms for such problems. This is an elective course for M.Tech third semester and iM.Tech 7th or 9th semester students. The field of approximation algorithms has been developed in response to the difficulty in solving a good many optimization problems exactly. The goal here is to design efficient (polynomial-time) algorithms that nearly-optimal (approximate) solutions, and have provable guarantees (both in terms of performance as well as on the near-optimality). The main focus of the course is problem solving and programming.	
Course Content	
The course will study some of the successful paradigms for designing approximation algorithms and for proving approximation guarantees.	

The techniques that will be covered in the course are: Greedy Algorithms, Dynamic Programming, Local search, randomized methods, LP techniques, primal-dual method, Lagrangian methods, metric methods, inapproximability.

The problems that will be covered in the course include Set cover, Vertex cover,Knapsack, Bin packing, Max Cut, TSP, Scheduling, Facility location, Steiner tree and other network design problems, Sparsest cut, multi-cut and other partitioning problems.

Assessments (optional for Special Topics courses)

Two class tests, one mid-term exam and one final exam. There will be one term paper presentation.

Text Book / References

1. Vijay Vazirani, Approximation Algorithms,Springer-Verlag, Berlin, 2001.
2. David Williamson and David Shmoys, The Design of Approximation Algorithms, 2011.

***Prep Term**: July; **Term I**: Aug – Nov; **Term II**: Jan – Apr; **Term III**: Jun – July;*

CS856*: Advanced Computer Graphics

International Institute of Information Technology, Bangalore

Term I 2015-16

* *The course number is subject to change upon change of the course type from Special Topics to General Elective.*

General Course Information

Course Name	Advanced Computer Graphics
Instructors	Prof. Jaya Sreevalsan-Nair & Prof. T. K. Srikanth {jnair, tk.srikanth}@iiitb.ac.in
Course Credits (Level)	4 (Level-2)
Grading	9-point scale (A, A-, B+, B, B-, C+, C, D, F)
Pre-requisites	CS606 (Computer Science) Good understanding of linear algebra and geometry Good object oriented programming skills (C++ preferrable)

Course Overview

This course aims at ramping up on the theory and practice of computer graphics from what was covered in CS606 (Computer Graphics). The emphasis will continue to be on applications programming. Advanced topics in the following modules will be covered:

- Modeling
- Rendering
- Animation/Kinematics
- Real-time/Interactive Performance

The outcome of this course is to advance the knowledge and practice of graphics in students to requirements of a graduate level course. Hence while first half of the course can be broadly seen as building up the concepts required for the specific modules, the second half of the course ramps up students being able to read, understand and implement the state of the art in academic research and industrial practice in computer graphics.

Course Contents

Module 1: Modeling

- Surfaces
  - Parametric sufaces - parametrization, continuity, Bézier and B-spline curves and surfaces, NURBS, interactive editing of control points, parametric versions of implicit surfaces, approxmiating splines by meshes.
  - Trimmed surfaces - topology and basic data structures, trimmed surfaces in OpenGL, tessellation.
- Solids
  - Overview of schemes such as CSG, and data structures such as B-rep.
- Mesh representations
  - Operations: adaptive refinement, mesh simplification, mesh smoothing.
  - Surface parametrization.
  - Volume representation and isosurfaces.

Module 2: Rendering

- Global illumination and Monte Carlo rendering
- Ray tracing
- Radiosity
- Texture mapping

Module 3: Animation

- Rigid body dynamics, inverse kinematics
- Collision detection and intersection
- Physically based modeling, cloth modeling.

Module 4: Real-time rendering

- Hardware acceleration and GPGPU computing
- Levels of detail and multiresolution modeling
- Spatial data structures

References/Reading Material

Selected papers from top-tier conferences and journals, e.g. ACM Siggraph

Grading

%-ages mentioned in this section is with respect to final grade.

- Seminars: 20%; Projects: 55% ; Midterm (written examination): 15% ; Final (0.5-hour viva voce): 10%

The scope of the deliverables are as follows:

- Seminars will be based on presentation of seminal papers in the modules covered in the course. Each student will undertake 2 seminars.
- Projects include a minor and a major project.
- The scope of the minor project is to tackle solving a given graphics problem using available tools, libraries, techniques.
- The scope of the major project is to build a system by integration of pieces from each of the modules.
- The minor project will account for 20% and the major project, for 35% of the final grade.

Timeline of the course:

- **Pre-midterm:** Modules: 1-2, Seminar1, Minor project
- **Post-midterm:** Modules: 3-4, Seminar2, Major project

Specifics on the submissions and assessment:

- **Academic Plagiarism:** This course has zero tolerance for cheating and plagiarism. Any violation shall result in an F grade and further disciplinary action shall be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructors. All material that will be used for assessment of the student's performance must be original work.

- **Assignments:** An evaluation booklet will be provided to the students in the first class which will give a complete description and logistics of the deliverables for the course.

  There will be a total of two reading assignments (seminars), one minor and one major project, which will be termed as "Assignments" hereafter. "*Start early and finish on time*" is the guiding principle for all assignments in this course. The list of papers for reading assignment will be published within two weeks into the semester.

  - On deadlines:
    - Assignment-n is due on *submit-date-*n, where $n = 0, 1, \ldots, 4$. The list of *submit-date-*n will be provided in the assignment booklet.
  - Rules on implementation:
    - Regarding the choice of paper for the reading assignment, no two students shall work on the same paper, unless the instructor(s) change the plan in the beginning of the semester. Hence, *first-come, first-served* policy is undertaken for the assignment of papers to the sudents. All students shall inform the instructor on the choice of the paper via e-mail. If students do not own up a paper by a specific deadline, a paper will be randomly assigned to them on the day.
    - All programming assignments shall be implemented in C++ using OpenGL libraries, on a Linux OS, preferrably Ubuntu or Fedora. Other environments may be
  - Rules on submissions:
    - Several submissions can be made for the programming assignments and the technical report. Only the last submission before the deadline will be considered for evaluation.
    - To incentivize early submissions and discourage late submissions the following bonus scheme will be used on the total for final grade:
      - $+1$ for submission before the designated Sunday, -0.5 for submission on the subsequent Monday or Tuesday, -1 for submission before the next Sunday, -3 for any time later.
    - All submissions must be sent to the instructor via e-mail.
    - Submissions should be named in the format: <RollNumber>_Assignment<Number>.* where * is tar.gz or pdf
    - Submission for a programming assignment would be a tarred-gzipped folder comprising of the source files, header files, README, subfolder containing screenshots and a Makefile.
      - There will be penalty for submissions containing intermediate files (e.g., *.o, *.C , etc.).
      - README files should contain information on sources referred to for help on the assignment, instructions on how to compile and run the application, expected input-outputs, and any notable defects/effects when running the application.

- **Examinations:** There will be a written examination during the Mid-term examination week and a viva voce for finals.
  - The examinations will be based on the topics covered in the class until the date of the examination and the viva voce may also include questions based on the assignments.
  - The viva voce will be conducted by the instructors. The examination will be conducted for 30 minutes per student. Each student will be allocated a time-slot for the examination day.
- **Evaluations:** All assignments, except the reading assignments, will be evaluated based on a demonstration and code-review.

Course Proposal Template

Course Name	Program Analysis for Software Engineering
Course Proposer Name(s)	Sujit Kumar Chakrabarti
Instructor Name(s)	Sujit Kumar Chakrabarti
Course Type	Elective
Credits	4
Area of Specialization (if applicable)	SE
Semester	Term I

Pre-Requisites (where applicable, specify exact course names)

Programming Languages or *Compilers*

Course Description

This course will introduce applications of program analysis techniques in solving software engineering problems. Following are the highlighted objectives of the course:

- Introduction to the theories and concepts of program analysis
- Introduction to the problems of software engineering
- Application of program analysis in software engineering

Course Content

Software Engineering (6 hours)

1. Review of basic concepts
2. V&V View of SE problems: Requirement engineering, design, coding, testing, maintenance ...

Introduction to Program Analysis Techniques (15 hours)

1. Type Theory
2. Data Flow Analysis
3. Abstract Interpretation
4. Points-to Analysis
5. Symbolic Execution

Related techniques:

1. Model checking
2. Theorem proving
3. Software testing

Readings (12 hours)

1. Proof carrying code
2. Predicate Abstraction
3. Steengard's Points-to analysis
4. Machine Learning Topics

Case Studies (9 hours)

1. Antlr, LLVM, CIL etc. (compiler frameworks)
2. NuSMV (CTL Model checking), TLA+, Spin, (LTL model checking), Z3, Choco (SMT solver), CBMC, ...
3. TAJS (Type analysis), SOOT (Points-to analysis)
4. DART (symbolic execution based test generation)

Assessments (optional for Special Topics courses)

1. Mid-term
2. Reading assignment
3. Project

Text Book / References

1. Software Foundations
2. Types in Programming Languages
3. Research Literature

Course Template (Syllabus)

Course Code / Course Name	**CS 873 - Cryptographic Engineering**
Course Instructor Name(s)	Srinivas Vivek

Credits (L:T:P)

(Lecture : Tutorial : Practical)

Select one from the following:

(Place X appropriately)

Hours	Component
3	Lecture (1hr = 1 credit)
1	Tutorial (1hr = 1 credit)
0	Practical (2hrs = 1 credit)
L:T:P = 3:1:0	**Total Credits = 4**

Grading Scheme	X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)

(Choose by placing X against appropriate box)		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable) *(Choose by placing X in box against not more than two areas from the list)*				
	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems		X	Cyber Security
X	General Elective			

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
X	M.Tech
	M.Sc.

	<table><tr><td>X</td><td>CSE</td></tr><tr><td>X</td><td>ECE</td></tr><tr><td></td><td>Digital Society</td></tr></table>
Course Category	Select **one** from the following: *(Place X appropriately)* <table><tr><td></td><td>Basic Sciences</td></tr><tr><td></td><td>CSE Core</td></tr><tr><td></td><td>ECE Core</td></tr><tr><td>X</td><td>CSE Branch Elective</td></tr><tr><td></td><td>ECE Branch Elective</td></tr><tr><td></td><td>Engineering Science and Skills</td></tr><tr><td></td><td>HSS/M</td></tr></table>

	X | General

Course Pre-Requisites (where applicable, specify exact course names)
Discrete Mathematics, Data Structures and Algorithms (both at undergraduate level)

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Jobs in industry that specialise in cyber security in general and cryptography in particular expect candidates to possess a basic knowledge of cryptographic algorithms and their secure implementation.

Focus on skill development	Yes	This course provides exposure to mathematical rigour and helps students build skills for formal reasoning.
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Outcomes and Competencies

Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the objectives of information security, cryptography and crypto engineering, the concept of perfect security and one time pad.	PO4	U	C	3	1
CO2	Solve problems on linear LFSR and non-linear LFSR, and statistical tests to check the quality of pseudorandom generators.	PO4	Ap	F,C	3	1
CO3	Understand what is a block cipher, its modes of operations and the design of AES.	PO4	U	C	3	1
CO4	Implement AES using tables and without using tables, and the corresponding implementation-based attacks including timing, power, cache-based side-channel attacks and fault attacks.	PO4	Ap	C,P	6	2
CO5	Design countermeasures for side-channel and fault attacks including tabled-based and ISW masking.	PO4	Ap	C	6	2
CO6	Understand the concepts of threshold implementation, whitebox cryptography, message authentication codes and hash functions.	PO4	U	C	3	1
CO7	Solve problems on the fundamentals of elementary number theory related to cryptography.	PO4	Ap	C	12	4

CO8	Implement Diffie-Hellman key exchange and RSA encryption schemes.	PO4	Ap	C	6	2
CO9	Understand the arithmetic of finite fields.	PO4	U	C	3	1
	Total				**45**	**15**

* *PO/PSO - Programme Outcome / Programme Specific Outcomes*

* *CL - Cognitive Level*

* *KC - Knowledge Category*

Course Content (List of Topics)

Lecture-wise plan

What is Information security - objectives + crypto (goals and taxonomy techniques), bigger picture of information security: crypto engineering, what is encryption? SKC vs. PKC, history (crypto vs. cryptanalysis).

One time pad - perfect security, types of attack scenarios on encryption, Kerchoff's principle, semantic security.

Indistinguishability definition of PRG, next bit unpredictability, what is a stream cipher? Linear congruential generator and attacks.

LFSR-based construction, LSFR + non-linear combiners, briefly on Trivium.

Brief discussion on TRNG, what is hypothesis testing + 5 basic statistical tests (monobit, two bit or serial test, poker test, runs test, autocorrelation test)? Notion of PRF, construction of a CPA secure symmetric-key scheme.

What is a block cipher? Modes of operation (ECB, CBC, OFB, CTR), Construction of AES including AES key expansion.

Briefly on algorithmic/black box attacks on AES (brute force + related key + Linear + differential attacks), introduction to implementation-based attacks (timing + power side-channel), basics of cache memory hierarchy.

Table-based implementation of AES + cache-timing attack on this implementation. Mitigations - including the use of AES-NI instructions.

ISW (table-free) implementation of AES: S-box arithmetic structure, bit-sliced implementation of AES, SPA power attacks.

DPA power attacks. Power SCA mitigation: masking vs. hiding countermeasure, table and ISW-based masking (for low masking orders).

Briefly on fault + quantum attacks on AES. Briefly on threshold implementation and white-box cryptography. Briefly on MAC: security definition + a construction, briefly on hash functions.

Peano’ axiom, e.g. of integer ring, definitions of group, ring, field, vector space; divisibility of integers.

FTA, division with remainder, ideals, GCD (Bezout’s relation), primeness condition, completing the proof of FTA.

I nfinitude of primes, GCD/LCM for many integers, equivalence relations, congruence relation, solving linear congruence relation.

CRT congruence, residue classes, CRT map, Euler’s phi function, multiplicative order arithmetic, Euler’s theorem.

Fermat’s little theorem, m-th powers definition, quadratic residues - Euler’s criterion, Wilson’s theorem, briefly on QR modulo n and no. of sq roots mod n, square roots of -1 mod p, briefly on Legendre symbol + quadratic reciprocity law.

DH Key exchange, RSA cryptosystem, security of RSA, implementation issue 1 (complexity of operations: add, multiply, divide, GCD - Euclid’s algorithm)

RSA - implementation issue 1 continued (CRT, distribution of primes, primality tests, briefly on prime order subgroup of Z_p), RSA Implementation Issues 2 & 3 - SCA and fault attacks on CRT-RSA signatures

Finite fields: characteristic, comparison with properties of integers (divisibility, division theorem, gcd, FTA, congruence), finite field construction, briefly on sub-field structure, briefly on polynomial arithmetic: add, multiplication, evaluation, DFT.

Instruction Schedule

Provide session-wise schedule

Learning Resources

Mention textbooks, reference books and other learning resources required as part of the course

1. Handbook of Applied Cryptography. Authors: Alfred Menezes, Paul van Oorschot and Scott Vanstone. Publisher: CRC Press. Year: 1996. Available at: http://cacr.uwaterloo.ca/hac/

2. A Computational Introduction to Number Theory and Algebra. Author: Victor Shoup. Edition no.: 2. Publisher: Cambridge University Press. Year: 2009. Available at: https://shoup.net/ntb

3. A Graduate Course in Applied Cryptography. Author: Dan Boneh and Victor Shoup. Draft. Available at: https://cryptobook.us/

4. Technical papers in the area.

Assessment Plan

List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)

Project + paper presentation - 40%

Class test - 20%

Mid-term exam - 20%

Final exam - 20%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	A team project consisting of at most three members that focuses on one of the following topics: side-channel attacks or countermeasures, formal verification of side-channel countermeasures, or applied homomorphic encryption.	CO4, CO5, CO6, CO8

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online.

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions will be permitted only upon prior approval.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[As per institute policy]

Citation Policy for Papers

NA

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[As per institute policy]
Accommodation of Divyangs *State any special action taken to accommodate Divyangs*
[As per institute policy]

Course Proposal

Course Name	**Introduction to Text Processing and Information Retrieval**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	2
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	DS/CS
Semester	Spring (Jan-May)

Pre-Requisites (where applicable, specify exact course names)

- Maths for IT or Courses covering basic Probability Theory, Linear Algebra and Discrete Mathematics
- First Course in Algorithms

*Those opting for this course would require to have got at least a **B** in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

Course Description

Covers the basics of Text Processing and Information Retrieval from unstructured data including feature selection and extraction, preprocessing techniques, Document Indexing, Document Classification and Clustering, Topic Models, Basics of Language and POS

Course Content

Module 1 Terms –- Basic Building Blocks in Text

- Words, Bi-Grams, n-Grams
- Stemming, Stop Words, Lemmatization, Normalization
- Positional Indexes, Dictionary/Lexicon Building, Query and Retrieval
- Handling Spellings

- Document Indexing --- In-Memory, Sorting-based, Distributed approaches

Suggested Reading:

a) Christopher Manning , “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
b) Christopher Manning, Prabhakar Raghavan and Hinrich Schutze, “*Introduction to Information Retrieval*”, Cambridge University Press. 2008.

Module 2 Document Representations, Comparison, and Scoring

- Term Frequency and Weighting
- Vector Space Models, Generative Models, Variant TF-IDF Functions
- Probabilistic Information Retrieval
- Document Classification and Clustering --- Naive Bayes, SVM, k_NN, K-Means
- Matrix decompositions and latent semantic indexing
- LDA and Topic Modeling

Suggested Reading:

a) Christopher Manning , “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
b) Christopher Manning, Prabhakar Raghavan and Hinrich Schutze, “*Introduction to Information Retrieval*”, Cambridge University Press. 2008.

Module 3 Basics of NLP

- Parts of Speech, Morphology, Phrase Structure, Grammar
- POS Tagging --- HMM Models
- Co-Occurrence and n-Gram Models

Suggested Reading:

a) Christopher Manning , “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.

Assessments

The evaluation will include three components, all of which carry equal weight: • Project which the students are expected to carry out in small groups (at most 3 in each group). • Written Exams
Text Book / References

Course Proposal

Course Name	**Neural Networks and Reinforcement Learning**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS / SP-PR
Semester	Spring (Jan-May) - 2018

Pre-Requisites (where applicable, specify exact course names)

At least one of the following:

- Maths for ML
- Machine Learning – I
- Introduction to Text Processing and Information Retrieval
- Machine Perception
- ASR

Course Description

This course is intended to be an intense, in-depth course Neural Networks and Deep and Reinforcement Learning. The primary references for this course would be:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, **Deep Learning (Adaptive Computation and Machine Learning series)**, MIT Press, 2017, 978-0262035613.
2. Neural Network and Deep Learning (Book, Jan 2017), Michael Nielsen. [html]
3. Richard Sutton, **Reinforcement Learning – An Introduction**, MIT Press, 2017, ISBN 978-0-521-51814-7. http://incompleteideas.net/book/bookdraft2017nov5.pdf

Template Version Number	1.6
Template update date	07 Mar 2013

Course Content

1. **Module 1 (Introduction to Deep Learning)**
    - Overview of Neural Networks, Why they work –- Universal Approximation Theorem, Representation Learning, Depth in Neural Networks, Relationship with Graphical Models
    - Basic Terminology & Notation; Training a NN --- Backpropagation and other Methods
    - Basic NN Architectures --- CNN, RNN and their variants, Capsules, Memory Networks
    - Unsupervised Models --- Autoencoders and their relationship with PCA, RBM and its extensions
    - Regularization in Deep Learning --- Dropout, Ensembling, Explicit Parameter Regularization, Adversarial Training.
    - Other Practical Tips --- Data Augmentation, Batch Normalization, Hyperparameter Tuning, Initialization, Transfer Learning, Performance Metrics/Monitoring, Visualization of NN computation, Debugging.

Suggested Additional Reading:

a) Visualizing and understanding convolutional networks (2014), M. Zeiler and R. Fergus [pdf]
b) Dropout: A simple way to prevent neural networks from overfitting (2014), N. Srivastava et.al., [pdf]
c) How transferable are features in deep neural networks? (2014)., J. Yosinski et. al, [pdf]
d) Learning and transferring mid-Level image representations using convolutional neural networks (2014), M. Oquab et al. [pdf]
e) A neural algorithm of artistic style (2015), L. Gatys et. al., [pdf]
f) Batch Normalization: Accelerating deep network training by reducing internal covariance shift (2015), S. Loffe and C. Szegedy [pdf]
g) Deep neural networks are easily fooled: High confidence predictions for unrecognizable images (2015), A. Nguyen et al. [pdf]
h) The Unreasonable Effectiveness of Recurrent Neural Networks, blog by Andrej Karpathy, [html]

2. **Module 2 (Deep Learning Implementation Insights)**
    - Tensors, Efficient Linear Algebra Computations, Parallelization
    - Numerical Issues --- Sensitivity/Stability Analysis, Conditioning
    - Computation Graphs and Symbolic Differentiation

Suggested Additional Reading:

a) The NumPy array: a structure for efficient numerical computation (2011), Stéfan van der Walt [pdf]
b) The Science of Programming Matrix Computations (2007), Robert A. van de Geijn and Enrique S. Quintana-Ortí [pdf]
c) Anatomy of High-Performance Matrix Multiplication (2008), Kazushige Goto and Robert A. Van De Geijn, Article in the book "Programming Dense Matrix Libraries: The FLAME Collection from ACM TOMS" [pdf], page 169.
d) What Every Computer Scientist Should Know About Floating Point Arithmetic (2005), Goldberg [pdf]
e) Computational Graphs, and Backpropagation, Chapter from the Course notes for NLP by Michael Collins, Columbia University, [pdf]
f) Symboling Differentiation (Chapter 6), [pdf]
g) Efficient Symbolic Differentiation for Graphics Applications, Brian Guenter, Microsoft Research [pdf]

3. **Module 3 (Optimization for Deep Learning)**
   - Non-Convex Optimization; First-Order and Second Order Methods
   - Saddle Point Theorem
   - Dealing with Ill-Conditioned Systems --- Momentum; Exponential Decay; Adaptive Gradient Methods
   - Metaheuristics for Deep Learning

Suggested Additional Reading:

a) Adam: A method for stochastic optimization (2014), D. Kingma and J. Ba [pdf].
b) Training very deep networks (2015), R. Srivastava et al. [pdf]
c) An overview of gradient descent optimization algorithms, blog by Sebastian Ruder [html]
d) Optimization and global minimization methods suitable for neural networks, Włodzisław Duch and Jerzy Korczak, [pdf]

4. **Module 4 (Architectural Patterns in Deep Learning)**
   - Generative Models --- GAN (Generative Adversarial Networks), VAE (Variational Autoencoder)
   - Sequence to Sequence Learning, CTC
   - Attention and Gating Mechanisms
   - Explicit memory in Networks --- Dynamic Memory Networks, Neural Turing Machines
   - Recursive Neural networks

Suggested Additional Reading:

a) Connectionist Temporal Classification: Labelling Unsegmented Sequence Data with Recurrent Neural Networks. Alex Graves et. al., ICML 2006, Pittsburgh, USA, pp. 369-376. [pdf]
b) Multi-Dimensional Recurrent Neural Networks. Alex Graves et. al., ICANN 2007, Porto, Portugal, pp. 549-558. [pdf]
c) Memory networks (2014), J. Weston et al. [pdf]
d) Neural turing machines (2014), A. Graves et al. [pdf]
e) Neural machine translation by jointly learning to align and translate (2014), D. Bahdanau et al. [pdf]
f) Sequence to sequence learning with neural networks (2014), I. Sutskever et al [pdf]
g) Highway Networks (2015), Rupesh Kumar Srivastava et. al., [pdf]
h) Show, attend and tell: Neural image caption generation with visual attention (2015), K. Xu et al. [pdf]
i) Show and tell: A neural image caption generator (2015), O. Vinyals et al. [pdf]
j) VQA: Visual question answering (2015), S. Antol et al. [pdf]
k) Tutorial on Variational Autoencoders (2016), C. Doersch. [pdf]
l) Neural Machine Translation and Sequence-to-sequence Models(2017): A Tutorial, G. Neubig. [pdf]
m) Attention Is All You Need (2017), A Vaswani et. al., [pdf]

5. **Module 5 (Bayesian Deep Learning and Relationship with Graphical Models)**

- Bayesian Analysis of Deep Learning --- Dropout as a Bayes Variational Approximation
- Incorporating Probabilistic Inference into Deep Networks. Exploiting Graphical Dependency Structures in Deep Learning.
- Variational Methods; Approximate & Monte-Carlo Inference.

Suggested Additional Reading:

a) Conditional random fields as recurrent neural networks(2015), S. Zheng and S. Jayasumana. [pdf]

b) Uncertainty in Deep Learning (2016), Yarin Gal, Ph.D. Thesis. [pdf]

c) Combining Graphical Models and Deep Learning (2017), Mathew James, Deep Learning (DLSS) and Reinforcement Learning (RLSS) Summer School, Montreal 2017, [html]

6. **Module 6 (Introduction to Reinforcement Learning)**
   - Markov Decision Processes, Actions, State, Value Function, Q Function,
   - Dynamic Programming and Bellman conditions, Value Iteration, Policy Iteration
   - Monte-Carlo Methods and Temporal-Difference learning
   - Off and On-Policy Methods

   Suggested Additional Reading:

   a) Csaba Szepasvari, Algorithms for Reinforcement Learning – Lecture published in the "Synthesis Lectures on Artificial Intelligence and Machine Learning" series by Morgan & Claypool Publishers. June 2009. [html]

7. **Module 7 (Deep Reinforcement Learning)**
   - Using Deep Learning in Reinforcement Learning
   - DQN and Double DQN
   - Replay Mechanisms

   Suggested Additional Reading:

   a) Playing atari with deep reinforcement learning (2013), V. Mnih et al. [pdf]
   b) Continuous control with deep reinforcement learning (2015), T. Lillicrap et al. [pdf]
   c) Prioritized experience replay (2015), Tom Schaul et. al., [pdf]
   d) Deep Reinforcement Learning with Double Q-Learning (2016), H. Hasselt et al. [pdf]
   e) Deep Reinforcement Learning: An Overview (2017), Y. Li, [pdf]

Assessments

The evaluation will include three components –- the weightage out of 100 for each component is shown in in brackets.

- There will be small implementation experiments/projects for each module which the students are expected to carry out in small groups (at most 3 in each group). (**20**)
- A reasonably big project involving deep learning (**50**)
- Online Quizzes (**30**)

Course Proposal

Course Name	**Machine Learning – I (Statistical Learning)**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS
Semester	Autumn (Aug-Dec) - 2015

Pre-Requisites (where applicable, specify exact course names)

- First level courses in Discrete Maths, Algorithms, Software Engineering
- Foundations for Big Data Algorithms

*Those opting for this course would require to have got at least a **B** in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

*Class strength will be limited to **30**.*

Course Description

This course is intended to be an intense, in-depth course in Statistical Learning methods. Primary Reference would be:

1. Trevor Hastie, Robert Tibshirani and Jerome Friedman. "The Elements of Statistical Learning ". Second Edition. Springer. 2008. Freely Downloadable.

Course Content

1. Module 1 (Statistical Learning Theory)

- VC Theory – PAC learning, VC dimensions, Sample Complexity Bounds.

- Rademacher Complexity
- Overfitting Phenomenon

Suggested Additional Reading:

a) Yaser S. Abu-Mostafa, Mailk Magdon-Ismail, and Hsuan-Tien Lin. "Learning From Data — A Short Course". AMLbook.com, 2012.
b) Michael J. Kearns and Umesh V. Vazirani. "An Introduction to Computational Learning Theory". The MIT Press. 1994. ISBN-13 978-0-262-11193-5.

2. Module 2 (Regularization and Model Selection)

- Bias-Variance Tradeoff; Structural Risk Minimization
- MDL
- Cross Validation
- Bayesian Approaches

Suggested Additional Reading:

a) Peter Grunwald. "A Tutorial Introduction to the Minimum Description Length Principle". Advances in Minimum Description Length: Theory and Application. ed. P.Grunwald, I.J. Myung and M. Pitt. MIT Press 2005.
b) Volker Nannen. "A Short Introduction to Kolmogorov Complexity". *arXiv Survey Article* 2003.
c) Volker Nannen. "A Short Introduction to Model Selection, Kolmogorov Complexity and Minimum Description Length (MDL)". *arXiv Survey Article* 2003.

3. Module 3 (Generalized Linear Models)

- Basis Expansions
- Least Squares. Logistic Regression, LDA – Lasso, Laplace
- Classification and Regression using GLM

Suggested Additional Reading:

a) Jeff Gill. "Generalized Linear Models – A Unified Approach". SAGE Publications. 2001. ISBN 0-7619-2055-2.
b) Annette J. Doson. "An Introduction to Generalized Linear Models". Second Edition. Chapman & Hall/CRC. 2002. ISBN 1-58488-165-8.

4. Module 4 (Kernel Methods and SVM)

- Primer on Duality and Optimization
- SVM Classification
- SVM Regression
- Kernel Methods – Designing Kernels, Kernel Feature Extraction, Reduced

- Set Methods, Kernel Trick
- PAC Bounds for SVM
- Implementation Issues

Suggested Additional Reading:

a) Nello Cristianini and John Shawe-Taylor. “Support Vector Machines”. Cambridge University Press. 2000. ISBN 978-0-521-78019-3.
b) Bernhard Scholkopf and Alexander Smola. “Learning with Kernels”. The MIT Press. 2012. ISBN 0-262-17475-9.

5. Module 5 (Additive Methods and Model Averaging)

- Random Forests
- Model Averaging & Stacking
- Boosting – Generalization Bounds, Margins Explanation
- Relationship to Convex Optimization, Game Theory and Information Theory
- Extensions – Ranking, Multiclass Discrimination, Continuous Time
- Boosting Trees
- Kernel Smoothing

Suggested Additional Reading:

a) Robert E. Schapire and Yoav Freund. “Boosting”. The MIT Press. 2012. ISBN 978-0-262-01718-3.

6. Module 6 (Neural Networks and Statistical Learning)

- Neural Networks
- Issues: Starting Values, Overfitting, Scaling of the Inputs, Number of Hidden Units and Layers, Multiple Minima.
- Hopfield Networks, Boltzman Machines, Adaptive Maps

Suggested Additional Reading:

b) James A. Anderson. “An Introduction to Neural Networks”. The MIT Press. 1995. ISBN 0-262-01144-1.

Assessments

The evaluation will include three components, all of which carry equal weight:

- There will be small implementation experiments/projects for each module which the students are expected to carry out in small groups (at most 3 in each group).
- Participation in In-Class and offline discussions on LMS on problems posted.
- There will be a class test after every module.
- A reasonably big project on something related to the modules listed above.

The course would progress one module at a time. Progress to the next module will be subject to a significant fraction of the class 'making-the-cut' in the test – a rough thumb-rule could be 50% median score and less than 10% of the class below 30% score. **The class mean will be calibrated based on the number of modules that have been covered during the course. Module 1 through 6 that the course eventually progressed to would correspond to class mean grades of C, C+, B-, B, B+ respectively in that order.**

Additional References:

1. Christopher M. Bishop. "Pattern Recognition and Machine Learning". Springer. 2006. ISBN 978-0387-31073-2.
2. Vladimir Charkassy ad Filip Mulier. "Learning from Data – Concepts, Theory and Methods". Second Edition. Wiley Interscience and IEEE Press. 2007. ISBN 978-0-471-68182-3.
3. Kevin Murphy. "Machine Learning – A Probabilistic Perspective". The MIT Press 2012. ISBN 978-0-262-01802-9.

Course Proposal

Course Name	**Machine Learning – II** **(Bayesian Learning methods and Graphical Models, Mixture Models, Neural Networks and Deep Learning, Adaptive Learning, Time Series and Continuous Markov Models)**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS
Semester	Spring (Jan-May) - 2016

Pre-Requisites (where applicable, specify exact course names)

- Foundations for Big Data Algorithms
- Machine Learning – I or Algorithms for Large Datasets

*Those opting for this course would require to have got at least a **B** in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

*Class strength will be limited to **30**.*

Course Description

This course is intended to be an intense, in-depth course covering Bayesian Learning methods and Graphical Models, Mixture Models, Neural Networks and Deep Learning, Adaptive Learning, Time Series and Continuous Markov Models. The two primary references for this course would be:

1. Kevin Murphy. **Machine Learning – A Probabilistic Perspective**. The MIT Press 2012. ISBN 978-0-262-01802-9.

2. David Barber, **Bayesian Reasoning and Machine Learning**, Cambridge University Press, 2012, ISBN 978-0-521-51814-7.

Course Content

1. Module 1 (Bayesian Learning)

- Bayesian reasoning/inference – Priors, Posteriors, Conjugacy
- Bayesian Model Selection
- MAP Estimation
- Naive Bayes
- Bayesian Decision Theory
- Revisiting some of the familiar ML problems – regression etc. - in a Bayesian setting

Suggested Additional Reading:

a) James V. Stone, Bayes' Rule – A Tutorial Introduction to Bayesian Analysis, Sebtel Press, 2013, ISBN 978-0-9563728-4-0.
b) Andrew Gelman et. al., Bayesian Data Analysis, CRC Press, 2014. ISBN-13:978-1-4398-9820-8.
c) Isabelle Guyon, "Model Selection: Beyond the Bayesian/Frequentist Divide", IJMR 11 (2010) 61-87.

2. Module 2 (Graphical Models, Markov Conditions, Causal Networks)

- Basics – Chain rule, conditional independence, Markov Conditions, d-separation rule.
- Causal Networks and the do-calculus
- Inference in BBN – Junction Tree Algorithm, Variational Methods, MCMC Method
- BBN Structure Learning
- Gaussian and Hybrid BBNs

Suggested Additional Reading:

a) Richard E. Neapolitan, Learning Bayesian Networks, ISBN-13: 978-0130125347.
b) Kevin Murphy, Ph.D Thesis, UC Berkeley, 2002.
c) David Heckerman, "A Tutorial on Learning With Bayesian Networks", MSR Technical Report, 1996.
d) Judea Pearl, "Causality: Models, Reasoning and Inference", 2nd Edition, Cambridge University Press, 2009, ISBN-13: 978-0521895606

3. Module 3 (Time Series and Continuous Time Markov Systems)

- Stationary Processes

- ARMA Models
- State-Space Models – Kalman Filters
- Spectral Analysis

Suggested Additional Reading:

a) Peter Brockwell and Richard Davis, "Introduction to Time-Series Analysis and Forecasting", Springer, 2002, ISBN 0-387-95351-5.
b) Duglas Montgomery et. al., Introduction to Time Series Analysis and Forecasting, Wiley Interscience, 2008. ISBN 978-0-471-65397-4.
c) Open Textbook on Time Series Analysis from Dell.
d) Greg Welch and Gary Bishop, "An Introduction to the Kalman Filter", SIGGRAPH 2001.

4. Module 4 (Mixture Models)

- Gaussian Mixtures and k-Means
- Mixtures of Multinoullis
- Latent Variable Models
- Mixture of Experts, Indicator Models, Mixed Membership Models

Suggested Additional Reading:

a) Franck Picard, "An introduction to mixture models", Technical Report, Statistics for Systems Biology Group, France, 2007.

5. Module 5 (Neural Networks and Deep Learning)

- Neural Networks
- Issues: Starting Values, Overfitting, Scaling of the Inputs, Number of Hidden Units and Layers, Multiple Minima.
- Hopfield Networks, Boltzman Machines, Adaptive Maps
- CNN and Deep Learning

Suggested Additional Reading:

a) James A. Anderson. "An Introduction to Neural Networks". The MIT Press. 1995. ISBN 0-262-01144-1.
b) David Kriesel, A Brief Introduction to Neural Networks.
c) Draft of the to be released book on Deep Learning from MIT Press – Deep Learning

6. Module 6 (Survey of Adaptive Learning)

- Query Strategies
- Adaptive Learning Paradigms – Semi-Supervised Learning, Reinforcement Learning, Submodular Optimization

Suggested Additional Reading:

a) Settles, Burr (2010), "Active Learning Literature Survey" (PDF), Computer Sciences Technical Report 1648. University of Wisconsin–Madison.

b) Simon Tong, “ACTIVE LEARNING: THEORY AND APPLICATIONS”, Ph.D Thesis, Stanford University, 2001.

c) Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning – An Introduction”, MIT Press, 2012.

d) Olivier Chapelle, Bernhard Sch¨olkopf and Alexander Zien, “Semi-Supervised Learning”, MIT Press, 2006. ISBN 978-0-262-03358-9.

e) Csaba Szepasvari, Algorithms for Reinforcement Learning – Lecture published in the “Synthesis Lectures on Artificial Intelligence and Machine Learning” series by Morgan & Claypool Publishers. June 2009.

Assessments

The evaluation will include three components, all of which carry equal weight:

- There will be small implementation experiments/projects for each module which the students are expected to carry out in small groups (at most 3 in each group).
- Participation in In-Class and offline discussions on LMS on problems posted.
- There will be a class test after every module.
- A reasonably big project on something related to the modules listed above.

Additional References:

3. Christopher M. Bishop. “Pattern Recognition and Machine Learning”. Springer. 2006. ISBN 978-0387-31073-2.

Course Proposal Template

Course Name	**Cyber Security – Fundamentals with tools and techniques for defense**
Course Proposer Name(s)	Dr. Tricha Anjali
Course Instructor Name(s)	1. Dr. Harish Ramani, M.Sc | Ph.D (Australia) | CEH | CND | CHFI | ECSA | CEI | ISO 9001:2015 IA 2. Mr. Mohan Ram C, M.Tech (IIT-Roorkee) - FISST
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Select one from the following: • Core • Elective • Preparatory-Mandatory • Preparatory-Optional • Special Topics
Credits	40 hrs.
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F) • Satisfactory/Unsatisfactory (S / X)
Area of Specialization (if applicable) **CSE** – Computer Science and Engineering **DS** – Data Sciences **NCS** – Networking & Communication and Signals **ES** – Embedded Systems **SoC** - System on Chip	CSE & NCS
Semester	Term: (I / II / III / Prep) Academic Year:
Pre-Requisites (where applicable, specify exact course names)	
Basic IT knowledge and operation of computers	
Course Description	
It is comprehensive basic course to learn the most effective steps to prevent attacks and detect adversaries with actionable techniques that one can directly apply when they get to use these tools and techniques. Also, this course sets basic knowledge for any advanced topics for specialization the students wish to pursue as a career in Cyber Security. Build a lucrative and futuristic career in the field of Cyber Security (on date at salaries are peaking to premium, as India / World goes Digital way …). According to NASSCOM, the estimated demand for security workforce to rise globally to six million by 2019, up from 4 million in 2015, with projected shortfall of 1.5 million (https://www.gadgetsnow.com/tech-news/Cybersecurity-to-create-1million-jobs-Nasscom/articleshow/51884133.cms)	

The participant will learn tips and tricks from the best of the experts from a mix of industry & academia, so that they can win the battle against the wide range of cyber adversaries that want to harm the enterprises' IT environment.

Course Content

Module 1 – Cyber Security Foundation Module – 10 hours

- Introduction & Overview of Cyber Security
  - CIA Triad
  - Physical Security
  - Social Media Security
  - Phishing
  - Defense in Depth – Classical Military
  - Defense in Depth – Information Security
  - Authentication
  - Passwords
  - What make a good password
  - Password – Chunking Theory
  - Password Security Implications
  - How Passwords work : Creation
  - How Passwords work : Storage
  - How Passwords work : Comparison
  - Password Cracking
  - Authorization
  - Application Security
  - Cross site Scripting
  - Mitigating XSS
  - CSRF
  - Security Misconfiguration
  - SQL Injection
  - SQLMap – Demo
  - Broken Auth & Session Management
  - Introduction To Crypto
  - Introduction to Digital Signature

Module 2 – Critical information infrastructure security including Physical Security for protection of IT Assets – 8 hours

- Physical Security Introduction
  - Introduction
  - Definition
  - Physical Security Design
  - Physical Security protection
  - Physical Protection system plan
  - Physical Security Destruction Plan

- Sample EASI
    - PPS Plan Objectives
    - Goals of Information Security
    - Physical Security Requirements
    - Goals of Physical Security
    - Cases Studies
    - Layered Defense Model
- Perimeter / Boundary Security
    - Layered Defense Model
    - Centralized Security Operations
    - Perimeter – First line of protection
    - Asset Protection
    - Quickly Deployable microwave complex
    - Control Room Connection
- Building Security
    - Second Line of protection Security at the Building / Factory / Unit
    - 3rd Eye – Hidden IOT Sensors to Improve security & Compliance
    - Remote Sites with Cyber Security
- Inside Building with back end command & control System
    - Alerts + Analytic & Forensic Layer
    - Vehicle ID using RFID tags
    - Layered Defense Model
    - Assets Tracking System (ATS)
- Overview of IOT devices Security & Concerns
    - The Case Study IOT based Baby Monitor hacked
    - The Case Study for Mirai Botnet
    - Sim cloning
    - Vulnerabilities of ATM
    - Skimming Trends
    - Malware threats
    - Security Consideration for IoT
    - Use Case
        - 1: Sophisticated ATM attack Methodology
        - 2: IoT and User Authentication at Branch Office
    - Introduction to other IoT Devices
        - IoT Growth Story
        - IoT Challenges
        - Security issues
        - IoT Security – Hardware Issues
        - IoT security Solution
    - Summary

Module 3 – Introduction to Digital Forensics – 10 hours

- Forensics of file system analysis

- Registry forensics
- Memory forensics
- Browser forensics
- Windows log file analysis
- Network forensics

Module 4 – introduction to some tools and techniques for Assess, Predict, Detect and Protect – 12 hours

- **General threats - Lab - 1**
  - How bypass windows passwords
  - Mobile hacking
  - Gathering information from system using USB
  - Nirsoft tool
  - Https based Phishing (anomor)
  - Javascript based information gathering (ipleak)
  - DOS Attack

- **Network Security tools**
  - NMAP
  - Packet Tracer
  - Wireshark
  - ETS 4
  - Fibaro

- **Cryptography Lab**
  - Crypt tool
  - WinHex
  - Cain & Able
  - HMAC
  - Diffie Hellman key exchange
  - RSA
  - S-Tool
  - Xiao
  - Wireshark – SSL key exchange
  - GPG4Win

- **Host Security & Application Security**
    - Acunetix
    - Belarc Advisor
  - Server log Analysis
    - Sawmill

Assessments (optional for Special Topics courses)
Quiz and Assessments at end of every module
Text Book / References
Various sources – mainly web research

***Prep Term**: July;* ***Term I**: Aug – Nov;* ***Term II**: Jan – Apr;* ***Term III**: Jun – July;*

Course Proposal

Course Name	**Reinforcement Learning**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS / SP-PR
Semester	Fall (Aug-Dec) - 2019

Pre-Requisites (where applicable, specify exact course names)

At least one of the following:

- Maths for ML
- Machine Learning – I
- Introduction to Text Processing and Information Retrieval
- Machine Perception
- ASR

Course Description

This course is intended to be an intense, in-depth course in Reinforcement Learning. The focus will be on setting up the formal foundations for RL and giving a flavour of the recent developments in Deep Reinforcement Learning, the amalgamation of deep neural networks and RL that has propelled what remained an obscure field of study till as late as a decade ago into the forefront of machine learning / AI research. The primary references for this course would be:

1. Dmitri P. Bertsekas, **Dynamic Programming and Optimal Control – Vol I & II**, 4th Edition, Athena Scientific, Belmont, Massachusetts, 2017.
2. Dimitri P. Bertsekas and John N. Tsitsiklis, **Neuro-Dynamic Programming**, Athena Scientific, Belmont, Massachusetts, 1996.

3. Richard Sutton, **Reinforcement Learning – An Introduction**, MIT Press, 2017, ISBN 978-0-521-51814-7. http://incompleteideas.net/book/bookdraft2017nov5.pdf

   The '**Suggested Reading**' Lists given for the modules detailed below, refer to material other than what you can expect to be covered in these books mentioned above.

Course Content

1. **Module 0 (Some Math Preliminaries)**: *(2-3 Lectures)*
   - Markov Chains and MDPs
   - Kalman Filters
   - Linear Stochastic Systems
   - Importance Sampling

   Suggested Reading:

   a) Greg Welch and Gary Bishop, An Introduction to the Kalman Filter, ACM SIGGRAPH Course 8, 2001 [pdf]
   b) Art B. Owen, Monte-Carlo Theory, Methods and Examples – book Manuscript, Chapter 9: Importance Sampling, [pdf]. The other chapters of the book can be accessed from [html]
   c) P.R. Kumar and Pravin Varaiya, Stochastic Systems: Estimation, Identification and Adaptive Control, Prentice Hall, 1986. Chapters 2-3. [pdf]

2. **Module 1 (Psychology & Neuroscience Motivation)**: *(1-2 Lectures)*
   - Pavlovian conditioning, Operant / Instrumental Conditioning
   - Neuroscience Basics, Dopamine, Basal Ganglia
   - Neural Actor-Critics

   Suggested Reading:

   d) Florentin Worgotter and Bernd Porr, Temporal Sequence Learning, Prediction, and Control - A Review of different models and their relation to biological mechanisms [pdf]
   e) Bar-Gad, I., Morris, G., Bergman, H.: Information processing, dimensionality reduction, and reinforcement learning in the basal ganglia. Progress in Neurobiology 71, 439–473 (2003)
   f) James Knierim, Basal Ganglia, [html]
   g) Brandon, S.E., Vogel, E.G., Wagner, A.R.: Computational theories of classical conditioning. In: Moore, J.W. (ed.) A Neuroscientist's Guide to Classical Conditioning, ch. 7, pp. 232–310. Springer, New York (2002)
   h) E. James Kehoe and Michaela Macrah, Fundamental Behavioural Models and Findings in Classical Conditioning, in "A Neuroscientist's Guide to Classical Conditioning", Ed John W. Moore, Springer 2002 [pdf]
   i) Yael Niv, The Neuroscience of Reinforcement Learning, ICML Tutorial 2009 [pdf]

3. **Module 2 (Introduction, Overview)**: *(1-2 Lectures)*
    - Basic Concepts and Terminology: Environment, Agent, State, Value Function, Actions and Policy, Reward, Prediction vs Control, Finite (Episodic) vs Infinite Horizon Tasks, Bandits, ...
    - Sequential Decision Making, MDP, RL vs Dynamic Programming
    - Model-Free RL Methods and Model-based RL Methods
    - Role of Function Approximators and Deep Learning in RL
    - RL Resources; Simulation Platforms; Practical Considerations

4. **Module 3 (Problem Formulation & Solution Taxonomy)**: *(3-4 Lectures)*
    - RL Problem Formulation, Bellman Equations, Optimality Criterion
    - Existence of Optimal Solutions; Shrinkage/Contraction, Monotonicity Arguments
    - Discounting and its implications
    - Solution Approaches

→→→→

Dynamic Programming	**Reinforcement Learning**
Exact Methods for Known/Small Environments	Approximate Methods for Unknown/Large Environments
Finite Horizon	Infinite Horizon
Deterministic	Stochastic
Model-based (Known/Assumed model of the world)	Model-free (Learning from Simulations)

5. **Module 4 (Exact Dynamic Programming)**: *(3-4 Lectures)*
    - Value Iteration; Policy Iteration; Hybrids
    - Convergence Properties
    - Stochastic DP and other variants
    - Infinite Horizon DP --- Stochastic Shortest Path problems, Discounted Cost MDPs

6. **Module 5 (Approximate DP / Reinforcemcnt Learning)**:
    - *Tabular Methods*: Monte-Carlo and Temporal Difference Methods, Eligibility Traces, Sarsa, Q-Learning, Rollout Algorithms (5-6 Lectures)
    - *Batch RL*: experience replay mechanisms; Least Square methods for policy iteration *(5-6 Lectures)*
    - *Using Function Approximators*: DQN, Policy Gradients --- REINFORCE / TRPO / PRPO, Actor-Critic Methods *(5-6 Lectures)*

Suggested Reading:

a) Csaba Szepasvari, Algorithms for Reinforcement Learning – Lecture published in the "Synthesis Lectures on Artificial Intelligence and Machine Learning" series by Morgan & Claypool Publishers. June 2009. [html]
b) Playing atari with deep reinforcement learning (2013), V. Mnih et al. [pdf]
c) Prioritized experience replay (2015), Tom Schaul et. al., [pdf]
d) Deep Reinforcement Learning with Double Q-Learning (2016), H. Hasselt et al. [pdf]
e) Deep Reinforcement Learning: An Overview (2017), Y. Li, [pdf]
f) V. Mnih et. al.,, Asynchronous Methods for Deep Reinforcement Learning [pdf]
g) John Schulman, Optimizing Expectations from Deep Reinforcement Learning to Stochastic Computation Graphs, Ph.D Thesis, University of California, Berkeley, 2016 [pdf]
h) John Schulman et. al.,, Proximal Policy Optimization Algorithms [pdf]

7. **Module 6 (Topics in Deep Reinforcement Learning)**: *(3-4 Lectures)*
   - Bayesian Reinforcement Learning
   - Reinforcement Learning in Continuous State-Action Spaces --- DDPG
   - Game Theory and Multiagent RL
   - Partially Observable MDPs

Suggested Reading:

a) Mohammad Ghavamzadeh et. al., Bayesian Reinforcement Learning: A Survey [pdf]
b) ICML-07 Tutorial on Bayesian Methods for Reinforcement Learning [html]
c) Nikos Vlassis et. al., Bayesian Reinforcement Learning, Technical Report [pdf]
d) Timothy P. Lillicrap et. al., Continuous Control with Deep Reinforcement Learning [pdf]
e) Thanh Thi Nguyen et. al., Deep Reinforcement Learning for Multi-Agent Systems: A Review of Challenges, Solutions and Applications [pdf]
f) L. Busoniu, R. Babuska, and B. De Schutter, A comprehensive survey of multi-agent reinforcement learning, IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, vol. 38, no. 2, pp. 156–172, Mar. 2008 [pdf]
g) State of the Art Leaderboards for Multiagent RL [html]
h) Tony's POMDP Page [html]
i) Kevin P. Murphy, A Survey of POMDP Solution Techniques, September 2000 [pdf]

Assessments

The evaluation will include four components –- the weightage out of 100 for each component is shown in brackets.
• 3 Assignments (**30**)
  ○ *Tentative Dates for the start of the assignments*: **Sep 16**, **Oct 21**, **Nov 25**
  ○ *Time*: **1 Week**
 	
• RL project --- theory or implementation (**30**)
  ○ *Start*: Asap
  ○ *Submission*: **Dec 4**
 	
• 3 Online Quizzes (**30**)
  ○ *Tentative Dates for the quizzes*: **Sep 4**, **Oct 16**, **Nov 27**
 	
• Paper Reading Report/Presentation (**10**)
  ○ *Start*: **Sep 2**
  ○ *Submission*: **Between Nov 9 and Nov 20**

CS 302: Introduction to Automata Theory and Computability
Fall 2020

Syllabus

- **Instructor**:

  Prof. Shrisha Rao <srao@iiitb.ac.in>

- **TAs**:

  Aayush Grover <aayush.grover@iiitb.org>
  Aditya Gulati <aditya.gulati@iiitb.org>
  Akshi <akshi.025@iiitb.org>
  Gopalakrishnan Venkatesh <gopalakrishnan.v@iiitb.org>

- **Class Time**:

  Tue & Thu: 13:30 PM – 15:00 PM

  Discussion sessions:

  Friday: 11 AM – 12 PM, OR 2 PM to 3 PM

- **Course Objectives**:

  (i) To understand the basic concepts in the theory of computation and automata theory.

  (ii) To understand the formal description of a computer as a Turing Machine.

  (iii) To understand the formal equivalence of formal languages and problems, and results like the Halting Problem.

  Note: This class has prerequisites—specifically, knowledge of discrete mathematics (especially proofs, basic set theory, and elementary logic), and possibly one programming language as well. Please work on firming up the prerequisites if necessary.

- **Suggested Texts:**

  (i) *Computability: Computable Functions, Logic, and the Foundations of Mathematics*, 2nd ed., by Epstein and Carnielli, Wadsworth/Thomson Learning, ISBN 0-534-54644-7.

  (ii) *Introduction to Automata Theory, Languages, and Computation*, 2nd ed., by Hopcroft, Motwani, and Ullman, Addison-Wesley, ISBN 0-201-44124-1.

  (iii) *Introduction to the Theory of Computation*, by Sipser. Thomson Learning, ISBN 981-240-226-8.

  (iv) *Languages and Machines*, 2nd ed., by Sudkamp. Addison-Wesley, ISBN 0-201-82136-2.

- **Letter Grade Distribution**: (Subject to change)

  A = 80th percentile and above
  B = 50th–80th percentile
  C = 10th–50th percentile

- **Course Outline**: Major Topics (take this as a plan, not a contract)

  - General mathematical background
  - Finite Automata, Regular Expressions
  - Turing Machines
  - Computability
  - Church's Thesis
  - Primitive Recursive Functions
  - Partial Recursive Functions
  - Undecidability

  We will cover chapters 1–5 and 8 of Hopcroft, *et al.*, and chapters 1–6 and 8–20 of Epstein, *et al.*

- **Policies and Hints**:

  ACADEMIC HONESTY

  1. Students are advised to look at `http://www.plagiarism.org/` and other such resources carefully to educate themselves in this important aspect of academic honesty.
  2. Other misconduct includes, but is not restricted to, copying in an assignment or examination. In case a student gives inappropriate help to another, both will suffer the same penalty.

HOMEWORK

1. All written work (assignments, project documents, papers) done as part of this course must be typeset neatly in Latin Modern Roman size 12 using LaTeX 2ε with the standard classes `article`, `report`, `memoir`, and with the default settings for margins, spacings, and other things. (Adding the line `\usepackage{lmodern}` in the preamble will cause the document to be typeset in Latin Modern.) Other TeX-based document systems like XeTeX, or IDEs like LyX, may be used, with the same classes and defaults. The use of MS Word, Libre Office, etc., is not permitted, and documents prepared using them will not be accepted.
2. There will be several homework assignments. Homework submission *must be on time*. An exception can only be made when there is previous notice given of a need, and when there is just reason for an extension—in the instructor's judgment, not the student's. Late submissions otherwise will attract a penalty, and may also be rejected. Homework is to be submitted on paper, and will not be accepted by electronic mail or other means. Missed assignments are grounds for a failing grade (even if there are enough points from other work to earn a passing grade).
3. It is strongly recommended that a start on homework be made early, as soon as it is assigned (or made available on LMS). The problems are meant to foster thinking, and working on solving them is an integral part of learning. As such, rushed work will not suffice. Homework assignments will generally take at least ten hours of effort each to complete.
4. A student may orally collaborate to understand homework problems, but may not share any written solutions. On each problem that is handed in, the names of the others with whom the student has had discussions concerning the solution must be stated. The student must indicate whether (s)he gave help, received help, or worked something out together. Failure to do this will be considered cheating.
5. The class is geared toward fostering excellence in a core area of computer science, and every student is expected to make a committed effort at meeting the challenge. It is expected that there will not be many mediocre results in this class. Either a student will do very well (i.e., get an A or a high B) or fail completely (withdraw or F). A student who works hard for an A in this class will probably get it, but a student who attempts to get a mere passing grade will probably not.

- **Students' Responsibilities**:

  - Attend classes as far as possible and participate actively in them.
  - Complete all assigned homework satisfactorily.

- **Grading**: Letter grade of A–D, F, I.

CS 702: Distributed Computing

Syllabus & Notes

1. **Instructor**: Shrisha Rao `<srao@iiitb.ac.in>`

2. **Class Time**: 11:15–13:15 Tuesday, Thursday.

3. **Description**: This is an *advanced* course in distributed computing, with students expected to do a lot of independent reading and presentations in class. There will be one conventional examination, and some assignments will be given, but a student will also be required to do a study or a project, and will be encouraged to write a research paper on a chosen topic.

   NB: Every student must be at least *adequate* in regular class work and independent study/project, but *excellent* in at least one.

4. **Textbook**: Distributed Computing (2d ed.) by H. Attiya and J. Welch, Wiley, 2004.

   Also recommended: Distributed Algorithms by N. A. Lynch, Morgan Kaufmann, 1996.

5. **Prerequisites**: This course requires a significant understanding of operating systems principles (particularly IPC, mutual exclusion, and the like), as well as mathematics and theoretical CS. Tt is required that students demonstrate having such background. The formal prerequisites are:

   - (For iMTech students:) CS 551: Introduction to Automata Theory and Computability, with a grade of B or better.
   - (For MTech students:) CS 601: Theory of Computation, with a grade of B or better.

   MTech students who have not taken CS 601 may be permitted to enrol provided that their BTech discipline was computer science, and if they have a good GATE score in CS. No waiver is applicable for iMTech students.

6. **Readings**:

   ↪ Marktoberdorf Summer School:
   `http://asimod.in.tum.de/`

   ↪ ACM SIGACT News Distributed Computing Column:
   `http://webee.technion.ac.il/~idish/sigactNews/`

   ↪ TARK conference:
   `http://www.tark.org`

   ↪ PODC conference:
   `http://www.podc.org`

   ↪ IPDPS conference:
   `http://www.ipdps.org/`

   NB: Other readings may be suggested occasionally.

7. **Focus Areas**:

   - Distributed algorithms basics
   - Correctness and fault-tolerance
   - Failure models and impossibility results
   - Application topics
   - Any other topics chosen by students

8. **Course Objectives**:

   - To give students a chance to appreciate the theory of distributed computing.
   - To enable students to mature professionally by interacting as independent, peer learners with good communications skills.

9. **Project Notes**:

   - A project *per se* is not needed, but can be done provided it is innovative and not merely an implementation of existing ideas. Each project idea needs instructor approval.
   - Each project must be undertaken by a single student, or at most by two working together. (Homework assignments must be done individually.)

- A project must follow suitable standards in documentation, coding, and reporting. (It is expected that any project undertaken will produce a real-world artifact of some note.)

10. **Students' Responsibilities**:

    - Attend all classes and participate actively in them, including making required presentations.
    - Study assigned materials.
    - Complete all assigned work satisfactorily.
    - Choose a project or research topic in consultation with the instructor, complete it satisfactorily, and report the results in a class presentation and suitable external means.

11. **Grading**: Letter grade of A–D, F (*sans* + or −).

CS 703: Automated Formal Verification

Meenakshi D'Souza
<meenakshi@iiitb.ac.in>

1. **Class Time**: Mondays and Tuesdays, 2:00 PM to 3:30 PM

2. **Description**: Formal verification methods are mathematical techniques and tools to formally prove properties about programs. After several decades of research, there is now success in terms of several formal methods based tools being used by industry, for e.g, NASA, IBM, Microsoft, Seimens, ABB etc. This course will cover topics and tools in two areas of formal verification methods: model checking and program analysis. ACM Turing award in 2008 was given to the poineers of model checking.

3. **Reference books and material:**

   - Edmund M. Clarke, Orna Grumberg and Doron A. Peled, *Model Checking*, MIT Press, 1999.
   - Christel Baier and Joost-Pieter Katoen, *Principles of Model Checking*, MIT Press, 2008.
   - Some sample papers for the program analysis part of the course:
     - P. Godefriod, Nels Klarlund and Koushik Sen, DART: Directed Automated Random Testing, *Proc. PLDI 2005*, 2005.
     - J. C. King, Symbolic Execution and Program Testing, *Communications of the ACM*, 19(7): 385-394, 1976.
     - Bhargav S. Gulavani, Thomas A. Henzinger, Yamini Kannan, Aditya V. Nori, and Sriram K. Rajamani, Synergy: A New Algorithm for Property Checking, in *Proc. of 14th FSE*, ACM SIGSOFT Distinguished Paper, 2006.

- Patrice Godefroid, Peli de Halleux, Michael Y. Levin, Aditya V. Nori, Sriram K. Rajamani, Wolfram Schulte, and Nikolai Tillmann, Automated Software Testing Using Program Analysis, in IEEE Software, IEEE Computer Society, October 2008.

4. **Prerequisites:** Discrete Mathematics, Algorithms, Automata Theory, Computability (Decidability and Undecidability of problems).

5. **Outline of Course Content**:

   This course will include the following major topics.

   - Introduction to Formal Verification.
   - Model checking: Modeling systems as Kripke structures, temporal logics (CTL, CTL* and LTL), CTL model checking, binary decision diagrams, symbolic model checking, NuSMV tool, SAT-based methods, handling state space explosion, abstraction techniques, modeling exercise involving the open source tool NuSMV.
   - Verifying programs: Basics of program analysis, symbolic testing techniques, techniques combining program analysis and testing to prove programs correct.

6. **Methods and Activities**: This course will be taught over a semester. There will be several lectures, class tests, mid-semester and final exams. There will be a small modeling and verification project as a part of the course.

7. **Grading**: Letter grade of A–D, F, I.

Course Proposal Template

Course Name	*CS 826:* **Fully Homomorphic Encryption & Applications**
Course Proposer Name(s)	Srinivas Vivek
Course Instructor Name(s)	Srinivas Vivek
Course branch	**CSE**
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	**Special topics**
Credits	**4**
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DS – Data Science ES – Embedded Systems SoC – System on Chip ITS – IT & Society NCS – Networking, Communication, and Signal Processing SE – Software Engineering	CS/ES/NCS
Semester	Term: Spring Year: 2019

Pre-Requisites (where applicable, specify exact course names)

CS/NC 616 Foundations of Cryptography **or** CS 873 Cryptographic Engineering **or** Instructor's consent

Course Description

Outsourcing of data and computation to cloud is happening at a faster pace than before. This is due to the availability of cloud storage and computing at more affordable prices, and also due to the increased availability of cloud applications. This inevitably entails privacy concerns about the outsourced data. (Fully) Homomorphic Encryption (FHE) is a powerful cryptographic primitive that enables computation on encrypted outsourced data. Unlike secure multi-party computation protocols that also enable computation on encrypted data, in FHE there is no need for any additional interaction with the cloud to do the computation hence potentially needing lesser communication bandwidth. In this course we will study FHE and related primitives, the techniques behind their construction, security analysis, and applications. Students are expected to have good mathematical maturity and some basic knowledge of cryptography is necessary as indicated above.

Course Outline

- Recall of semantic security notion for encryption schemes
- Homomorphic encryption schemes supporting only one type of operation: RSA, multiplicative/additive ElGamal, Goldwasser-Micali, Paillier
- Partially homomorphic encryption schemes: Boneh-Goh-Nissan

- Somewhat/fully homomorphic encryption schemes: Gentry's blue print including bootstrapping, ideal-lattice based schemes (BGV, FV, LTV, YASHE), integer-based schemes (DGHV), LWE-based schemes (GSW)
- Introduction to S/FHE libraries: HElib, SEAL
- Applications in e-voting, bio-informatics, image processing, machine learning

Assessments (optional for Special Topics courses)
The evaluation scheme depends on the number of participants in the course and will be communicated at the beginning of the course. Broadly, it will consist of scribing, mid-term and end-term examinations, presenting technical papers, and a mini project.

Text Book / References

1. A Survey on Homomorphic Encryption Schemes: Theory and Implementation. ACM Computing Surveys, September 2018, *and the references there in*.
2. Introduction to Modern Cryptography, 2nd Edition. Authors: Yehuda Lindell, Jonathan Katz. CRC Press.

***Spring Term**: Jan – Apr; **Summer Term**: Jun – July; **Prep Term**: July; **Fall Term**: Aug – Nov*

Course Handbook : CS-835 Algorithmic Thinking

Course Name	Algorithmic Thinking
Course Proposer Name(s)	Ashish Choudhury
Course Instructor Name(s)	Prof. C. Pandu Rangan
Course Type	Special topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS
Semester	Term II, Academic Year 2018-19

Pre-Requisites (where applicable, specify exact course names)

Knowledge of basic data structures and some programming experience plus lots of mathematical maturity is needed.

Course Description

This course aims to build a new style of thinking appropriate for problem solving using Computers. While mathematical-thinking is needed for problem solving, algorithmic thinking is for problem solving using tools (parallel or distributed, security, in any context for that matter). So, algorithmic thinking will be a great value.

Similar course has been already offered by the instructor at various IITs and IISc with tremendous success. The course will have minimal overlap with the topics covered in a typical algorithm or advanced algorithms course. Similar course has been also offered for the industry people in the past, for example at IBM Tokyo, Samsung South Korea, Infosys, TCS and NTT, Docomo labs Japan, just to name few industries, where the course contents and overall offering has been widely appreciated.

Course Content

The following is the tentative list of topics to be covered in this course.

- Review of basic paradigms - incremental, decremental, pruning, Divide and conquer, Dynamic programming, preprocessing, Lazy computations. Here we will have completely different set of case studies and examples with only 20% overlap with any traditional books/course coverage. The objective here is to promote advanced problem solving skills and intuition development. insight and connections and patterns of thoughts are most important here.

- Intermediate algorithmic design - reductions and transformations (case studies), Methods of iterated improvements, Matching, network flows, LP , unifying techniques of combinatorial optimization
- Advanced algorithms - Approximate algorithms, greedy paradigm, layering technique, local search, Primal dual strategies
- Randomized algorithms - Las vegas, Monte carlo methods, Chernoff type bounds and their applications in analysis, Randomized attrition paradigm, one-sided and two sided errors, abundance of witness for Monte Carlo algorithms (case studies from Number theory on primality test, discrete log, factoring and quadratic residuacity), randomized incremental methods and backward analysis (sampling strategies)

Assessments

The tentative assessment plan is as follows:

4 assignments (30 marks), mid semester exam (30 marks) and final exam (40 marks). Exam questions will be based on class room discussions and assignments. A small set of exceptional students may be given the option of seminar and term paper in place of final exam.

Text Book / References

There is no single text book covering all the topics. We will be covering various topics from various resources, which will be discussed as and when a particular topic will be covered.

Course Proposal

Course Name	Advanced Computer Graphics
Course Proposer Name(s)	Jaya Sreevalsan-Nair and T. K. Srikanth
Course Instructor Name(s)	Jaya Sreevalsan-Nair and T. K. Srikanth
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	Special Topics (Level 2)
Credits	4
Grading Scheme	9-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable)	Computer Science
Semester	Term: Fall Term Year: 2014

Pre-Requisites (where applicable, specify exact course names)

Computer Graphics (CS606)

Course Description

The goal of this course is to explore advanced topics in Computer Graphics. This course builds on the foundation of the core principles of interactive computer graphics and provides a hands-on understanding of recent innovations in this field, specifically in the areas of rendering, modeling, animation and real-time graphics. This course will help students to deepen their understanding of several key algorithms and techniques used in graphics and related areas; and also improve their skills for developing as well as measuring performance of complex graphics applications. This course will be driven by students undertaking technical presentations, writing, and programming.

Course Content

Rendering (Weeks 1-4)

- Global Illumination and Monte Carlo Rendering
- Ray tracing
- Radiosity

Modeling (weeks 5-8)

- Meshes: adaptive refinement, mesh simplification, wavelets, mesh smoothing and fairing
- Volumetric representations

Animation (weeks 9-12)

- Inverse Kinematics
- Collision detection and Intersections
- Physically based modeling, Cloth Modeling

Real-time Rendering (weeks 13-16)

- GPU's and GPGPU's
- Level of Detail and Multi-resolution modeling
- Spatial data structures

Additional topics published in recent ACM Siggraph conferences under these 4 modules will also be discussed in class.

Assessments (optional for Special Topics courses)

Seminar presentations: 30%. Each student will review and present two papers (and related developments) during the semester. This will include writing technical reports.

Class Participation: 10%. All students are expected to read the assigned papers and participate in class discussions

Mini-project: 20%: A programming assignment that explores specific graphics tools and frameworks

Main project: 40%: A collaborative project where each student will implement a set of features or sub-system of a larger project.

Books / References

The set of papers covering the seminar topics will be provided at the beginning of the course. In addition, the following books are recommended:

- Matt Pharr, and Greg Humphreys, Physically Based Rendering, Second Edition: From Theory To Implementation, Morgan Kaufmann, 2010.
  1. Resources for the textbook is available at http://www.pbrt.org/
- Real-Time Rendering, Third Edition, by Tomas Akenine-Möller, Eric Haines, and Naty Hoffman, A. K. Peters/CRC Press, 2008.
  1. Resources for the textbook is available at http://www.realtimerendering.com/

***Spring Term**: Jan – Apr; **Summer Term**: Jun – July; **Prep Term**: July; **Fall Term**: Aug – Nov*

Course Proposal Template

Course Name	Compilers
Course Proposer Name(s)	Sujit Kumar Chakrabarti
Course Instructor Name(s)	Sujit Kumar Chakrabarti
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Select one from the following: • Elective
Credits	
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E –** Networking & Communication and Embedded Systems **SE** – Software Engineering	(Choose at most two areas from the list) SE, CS
Semester	Term: I

Pre-Requisites (where applicable, specify exact course names)

Data-structures and algorithms
Basic Knowledge of Automata Theory and Theory of Computation
Proficiency in programming with at least a couple of programming languages (e.g. C++, Java, Ocaml, Haskell etc.)
Soft pre-requisite: Programming Language course

Course Description

Compilers is the second of our courses in the broader area of design and implementation of programming languages (PLDI), the first being Programming Languages. The course involves in-depth discussions on the implementation of compilers starting with lexical analysis through to code generation and optimisation. At the end of the course, the student will:

- have in-depth knowledge of the internal structure of a compiler for modern programming languages
- have implemented significant parts of a real compiler as stand-alone programming assignments and term project.

Course Content

- Compiler Structure
- Lexical Analysis
- Syntax Analysis
- Semantic Analysis
- Runtime Organisation
- Code Generation

- Code Optimisation
- Topics in Program Analysis

Assessments (optional for Special Topics courses)

Course project – 60%
Mid-term exam – 20%
End-term exam – 20%

Text Book / References

Compilers: Principles, Techniques, and Tools
- Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman
Advanced Compiler Design and Implementation
- Steven Muchnick
Modern Compiler Implementation using Java/ML
- Andrew Appel

Relevant literature

***Prep Term**: July;* ***Term I**: Aug – Nov;* ***Term II**: Jan – Apr;* ***Term III**: Jun – July;*

CS 872: Computational Sustainability

Syllabus

- **Instructor**: Prof. Shrisha Rao <srao@iiitb.ac.in>
- **Description**: This is a graduate-level course in computational sustainability, with students expected to do a lot of independent reading, project work, and presentations in class.

  There will be no conventional examinations, but some assignments will be given, and a student will be required to complete a project, and to write a paper, on a chosen topic. There is no specific textbook, but readings will be suggested.
- **Prerequisites**: This course requires a significant understanding of and depth in core CS areas—including but not limited to systems programming using C, shell scripting, and theoretical CS (algorithms, automata theory, etc.). Students lacking such background may find it difficult.

  Owing to the multi-disciplinary nature of the subject, the class also requires reading and writing ability of a very high quality, and in large quantity.

  The formal prerequisites are:

  - (For iMTech (CSE) students:) Grade of B or better in CS 202 Design and Analysis of Algorithms, EG 211 Computer Architecture, CS 302 Introduction to Automata Theory and Computability.
  - (For MTech (CSE) students:) Grade of B or better in CS 511 Algorithms, CS 512 Discrete Mathematics and Computability, and CS 513 Software Systems.

  MS and PhD students need approval from their advisors. MSc Digital Society and ECE students need explicit consent from the instructor.
- **Class Time**:

  Mon & Wed: 11:30 AM – 1 PM

NB: There will not be a live class session every week; some weeks there may only be a recorded lecture, or only student presentations.

- **Office Hours**:

  Mon/Tue: 2 PM – 3 PM, or by appointment

- **Course Objectives**:

  (i) To understand well the basic concepts—such as carbon footprint, renewable resources, energy efficiency, and smart technologies—that are involved in computational sustainability.

  (ii) To demonstrate mastery of some concepts in computational sustainability by completing a challenging project that involves solving a realistic problem.

- **Starting References:**

  (i) Gomes, C., et al. *Computational Sustainability: Computing for a Better World and a Sustainable Future*. Communications of the ACM, September 2019, Vol. 62 No. 9, Pages 56–65. doi:10.1145/3339399.

  (ii) Computational Sustainability Network. `https://www.compsust.net/`.

  (iii) Chatterjee, D, Rao, S. *Computational Sustainability: A Socio-Technical Perspective*. ACM Computing Surveys, vol. 53 (5), Article 101, 2020. doi:10.1145/3409797.

- **Letter Grade Distribution**: (Subject to change)

  A = 80th percentile and above
  B = 50th–80th percentile
  C = 10th–50th percentile

- **Scoring**:

  50%: Assignments and class participation
  50%: Project work and related activities

- **Course Outline**: Major Topics (take this as a plan, not a contract)

  – General ideas about sustainability: the Earth's carbon cycle, GHGs and their impacts

  – Concerns about ecology: pollution and hazardous wastes

- Renewable resources: describing renewables vs. non-renewables, concepts such as "reduce, reuse, and recycle"
- Renewable energy sources: important characteristics of solar and wind energy
- Green IT: sustainable computing, how to make computing more eco-friendly, DVFS and energy-efficient process management, PUE for a data center
- A selection of advanced and related topics: sustainabile manufacture, smart systems and technologies, electric vehicles

- **Policies and Hints**:

1. Every student is expected to check the LMS page for this course at https://learn.iiitb.net/ quite frequently (at least once a day) for new announcements and material that may be posted.
2. Students are advised to look at http://www.plagiarism.org/ and other such resources carefully to educate themselves in this important aspect of academic honesty. Inappropriately copying as much as a single line of text/source-code, or one small diagram, etc., will be grounds for setting the score on that assignment, project, etc., to zero, and more serious violations will attract severe penalties up to a failing course grade. It may be noted that the IEEE, which is an important professional society in our domain, has severe policies* for handling plagiarism which include banning offenders for years, and requiring them to write letters of apology which are published. Therefore, it is essential that students conduct themselves to the highest standards. *Note in particular that giving a citation is not a license to copy something wholesale.*
3. Other misconduct includes, but is not restricted to, copying in an assignment, project, or presentation. In case a student gives inappropriate help to another, both will suffer the same penalty.
4. All homework must be done individually, but projects must be done in a group of no more than three students together.
5. All written work (assignments, project documents, papers) done as part of this course must be typeset neatly in Latin Modern

*See http://www.ieee.org/publications_standards/publications/rights/Section_822.html, especially Section D, GUIDELINES FOR ADJUDICATING DIFFERENT LEVELS OF PLAGIARISM.

Roman size 12 using $\LaTeX\,2_\varepsilon$with the standard classes `article, report, memoir`, and with the default settings for margins, spacings, and other things. (Adding the line `\usepackage{lmodern}` in the preamble will cause the document to be typeset in Latin Modern.) Presentations are to be prepared using the `beamer` class. Other TeX-based document systems like XeTeX, or IDEs like LyX, may be used, with the same classes and defaults. The use of MS Word, Libre Office, etc., is not permitted, and documents prepared using them will not be accepted.

6. It is expected that all students will be familiar with, and will primarily use, Linux (or Mac OS X) for almost all their work in this course. Students should speedily acquire sufficient expertise in Linux if they do not already have it. Students will also need to know shell scripting; Unix regular expression syntax; how to download, compile, and install open-source software; etc.

7. Since the projects and homework assignments will involve writing significant amounts of program code for specific problems, students are likewise expected to be *proficient* in programming and algorithms. (A minimal ability is not acceptable.)

8. There will be several homework assignments, possibly three or more. Homework submission must be on time. Homework is to be submitted on LMS (with program code, sample runs, etc., also being submitted online as required), and will not be accepted by electronic mail or other means. Missed assignments are grounds for a failing grade (even if there are enough points from other work to earn a passing grade).

9. It is strongly recommended that a start on homework be made early, as soon as it is assigned (or made available on LMS). The problems are meant to foster thinking, and working on solving them is an integral part of learning. As such, rushed work will not suffice. Homework assignments will generally take at least ten hours of effort each to complete.

- **Methods and Activities**: This course will be taught over the course of a semester. There will be several lectures, traditional assignments, presentations. The students will each also have to choose, in consultation with the instructor, a significant individual project on computational sustainability, and complete it as a course requirement.

- **Students' Responsibilities**:
  - Attend all live sessions and participate actively in them, including making required presentations.
  - Study assigned materials.
  - Complete all assigned homework satisfactorily.
  - Choose an individual project in consultation with the instructor, and complete it satisfactorily.
- **Grading**: Letter grade of A–D, F, I.

Course Syllabus Template

<table>
<tr><td>Course Code / Course Name</td><td colspan="3">CS/DS 720: Topics in Artificial General Intelligence (AGI)</td></tr>
<tr><td>Course Instructor Name(s)</td><td colspan="3">Srinath Srinivasa</td></tr>
<tr><td rowspan="5">Credits (L:T:P)
(Lecture : Tutorial : Practical)</td><td>Hours</td><td colspan="2">Component</td></tr>
<tr><td>40</td><td colspan="2">Lecture (1hr = 1 credit)</td></tr>
<tr><td>8</td><td colspan="2">Tutorial (1hr = 1 credit)</td></tr>
<tr><td></td><td colspan="2">Practical (2hrs = 1 credit)</td></tr>
<tr><td>L:T:P = 10:8:0</td><td colspan="2">Total Credits = 4</td></tr>
<tr><td rowspan="2">Grading Scheme
(Choose by placing X against appropriate box)</td><td>X</td><td colspan="2">IIITB scale (A,A-,B+,B,B-,C+,C,D,F)</td></tr>
<tr><td></td><td colspan="2">Satisfactory/Unsatisfactory (S / X)</td></tr>
<tr><td colspan="4">Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)</td></tr>
<tr><td>X Theory and Systems for Computing and Data</td><td></td><td></td><td>Networking and Communication</td></tr>
<tr><td>X Artificial Intelligence and Machine Learning</td><td></td><td></td><td>Digital Society</td></tr>
<tr><td>VLSI Systems</td><td></td><td></td><td>Cyber Security</td></tr>
<tr><td>General Elective</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><td>Programme / Branch</td><td>Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)
Programme: Branch:
<table>
<tr><td></td><td>iMTech</td></tr>
<tr><td>X</td><td>M.Tech</td></tr>
<tr><td></td><td>M.Sc.</td></tr>
<tr><td>X</td><td>CSE</td></tr>
<tr><td></td><td>ECE</td></tr>
<tr><td></td><td>Digital Society</td></tr>
</table></td></tr>
<tr><td>Course Category</td><td>Select <u>one</u> from the following:
(Place X appropriately)
<table>
<tr><td></td><td>Basic Sciences</td></tr>
<tr><td></td><td>CSE Core</td></tr>
<tr><td></td><td>ECE Core</td></tr>
<tr><td>X</td><td>CSE Branch Elective</td></tr>
<tr><td></td><td>ECE Branch Elective</td></tr>
<tr><td></td><td>Engineering Science and Skills</td></tr>
<tr><td></td><td>HSS/M</td></tr>
<tr><td></td><td>General</td></tr>
</table></td></tr>
<tr><td>Course Pre-Requisites</td><td>First level course in Discrete math and logic
First level course in Graph Theory
First level course in Probability and Statistics</td></tr>
</table>

	• First level course in AI/ML Students wishing to take this course on credit, should have secured at least B+ or higher grade in the pre-requisite courses.

Additional Focus Areas

None

Course Context and Overview

The field of AI started off with a quest for mechanized general intelligence. But much of present day AI may be termed "narrow" or "weak" AI. They represent models created for specific domains or problems, and require specialised knowledge structures, or training data. In contrast to this, the original goal of AI which is now called Artificial General Intelligence (AGI), is to explore computational models representing intelligence of a general nature. This entails some element of "common sense" ability that can be applied across domains, as well as be useful for acquiring specialised intelligence on the fly.

Given the several false starts and "AI winters," some experts believe that AGI may never be realised, and its quest is somewhat like the quest for perpetual machines, which can never be possible. Nevertheless, the grand quest for understanding general intelligence has resulted in a number of interesting computational models that have variegated and versatile applications.

This course explores some such topics relevant to the overarching goal of AGI.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand the history of Artificial Intelligence--its various phases and the resulting "winters" and the predominant paradigm in each wave					
CO2	Build formal conceptual models for textual descriptions					
CO3	Understand epistemological constructs of common knowledge and Frames, and non-monotonic reasoning paradigms					
CO4	Understand ethical concerns around the design, training, and deployment of AI					

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide list-wise topics]

Instruction Schedule

[Provide session-wise schedule]

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

[You can use / modify the sample given below]
The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions

- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[REMOVE THIS LINE: You can use / modify the sample given below]
As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

[You can use / modify the sample given below]
As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

[You can use / modify the sample given below]
As per institute policy

Theory of Computation

Meenakshi D'Souza

International Institute of Information Technology
Bangalore.

January 1, 2017

Course Outline

- Quick recap of Regular languages and finite state automata: Closure properties, determinization, pumping lemma, alternate characterizations.
- Logical characterizations of certain first order theories, Presburger arithmetic.
- Quick recap of context free languages and push down automata: Closure properties, normal forms, alternate characterizations.
- Applications of context free languages and push down automata: Parsing, push down reachability, inter-procedural program analysis.

Course Outline, contd.

- Turing machines, recursive and recursively enumerable languages: alternate models of Turing machines, non-deterministic Turing machines, some properties.
- Halting problem, reductions, undecidability, Rice's theorem, Gödel's theorem.
- Complexity theory: Class NP, Class P, NP-complete problems.

Text books

- Theory of Computation by Michael Sipser
- Automata and Computability by Dexter Kozen
- Some relevant papers describing applications of automata models

Evaluation

- Two class tests, mid-semester and final exams will be conducted.
- Final grade will be given based on performance on all of the above, percentage of each module will be decided after discussions.
- All tests will focus on problem solving.
- There is no project work in this course.

Course Hand Book – CS/DS 818 Block Chain and Cryptocurrencies

Course Name	Block Chain and Cryptocurrencies
Course Proposer Name(s)	Ashish Choudhury
Course Instructor Name(s)	Ashish Choudhury
Course Type *(Select one)* *“Special Topics” course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Special Topics
Credits	4
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	(Choose at most two areas from the list) **CS** – Computer Science **DS** – Data Sciences
Semester	Term: (II) Academic Year: 2017 - 2018

Pre-Requisites (where applicable, specify exact course names)

To credit the course, a student should satisfy **one** of the following eligibility criteria:

1. Should have obtained B or higher grade in the CS-NC-616 (Foundations of Cryptography) course taught by Dr. Ashish Choudhury
2. Should have obtained B+ or higher grade in the CS501 (Data Structures and Algorithms) course taught by Dr. Muralidhara

I would prefer to have the class strength not more than 40 with a good mix of iMTech and MTech. If I find that the number of students satisfying the above eligibility criteria is crossing 40, then I may apply more strict eligibility criteria to reduce the number of registered students.

There is **NO** pre-requisite for the MS/PhD/ students to register for the course. Students are also welcome to audit the course, without registering for it.

Course Description

Bitcoin, cryptocurrencies and Blockchains are emerging technologies. The aim of this course is to give an introduction to these concepts. To understand these related concepts, we need to understand how they work at a technical level. We will address some of the important questions about Bitcoin and cryptocurrencies in general. How does Bitcoin work? What makes it different? How secure is the bitcoin protocol? What level of anonymity we can achieve? What applications can we build using Bitcoin as a platform? Can cryptocurrencies be regulated? If we were designing a new cryptocurrency today, what would we change? What might the future hold?

Course Content

1. Introduction to cryptocurrencies and cryptography
2. How Bitcoin achieves decentralization
3. Mechanics of Bitcoin
4. How to store and use Bitcoins
5. Bitcoin mining
6. Anonymity in Bitcoin
7. Community, politics and regulation
8. Alternate mining puzzles
9. Bitcoin as a platform
10. Altcoins and cryptocurrency ecosystem
11. The future of Bitcoins
12. Applications of Blockchains
13. Alternate cryptocurrencies (if time permits)

Assessments (optional for Special Topics courses)

The tentative assessment includes:

1. One test: 25 marks
2. Research paper presentation: 25 marks
3. Term paper / practical project: 50 marks

Text Book / References

1. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction by Arvind Narayanan, Joseph Bonneau, Edward W. Felten, Andrew Miller, Steven Goldfeder and Jeremy Clark. Princeton University Press, 2016.
2. Mastering Bitcoins: Unlocking Digital Cryptocurrencies by Andreas Antonopoulos. O'Reilly Media, Inc, 2013.
3. Various lecture notes on similar topics available online

***Prep Term**: July; **Term I**: Aug – Nov; **Term II**: Jan – Apr; **Term III**: Jun – July;*

Course Proposal Template

Course Name	Network Security
Course Proposer Name(s)	Prof. Tricha Anjali
Course Instructor Name(s)	Prof. T. Anjali
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	Elective (Special Topic)
Credits	4
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DBIS – Database and Information Systems ES – Embedded Systems ITS – IT & Society NC – Networking and Communication SE – Software Engineering	(Choose at most two areas from the list) NC and CS
Semester	Term: Fall (Aug - Dec) Year: 2014

Pre-Requisites (where applicable, specify exact course names)

Fundamentals of Computer Networking and Communication (if you have done in your BTech or in IIITB or with the permission of instructor)

Course Description

Information and Network security is an area of expertise highly in demand, even more so nowadays when information is readily available and stored at unimaginable locations. Personnel with knowledge and proficiency in various aspects related to security are coveted by many organizations. To meet the national demand for network security experts, this course is being developed.

In this course, we will explore the topics related to network security. We will look at various secure protocols and their applications. It will present a comprehensive treatment of network security.

Course Content

1 Secret and Symmetric Key Cryptography
2 Public Key Algorithms
3 Public Key Infrastructures (PKI)
4 Hashes and Message Digests
5 Authentication Systems, AAA
6 IPsec

7 Internet Key Exchange (IKE)
8 SSL, TLS, TCP/IP security attacks
9 Virus, root kits, malware, honeypots
10 E-mail Security
11 VPN Security
12 DNSSEC
13 IDS/IPS
14 Creditcard transactional security
15 DoS Attacks, Botnet
16 Onion Routing
17 Wi-Fi security
18 LTE Security (time permits)

Assessments (optional for Special Topics courses)

Assessment has three primary components:

- Project work
- Lab work
- Exams (2 class tests, 1 midterm and 1 final)

Text Book / References

- **Network Security Essentials:** Applications and Standards, William Stallings
- Network Security: Private Communication in a Public World (2nd Edition), Charlie Kaufman, Radia Perlman, Mike Speciner

Spring Term*: Jan – Apr;* ***Summer Term****: Jun – July;* ***Prep Term****: July;* ***Fall Term****: Aug – Nov*

<CS/NCE/ESD 854: DIGITAL IMAGE PROCESSING >

GENERAL COURSE INFORMATION

Course Name	Digital Image Processing
Term	Term II (2014-15)
Instructor(s)	Dr. Neelam Sinha and Dr. Dinesh Babu J
Course credits	4
Pre-requisite(s)	DSP in undergraduate; else please talk to the instructors

COURSE OVERVIEW AND OBJECTIVES

This course is a graduate level course. Also, assumes students have a background in DSP- time and frequency domain analysis of 1D signals and systems; LTI systems. The objective of the course is to train the students in the necessary mathematical and theoretical concepts, followed by applying them in MATLAB. We also plan to emphasize the state-of-the-art in Image segmentation, Image matching and Object Recognition.

COURSE CONTENTS

1. Introduction to Digital Image Processing
2. Imaging Process (3D to 2D geometry; Illumination; Color)
3. Image Enhancement – includes Edge detection
4. Image Segmentation (getting semantically meaning regions)
5. Interest Point Detectors and Descriptors
6. Image Matching and Object Recognition
7. Transform domain – Introduction
8. Frequency domain and Orthonormal transforms
9. Image Compression
10. Image Denoising

GRADING

Quizzes(20%); Assignment(20%); Mid Sem(20%); End Sem(20%); Mini Project – 20%

TEXT BOOK AND REFERENCES

Fundamentals of Digital Image processing
– A practical approach with examples in MATLAB by Chris Solomon and Toby Breckon

Course Proposal

Course Name	**Natural Language Processing**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Nam	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering SP – Signal Processing and Machine Learning	DS/SP
Semester	Spring (Jan-May)

Pre-Requisites (where applicable, specify exact course names)

- Maths for IT or Courses covering basic Probability Theory, Linear Algebra and Discrete Mathematics
- First Course in Algorithms, ML
- Working familiarity with Deep Learning

Course Description

This is intended to be a deep-dive into automated processing of natural language text with a bias towards ML-based techniques (learning directly from available text corpus with / without annotations). Language has been the hardest to 'conquer' so far for ML compared to the other domains that ML has taken on like Vision and Speech. There continues to be an active debate on whether traditional linguistic knowledge / theories will eventually be overrun by the deep learning juggernaut (see this MIT Press article for example). This course will build up from traditional linguistic basics to the more modern ML based and deep learning approaches to NLP. The other thread in the course will be to move up from the lowest linguistic feature in text (alphabet) to progressively higher levels of abstraction – n-grams and words, phrase structure, sentence structure, passages, documents, corpus. At the lower levels of this hierarchy it would be largely the lexical patterns / syntactic structure / grammar that we will study/model and the higher levels would largely be about semantic abstractions such as knowledge, meaning, intent and discourse.

The course will be entirely assignment (implementation) and project based. A list of indicative projects is given in Appendix A. The students are however free to come up with project ideas and have them whetted by the instructor.

Key References:

1. Christopher Manning , "*Foundations of Statistical Natural Language Processing*", MIT Press, 1999.
2. Christopher Manning, Prabhakar Raghavan and Hinrich Schutze, "*Introduction to Information Retrieval*", Cambridge University Press. 2008.
3. Ruslan Mitkov, "*The Oxford Handbook of Computational Linguistics and Natural Language Processing*", Wiley-Blackwell 2010.
4. Steven Bird, Ewan Klein, and Edward Loper, "*Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit*", Online Version under Creative Commons License, O'Reilly 2010.
5. Dan Jurafsky and James H. Martin, "*Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*", Pearson 2014.
6. Lots of code samples and implementations in PyTorch at this repo. Go down the page to see links grouped under "General NLP", "Question and Answering", "Document and Text Classification", "Text Generation", "Translation", "Sentiment Analysis" etc.

Course Content

Module 1: Characters and Encoding (2 – 3 Lectures)

- Character Encodings, Unicode --- Indian Language; Character-level models
- Character-level models for many sophisticated tasks – translations, learning complex syntax, bio-informatics, etc.
- Character Embeddings
- Phonetic Representations of language

Module 2: Basic Language Concepts (2 – 3 Lectures)

- Information Theoretic and Probabilistic views of language - Language Entropy, Mutual Information
- Distributional features of language --- character and word distributions; Zipf's Law and other power laws
- Collocations/Co-occurrences; Concordances; Parts of Speech; Morphology; Phrase Structure; Dependencies; Parsing
- Other quirks of natural language --- coreference, anaphora, Hyponyms and hypernyms, Synonyms and Word Senses; 'abstract' idiosyncracies like intent, joke, sarcasm, shortforms and acronyms, etc.

Module 3: **Tools & Resources (1 – 2 Lectures)**

- IR Tools --- ElasticSearch
- NLP toolkits and libraries –- Spacy, NLTK, Gensim, …
- Corpora and datasets
- Preprocessing; Tokenization
- Markup schemes for annotation / segmentation; Grammatical tagging
- Evaluating Text Models --- Precision, Recall, F-Score, Threshold-free metrics, BLEU, ROUGE

Module 4: **n-Grams and Words (2 – 3 Lectures)**

- Words, Bi-Grams, n-Grams
- Stemming, Stop Words, Lemmatization, Normalization, Canonicalization
- Positional Indexes, Dictionary/Lexicon Building, Query and Retrieval
- Handling Spellings
- Document Indexing --- In-Memory, Sorting-based, Distributed approaches
- Probabilistic Information Retrieval
- n-Gram and word Statistics --- TF-IDF and its variants
- n-Gram and Word Embeddings / Vector Space Models --- Factorization, PMI, Word2Vec, GloVe, FastText, Bert
- Co-Occurrence Graphs

Suggested Additional Reading:

1. Yoav Goldberg, "*A Primer on Neural Network Models for Natural Language Processing*", arXiv Oct 2015.
2. Tomas Mikolov et. al., "*Distributed Representations of Words and Phrases and their Compositionality*"**,** NIPS 2013.
3. Jeffrey Pennington, Richard Socher, and Christopher D. Manning, "*GloVe: Global Vectors for Word Representation*". 2014.
4. Jacob Devlin, Ming-Wei Chang, Kenton Lee, Kristina Toutanova, "*BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding*", arXiv May 2019.
5. (**FastText**) Piotr Bojanowski, Edouard Grave, Armand Joulin, Tomas Mikolov, "*Enriching Word Vectors with Subword Information*", TACL 2017.
6. Jose Camacho-Collados and Mohammad Taher Pilehvar, "*From Word to Sense Embeddings: A Survey on Vector Representations of Meaning*", Journal of Artificial Intelligence Research 63 (2018) 743-788.

Module 5: **Morphology, POS, Phrase Structure, Grammar, Parsing (4 – 5 Lectures)**

- Sequence Labeling as a generic framework for Named Entity Recognition (NER), POS tagging --- Entropy based, Discriminative Models, HMM based and Neural net based models for Sequence Labeling
- Phrase Chunking

- Unsupervised Sequence Labeling
- Language Grammars --- Context Sensitive Grammars; Probabilistic Context Free Grammars; Neural language generators
- Dependency Parsing – Graph based; Neural dependency parsers

Module 6: Document (as a Bag-of-Words) Analysis (4 – 5 Lectures)

- Document Classification and Clustering --- Naive Bayes, SVM, k_NN, K-Means
- Latent Semantic Indexing
- LDA and Topic Modeling
- Neural net architectures --- Hierarchical, Recurrent, Convolutional, RBM based architectures for document processing

Module 7: Semantics in Language and Knowledge Extraction (4 – 5 Lectures)

- Named Entity Recognition; Word-sense Disambiguation; Reference Resolution
- Logic-based Semantics
- Knowledge Structures --- Associative Memory; Dynamic Memory Architectures; Knowledge as a Graph; Relational Models.
- Building Knowledge Structures from text corpus.
- Distributional Semantics
- Discourse Analysis

Module 8: Discussions on representative NLP Use Cases (Remaining 5 – 10 Lectures)

(as many of these as possible; not necessarily in this order nor are these mutually exclusive) Will involve typical neural architectures for each of these, mathematical formulations and implementation tricks.

- Automated Assessment of Descriptive Text
- Causal Inference from Text --- Counterfactuals, Implications
- Dialog Management and Conversational Engines
- Document Summarization
- Generative Models for Text
- Language Translation
- Multimodal Models --- NLP with Speech, Visual Interpretation, etc.
- Question Answering and Fine Grained Information Retrieval
- Temporal Inference from Text
- Unstructured text to structured entities – description to program, natural language SQL interface,

Suggested Additional Reading:

1. Freely available chapters from the book *Deep Learning in Natural Language Processing*, Springer, 2018
   a) **Chapter 2** by Gokhan Tur, Asli Celikyilmaz, Xiaodong He, Dilek Hakkani-Tur, and Li Deng. *Deep Learning in Conversational Language Understanding,*

b) **Chapter 3** by Asli Celikyilmaz, Li Deng, and Dilek Hakkani-Tur, Deep Learning for Spoken and Text-Based Dialog Systems.

c) **Chapter 6** by Y. Liu. Deep Learning in Machine Translation.

2. Yonghui Wu, et., al., "*Google's Neural Machine Translation System: Bridging the Gap between Human and Machine Translation*", Oct 2016.
3. Ronan Collobert†, "*Deep Learning for Efficient Discriminative Parsing*", AISTATS 2011.

Assessments
Assessment will be based on assignments and a big project. See Appendix A for an indicative list of Projects. There may be a few surprise quizzes thrown in between as an additional assessment component. The weightage for these three components is: **Assignments: 40%** **Quizzes: 10%** **Project: 50%**

Appendix A: Project Ideas

(some of these may require you to put together an appropriate dataset yourself. Almost all of these have potential to be turned into a good publication. Feel free to choose anything else that you may have in mind, with the instructor's prior concurrence of course.)

1. Investigate cognitive models of how language is learnt by humans and leverage them to come up with a curriculum learning scheme for language learning. For example: build a model that can generate language text. Start by training the model on children's books, and gradually build it up to read more-and-more sophisticated pieces of text. Come up with a series of experiments that you can use to demonstrate that the language capability of the model is improving as you move from one stage to another.

2. Summarize a comic strip as another but shorter comic strip. This would be a multi-modal exercise using both the visuals and the text in the comic strip.

3. Create a financial advisory note for someone who wants to invest in the stocks of a company, using data about the market performance, social media presence, the company's own annual report, press releases, etc.

4. Develop an embedding scheme of medical terms that has properties such as: (1) the embedding for a term must tell us (at least indicate) if the term is a disease, generic drug, treatment, part of the human anatomy, some physiological process, symptom, etc. (2) embedding for a disease is close those for its symptoms, drugs categories used to treat it, part of the anatomy it is typically associated with, etc. Similar associations for embeddings of others terms as well.

5. Design and build an intelligent code-completion system for a programming language of your choice. The traditional code-completion that IDEs usually provide are limited to static / terminal level completions (variables, keywords, methods/functions with arguments, etc.). Try extending this to non-terminal level completions (long-rnage structures such as loops, conditionals, etc.) by predicting intended program structure to some extent. Here in one representative attempt.

6. Take a shot at "The Allen AI Science Challenge" that aims to buld a system that can answer science multiple-choice questions based on the K-12 textbook corpus. The dataset is available at AI Science Challenge Dataset.

7. Pick up any of the NLP based challenges from CodaLab, like:

    a) First TextWorld Problems

b) Modeling Causal Reasoning: Detecting Counterfactuals in Text

c) Commonsense Reasoning and Explanation

d) Predicting Multilingual and Cross-Lingual (Graded) Lexical Entailment

e) Assessing the Funniness of Edited News Headlines

8. Take a shot at one of the TempEval challenges that aim to create approaches for automatic identification of temporal expressions (timexes), events, and temporal relations within a text. Here is the link to TempEval-3.

9. Design and implement a prototype WordNet equivalent for any one of the Indian languages. See this paper for a start: Building Wordnets, Kannada WordNet and Hindi WordNet. This may have some overlap with Project 11 (embeddings for Indian languages).

10. Transformers have turned out to be pretty successful at text sequence learning and have formed the basis for many successful models that followed --- ELMO, BERT etc. One drawback of transformers is that the model size (number of parameters) is quadratic in the size of the input. Come up with an architecture that works like a transformer for text processing tasks, however has sub-quadratic size.

11. Design and implement a generic embedding scheme for Indian language text. Given that the structure of most Indian languages Is similar (under the broad assumption that most of the Indian languages trace their grammatical rules back to Paninian grammar for sanskrit) it seems plausible to think of a generic embedding scheme that works seamlessly across multiple Indian languages. Start with a small subset of Indian languages to prototype this. (the four south-Indian languages, Bengali-Oriya-Assamese, Marathi-Gujarati, Hindi-Punjabi-Rajasthani, could be some examples of language cluster one can consider for this project). This may have some overlap with Project 9 (WordNet for Indian languages).

12. Indian Language NLP is a largely unexplored area. Besides the projects 9 and 11, one could potentially think of Indian language versions of any of the other projects listed here or otherwise. Any of them is a potential project.

13. WordClouds are very popular for visualization. They show words with their sizes indicating the relative frequency of occurrence (possibly normalized) laid out as a collage inside a canvas. On similar lines design and implement a multi-level (hierarchical) topic/concept cloud for a document corpus / single document / piece of text with the ability to drill down to documents / parts of documents starting from a topic and drilling down through sub-topics. A topic cloud is intended to show the relative predominance of a topic ('aboutness' / 'primary discourse' of a piece of text)

as a collage.

14. Design a system that automatically builds a glossary for a book / chapter / essay. There are supervised ways for this that have been attempted --- see here and here. Explore unsupervised ways to construct a glossary --- a seed idea is to try isolating the words that in some sense 'imply' everything else. In other words knowing the glossary terms and enough 'commonsense' and 'background knowledge' the rest of the text should be comprehensible. Figure out the dependencies of the text in some sense on words and get to the roots of that dependency relation. One also needs to extract the definition for each term in the Glossary.
15. Similar to Project 11 --- build a generic dependency parser for Indian language text. Here is an example of a multilingual dependency parser.
16. Google has released a massive freely available dataset of n-grams extracted from thousands of books over the last few hundred years, under the Google Books project. The dataset contains ngrams with frequencies and year. Come up with interesting questions, the answers to which can give some insight into the temporal evolution of the English language over the last 200-300 years. Come up with models to answer your questions using the Google n-gram dataset. Here is an example of the use of this dataset.
17. Large number of conference papers are accessible today and all of have some standard features: starting with a short abstract, introduction, related work, main contribution, conclusions/discussion etc. Scrape these to create a dataset for papers and their abstract. Train an 'Abstract Generator' for papers using the scraped data as annotated data for supervised learning.
18.

Text Book / References

Course Proposal Template

Course Name	DS / AI 608: Network Science for the Web	
Course Proposer Name(s)	Srinath Srinivasa	
Course Instructor Name(s)	Srinath Srinivasa, Sridhar Mandyam	
Credits	4	
Grading Scheme (Choose by placing X against appropriate row)	**X**	IIITB grading scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X against not more than two areas from the list)

	Theory and Systems		Networking and Communication
X	Data Science		Signal Processing and Pattern Recognition
	VLSI Design		General Elective

Pre-Requisites (where applicable, specify exact course names)

First level courses on Probability & Statistics, Discrete Mathematics and Graph Theory.

Course Description
A brief description of the course

Network Science deals with models, methods, tools, and mathematical techniques to study and analyze the behaviour of networks. Networks comprise entities represented as nodes (also referred to as vertices), and the relationships among the nodes are denoted by edges (also referred to links).

Networks are everywhere – connecting 'agents' of different types by edges representing their interactions: phone networks connect people through voice, text, or video linkages; electrical networks capture the connectivity between sources of generation and loads which consume the power that flows in the network; biological networks are used to model the nature of interaction between agents representing biological entities such as proteins; social networks model online interactions between social agents – people; and so on.

Network Science today has rapidly emerged as a vast interdisciplinary field of investigation, with tools and techniques drawn from many disciplines, ranging from the basic sciences, such as physics and biology, to the engineering sciences such as electrical engineering, through graph theory and learning in computer science and mathematics, and the social sciences, drawing in topics from microeconomics and game theory.

One of the central goals of Network Science is the study of complex phenomena arising from the interaction of a large number of agents interconnected by a network of linkages. These studies attempt to model and characterize the behaviour of agents located at the nodes, the impact of network structure on such behaviour and their characterization, and the dynamics that may result from changes to the network structure and properties.

Course Outcomes *Course Outcomes are statements that describe what students are expected to know, and be able to do at the end of the course. These relate to the skills, knowledge, and behavior that students acquire in their progress through the course.*
By the end of the course, students are expected to do the following: ● Analyse network structures based on different structural characteristics ● Build and simulate generative models for network related problems ● Build and simulate probabilistic reasoning models for network related problems
Course Content
Mandate - 1: Network Science and Analytics Fundamentals ● Introduction to Network Science for the Web ● Models of the Web ● Analytics Fundamentals ○ Confirmatory Analytics ○ Exploratory Analytics ○ Generative Analytics ● Stochastic Processes **Mandate - 2: Structural Analytics of Networks** ● Measures of Network Centrality ○ Facility location based centralities ○ Stress centralities ○ Vitality measures ○ Web centralities ○ Estimating centrality measures for very large graphs ● Groups and Densities ○ Cliques, Plexes, Cores ○ Community detection models **Mandate - 3: Reasoning on Network Structures** ● Causal Networks and Bayesian Reasoning ● Markov Random Fields ● Network Learning and Graph Neural Networks ● Intervention and Counterfactual Analysis **Mandate - 4: Social Network Generative Models** ● Erdos-Renyi model ● Watts-Strogatz model ● Barabasi-Albert model ● Kleinberg model

- Information diffusion models

Assessments

Mandate system of assessment is used in this course. Each learning mandate requires every student to make at least one primary (and any number of secondary) mandate contributions, which are graded directly with the IIITB letter grade. Each mandate also has an end-of-mandate quiz that is administered as a pass/fail requirement. Overall grade is the average of letter grades obtained over all mandate contributions.

Text Book / References

Some mandate-specific reading materials, that are updated year on year, are made available through the LMS during the course.

Reference texts:

1. Albert-Laszlo Barabasi. Network Science. http://networksciencebook.com/
2. Filippo Menczer, Santo Fortunato, Clayton Davis. A First Course in Network Science. Cambridge University Press. Feb 2020.
3. Börner, Katy, Soma Sanyal, and Alessandro Vespignani. "Network science." ARIST 41, no. 1 (2007): 537-607.
4. Ulrik Brandes and Thomas Erlebach. 2005. Network Analysis: Methodological Foundations (Lecture Notes in Computer Science). Springer-Verlag New York, Inc., Secaucus, NJ, USA.
5. Easley, D. Kleinberg, J. Networks, Crowds, and Markets: Reasoning About a Highly Connected World. ISBN 9781139490306. http://books.google.co.in/books?id=atfCl2agdi8C 2010. Cambridge University Press
6. Ben Gal I (2007). "Bayesian Networks" (PDF). In Ruggeri F, Kennett RS, Faltin FW (eds.). *Support-Page*. *Encyclopedia of Statistics in Quality and Reliability*. John Wiley & Sons. doi:10.1002/9780470061572.eqr089. ISBN 978-0-470-01861-3.

WWW links:

1. Cuttlefish: https://github.com/dev-cuttlefish/cuttlefish
2. Cytoscape: https://cytoscape.org/
3. Gephi: https://gephi.org/
4. igraph: https://igraph.org/
5. NodeXL: https://www.smrfoundation.org/nodexl/
6. Pajek: http://mrvar.fdv.uni-lj.si/pajek/
7. OpenBUGS (Bayesian Inference Using Gibbs Sampling) http://www.openbugs.net/
8. JAGS (Just Another Gibbs Sampler) http://mcmc-jags.sourceforge.net/
9. DAGitty (Draw and analyze causal diagrams) http://dagitty.net/

Network Datasets:

1. Network Science Book Datasets. http://networksciencebook.com/translations/en/resources/data.html
2. SNAP. Stanford Large Network Dataset Collection. https://snap.stanford.edu/data/
3. Network Repository. http://networkrepository.com/networks.php

Course Proposal

Course Name	**Foundations for Big Data Algorithms**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS
Semester	Spring (Jan-May) - 2015

Pre-Requisites (where applicable, specify exact course names)

- Maths for IT or Courses covering basic Probability Theory, Linear Algebra and Discrete Mathematics
- First Course in Algorithms

*Those opting for this course would require to have got at least a **B** in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

*Class strength will be limited to **30**.*

Course Description

This is similar to a course taught by John E. Hopcroft and Ravindran Kannan. The book "Foundations of Data Science" by Hopcroft and Kannan based on this course is freely available for download.

Course Content

1. **Module 1 (The Probabilistic Method – Primer on Randomized Algorithms)**
   - Common Distributions and their characteristics
   - Chernoff Bounds, Martingales
   - Lovasz Local Lemma

- PAC (Probably Approximately Correct) Algorithms
- Probabilistic Decision Theory
- Frequentist vs Bayesian Approaches

Suggested Reading:

a) James O. Berger. "Statistical Decision Theory and Bayesian Analysis". 2Nd Edition. Springer. 1980. ISBN 3-540-96098-8.

b) B. Efron. "Why isn't everyone a Bayesian?". The American Statistician, Vol. 40, No. 1 (Feb., 1986), pp. 1-5.

c) Wassily Hoeffding. "Probability Inequalities for Sums of Bounded Random Variables". American Statistical Association Journal. March 1963.

d) J.Hromkovič. "Design and Analysis of Randomized Algorithms – Introduction to Design Paradigms". Springer, 2005. *ISBN-13 978-3-540-23949-9*

e) Anjali Mazumder. "Statistical Decision Theory: Concepts, Methods and Applications". Report 2003.

f) Michael Mitzenmacher and Eli Upfal. "Probability and Computing – Randomized Algorithms and Probabilistic Analysis". Cambridge University Press, 2005. *ISBN 0-521-83540-2*

g) Rajeev Motwani and Prabhakar Raghavan. "Randomized Algorithms". Cambridge University Press, 1995. *ISBN 0-521-61390-6*

h) Sheldon M. Ross. "Introduction to Probability and Statistics for Engineers and Scientists". Elsevier Academic Press 2009. ISBN 13: 978-0-12-370483-2.

i) D. Warner North. "A Tutorial Introduction to Decision Theory". IEEE Transactions on Systems Science and Cybernetics, Vol. SSC-4, No. 3. September 1968.

2. Module 2 (Probability and Information Theory)

- Probability and Entropy
- KL Divergence
- Information Complexity and Minimum Description Length
- Kolmogorov Complexity

Suggested Reading:

a) Peter Grunwald.and Paul Vitanyi. "Shannon Information and Kolmogorov Complexity". EuroCOLT II 2004.

b) David J.C. MacKay. "Information Theory, Inference, and Learning Algorithms". Cambridge University Press 2003.

3. Module 3 (Random Walks and Markov Chains)

- Random Walks, Markov Chains – properties, stationarity, convergence
- Hidden Markov Models
- Markov Random Fields
- Linear Dynamical Systems – Kalman Filters
- Applications – Simulated Annealing, Page Ranking

Suggested Reading:

a) Lazlo Lovasz. "Random Walks on Graphs: A Survey". In: Combinatorics — 'Paul Erdos is Eighty'. Vol. 2. Bolyai Society Mathematical Studies. Keszthely (Hungary): Bolyai Society, 1993, pages 1–46.

b) Olle Haggstrom. "Finite Markov Chains and Algorithmic Applications". Cambridge University Press 2002, ISBN 0 511 01941 6 virtual (netLibrary Edition).

c) Ross Kindermann and J. Laurie Snell. "Markov Random Fields and Their ApplicationsMarkov Random Fields and their Applications" (1980) American Mathematical Society, ISBN 0-8218-5001-6

d) Eds. Andrew Blake, Pushmeet Kohli, Carsten Rother. "Markov Random Fields For Vision And Image Processing". MIT Press. July 2011. ISBN: 9780262015776. Introductory Chapter on MRF.

4. Module 4 (Random Sampling Theory)

- MCMC (Markov Chain Monte-Carlo) method
- Sampling from standard distributions – Uniform, Gaussian, Poisson, Dirichlet, ...
- Reservoir Sampling
- Rejection Sampling and its variants
- Gibbs Sampling

Suggested Reading:

a) Christopher M. Bishop. "Pattern Recognition and Machine Learning". Springer, *Information Science and Statistics* Series. ISBN-13: 978-0387-31073-2. Chapter 11.

b) Jure Leskovec and Christos Faloutsos. "Sampling from Large Graphs". KDD'06, August 2006.

c) Dinakar Vasudevan and Milan Vojnovic. "Random Sampling for Data Intensive Computations". MSR Technical Report MSR-TR-2009-8. April 2010.

d) Jeffrey Scott Vitter. "Faster Methods for Random Sampling". Communications of the ACM. Vol 27. Issue 7. July 1984.

e) Jeffrey Scott Vitter. "Random Sampling with a Reservoir". ACM Transactions on Mathematical Software. Vol 11. No 1. March 1985. pages 37—57.

5. Module 5 (Geometry in High Dimensions)

- Standard higher dimensional 'shapes' --- vectors, hyperplanes, polytopes, projections, spheres, hypercubes, simplices and simplicial complexes
- Projections, Sections of high-dimensional solids
- Convexity.
- Metrics and Volumes in high dimensional spaces
- The Curse of Dimensionality

Suggested Reading:

a) Keith Ball. "An Elementary Introduction to Modern Convex Geometry". Flavours of Geometry. MSRI Publications Volume 31. 1997.
b) Andrew J. Hanson. "Geometry for N-Dimensional Graphics". Academic Press 1994. ISBN 0-12-336156-7.
c) Roman Vershynin. "Estimation in High Dimensions: A Geometric Perspective". SAMSI-CRM Workshop on Geometric Aspects of High-dimensional Inference: March 31-April 2, 2014.
d) Hermann Flaschka. "Some Geometry in High-Dimensional Spaces". Course Notes for Math 527a, Fall 2002, University of Arizona.

6. Module 6 (Spectral Methods, Dimensionality Reduction)

- SVD and PCA. Other decompositions.
- Random Projections, Johnson-Lindenstrauss Theorem
- Compressed Sensing
- Large Matrices, Random Matrices and Rank Minimization
- ICA. SOM (Self Organizing Maps)

Suggested Reading:

e) Golub, Gene H.; Van Loan, Charles F.. "Matrix Computations" (3rd ed.), Johns Hopkins, 1996. ISBN 978-0-8018-5414-9.
f) Lawrence K. Saul, et. al. "Spectral Methods for Dimensionality Reduction". Report from University of California, San Diego.
g) van der Maaten, Laurens JP, Eric O. Postma, and H. Jaap van den Herik. "Dimensionality reduction: A comparative review". Journal of Machine Learning Research 10.1-41. 2009. pages 66-71.
h) Santosh S. Vempala. "The Random Projection Method". AMS DIMACS Series in Discrete Mathematics and Theoretical Computer Science, vol. 65. 2004. ISBN-13: 978-0-8218-2018-6.

Assessments

The evaluation will include three components, all of which carry equal weight:

- There will be small implementation experiments/projects for each module which the students are expected to carry out in small groups (at most 3 in each group).
- Participation in In-Class and offline discussions on LMS on problems posted.
- There will be a class test after every module.

The course would progress one module at a time. Progress to the next module will be subject to a significant fraction of the class 'making-the-cut' in the test – a rough thumb-rule could be 50% median score and less than 10% of the class below 30% score. **The class mean will be calibrated based on the number of modules that have been covered during the course. Module 1 through 6 that the course eventually progressed to would correspond to class mean grades of C, C+, B-, B, B+, A- respectively in that order.**

Text Book / References

Course Proposal

Course Name	**Core Algorithms for Massive Data (DS 862)**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS
Semester	Autumn (Aug-Dec) - 2015

Pre-Requisites (where applicable, specify exact course names)

- Basic course in database systems.
- First level courses in Discrete Maths, Algorithms, Software Engineering
- Foundations for Big Data Algorithms

*Those opting for this course would require to have got at least a **B+** in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

*Class strength will be limited to **30**.*

Course Description

This is similar to a course taught by Anand Rajaraman and Jeffrey D. Ullman at Stanford. The course material can be accessed at http://infolab.stanford.edu/~ullman/mining/2009/index.html#info

The recent book authored by Jure Leskovec, Anand Rajaraman and Jeffrey D. Ullman based on this course can be found at:

http://infolab.stanford.edu/~ullman/mmds/bookL.pdf

The last three modules are major applications – **recommender systems**, **online ad-serving** and **social network analysis** – these will be run more as projects, not necessarily through lectures.

Other useful generic reference:

Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütz. "Introduction to Information Retrieval". Cambridge University Press. 2009. Online Edition.

Course Content

1. Module 1 (Large Scale File Systems & Map Reduce)

- Distributed File Systems
- External memory model of Vitter - Computational Models for External Memory Access, Fundamental I/O operations and Bounds, Exploiting Locality and Load Balancing.
- Map-Reduce Algorithms
- Complexity Theory of Map-Reduce Algorithms; Communication Complexity

Suggested Additional Reading:

a) Jeffrey Scott Vitter. "External Memory Algorithms and Data Structures - Dealing with Massive Data". In: ACM Computing Surveys 33.2 (June 2001), pp. 209–271.

2. Module 2 (Algorithms for Data Streams)

- The stream data model
- Estimating / Counting Stream statistics – Moments, Distinct Elements (Flajolet-Martin Algorithm)
- DGIM Algorithm
- Filtering Streams – Bloom Filter

Suggested Additional Reading:

a) Susanne Albers. "Online Algorithms". In: Interactive Computation: The New Paradigm. Ed. by S.A. Smolka D.Q. Goldin and P. Wegner. Springer, 2006, pp. 143–164.

b) S. Muthukrishnan. "Data Streams: Algorithms and Applications". Foundations and Trends in Computer Science. ISBN 1-933019-14-X. NOW: the essence of Knowledge, 2005.

c) S. Muthukrishnan. "Data Stream Algorithms". The 2009 Barbados Workshop on Computational Complexity. March, 2009.

3. Module 3 (Counting & Inferring Associations in Large Datasets)

- Frequent Itemsets – Market Basket Model & A-Priori Algorithm
- A-Priori on very large Datasets – Mutlihash, Multistage Algorithms
- SON Algorithm

- Toivonen's Algorithm

Suggested Additional Reading:

a) Pang-Ning Tan, Michael Steinbach, Vipin Kumar. "Introduction to Data Mining". Chapter 6 . Addison Wesley 2005. ISBN : 0321321367.

4. Module 4 (Algorithms for Large Networks)

- Random Graph model of Erdos and Renyi
- Phase transitions, degree distribution and other properties of large networks
- Page Rank – theory, implementation strategies
- Topic Sensitive Page rank

Suggested Additional Reading:

a) U Kang, Duen Horng Chau, Christos Faloutsos. "Mining Large Graphs: Algorithms, Inference, and Discoveries".
b) J. Kleinberg. "The small-world phenomenon: An algorithmic perspective". Proc. 32Nd ACM Symposium on Theory of Computing, 2000.
c) J. Kleinberg. "Complex Networks and Decentralized Search Algorithms". Proceedings of the International Congress of Mathematicians (ICM), 2006.
d) Ted G. Lewis. "Network Science: Theory and Practice". John Wiley & Sons, Inc. 2009. ISBN 978-0-470-33188-0.
e) Lazlo Lovasz. "Large Networks and Graph Limits". Book draft.
f) M.E.J.Newman. "The structure and function of complex networks". arXiv.

5. Module 5 (Nearest Neighbour Searches from Large Datasets)

- Similarity Metrics including those involving Categorical Attributes – Jaccard, Euclidean, Cosine, Edit, Hamming, ...
- Locality Sensitive Hashing (LSH) & Fingerprinting – Theory and Applications
- LSH for different distance measures
- Minhashing
- Shingling of Documents

Suggested Additional Reading:

a) Mohammad Raza Abbasifard, et.al. "A Survey on Nearest Neighbor Search Methods". International Journal of Computer Applications (0975 – 8887). Volume 95. No. 25, June 2014.
b) Alexandr Andoni and Piotr Indyk. "Near-Optimal Hashing Algorithms for Approximate Nearest Neighbour in High-Dimensions". Communications of the ACM. Vol. 51, No. 1. January 2008.

6. Module 6 (Clustering on Large Datasets)

- Hierarchical Clustering
- k-Means
- CURE Algorithm
- GRGPF Algorithm for Non-Euclidean Spaces
- Fuzzy Clustering Algorithms
- Clustering and Mixture Models
- Stream Clustering

Suggested Additional Reading:

a) A.K. Jain, M.N.Murthy and P.J.Flinn. "Data Clustering: A Review". ACM Computing Surveys, Vol. 31, No. 3, September 1999.
b) Lior Rokach. "Clustering Methods". In the 'Data Mining and Knowledge Discovery Handbook.
c) Pang-Ning Tan, Michael Steinbach, Vipin Kumar. "Introduction to Data Mining". Chapter 8, Chapter 9. Addison Wesley 2005. ISBN : 0321321367.
d) Rui Xu. "Survey of Clustering Algorithms". IEEE Transactions on Neural Networks, Vol. 16, No. 3, May 2005.

7. Application Module 1 (Large Scale Recommender Systems)

- Utility Model
- Collaborative Filtering Based algorithms
- Content Based algorithms

Suggested Additional Reading:

a) Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor Eds. "Recommender Systems Handbook". Springer 2011. ISBN 978-0-387-85819-7.

8. Application Module 2 (Serving Contextual Advertisements)

- Online Algorithms – Greedy and other strategies.
- Matching Problem.
- Adwords Problem. Implementation
- Game theoretic perspective.

Suggested Additional Reading:

a) Course on "Introduction to Computational Advertising" at Stanford.

9. Application Module 3 (Mining Social Networks)

- Clustering
- Community Discovery. Overlapping.
- Partitioning
- Counting. Reachability.

Suggested Additional Reading:

a) Robert A. Hanneman. Online Book "Introduction to Social Network Methods". 2005.

Assessments
There will be small implementation experiments/projects for each module which the students are expected to carry out in small groups (at most 3 in each group). Participation in In-Class and offline discussions on LMS on problems posted. There will be a class test after every module. Progress to the next module will be subject to a significant fraction of the class 'making-the-cut' in the test. A reasonably big project on something related to the last 3 modules listed above. All the components of the assessment given above would carry equal 'weight'.

Similar Courses in Other Universities:

1. University of Minnesota
    - **Title**: Algorithmic Techniques for Big Data Analysis
    - **Instructor**: Barna Saha, AT&T Shannon Laboratory
2. MIT
    - **Title**: Algorithms for Massive Data Sets
    - **Instructor**: Piotr Indyk, MIT
3. Columbia University:
    - **Title**: Dealing with Massive Data
    - **Instructor**: Sergei Vassilvitskii, Yahoo Research
4. University of Massachussets
    - **Title**: Algorithmic Techniques for Big Data Analysis
    - **Instructor**: Andrew McGregor, UMass
5. Duke University
    - **Title**: Algorithms for Big-Data Management
    - **Instructor**: Ashwin Machanavajjhala, Duke

6. Dartmouth College

- **Title**: Data Stream Algorithms
- **Instructor**: Amit Chakrabarti, Dartmouth

Course Proposal Template

Course Name	Spatial Computing
Course Proposer Name(s)	Uttam Kumar
Course Instructor Name(s)	Uttam Kumar
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Special Topics
Credits	4
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F) • Satisfactory/Unsatisfactory (S / X)
Area of Specialization (if applicable) **CSE** – Computer Science and Engineering **DS** – Data Sciences **NCS** – Networking & Communication and Signals **ES** – Embedded Systems **SoC** - System on Chip	DS
Semester	Term: (II) Academic Year: 2019 - 2020

Pre-Requisites (where applicable, specify exact course names)

- Knowledge of GIS (DS 703), Digital Image Processing (SP 854) and Machine Learning (GEN 511) is desirable but not mandatory.
- Students who have attended GIS course (DS 703) *will have advantages*.

Course Description

Geospatial analysis and geospatial technologies are used in a growing number of industries, for example, ride-sharing, autonomous vehicles, electric grid, telecommunication, banks, airlines, cloud computing and many other critical infrastructures. From Google maps to consumer global positioning system (GPS) devices, spatial technology shapes many lives in both ordinary and extraordinary ways. Many organizations and industries have recently started major initiatives such as NASA Earth Exchange, Amazon's Earth on AWS, Google Earth Engine, Microsoft's AI for Earth, Apple maps and Facebook maps for meeting grand challenges facing our changing planet such as conservation, climate change and sustainability. This progress has created an increased demand for employees with essential geospatial skills, competencies, and training. Thanks to spatial computing, a hiker in a mountain and a taxi driver in Bangalore can know precisely where they are, discover nearby points of interest and learn how to reach their destinations. Spatial computing technology is what powers the Foursquare check-in, the maps app on your smartphone, the devices used by scientists to track endangered species, the routing directions that help you get from point A to point B, the precision agriculture technology that is revolutionizing farming, and the augmented reality devices like Google Glass that may soon mediate our interaction with the real world.

This course introduces concepts, algorithms, theory and design of spatial computing technologies, big data in spatial analysis, spatial data mining and computational problems. Spatial knowledge is boundless, so start your classic journey now by learning about geospatial data methods and tools and equip yourself with practical skills in spatial analysis.

Course Content

Introduction to spatial computing – spatial thinking, fundamental ideas underlying the geo-spatial services (e.g. Uber, Google Maps), exploratory analysis of spatial data, digital road map, spatial association, spatial data objects, big spatial data analysis, real time spatio-temporal data modelling and processing, spatial prediction, spatial analysis in business intelligence and routing, spatial time series.

Computational methods and tools – understanding spatial statistical relationships, parametric and nonparametric classification of remotely sensed data, clustering in spatial data, PCA, data fusion, subpixel classification, hyperspectral data analysis, Google Earth Engine.

Case studies – crime hotspots, epidemic, fraud detection, evacuation route planning.

Assessments (optional for Special Topics courses)

- Paper presentation (30 marks)
- Project (40 marks)
- Final exam (30 marks)

Text Book / References

There is no text book. Individual topics will be covered from various resources. The course will be based on recent research literature from peer-reviewed journals and conferences.

__Prep Term__: July; __Term I__: Aug – Nov; __Term II__: Jan – Apr; __Term III__: Jun – July;

DS/NC 866: ADVANCED MACHINE PERCEPTION

GENERAL COURSE INFORMATION

Course Name	Advanced Machine Perception
Term	Term II (Jan-May 2018)
Instructor(s)	Dr. Dinesh Babu J
Course credits	4
Pre-requisite(s)	Machine Perception or Machine Learning

COURSE OVERVIEW AND OBJECTIVES

This course will advance the modeling concepts taught in the Machine Perception or Machine Learning course to include Neural networks, Deep Neural Networks, Time series models, and Graphical models. The applications will include robust object recognition, basics of speech recognition, document categorization, and object tracking.

COURSE CONTENTS

Topics covered in the course include:

- Neural Networks, Deep Neural Networks
- Convolutional Neural Network
- Gaussian Mixture Models (GMM)
- Parameter estimation using Expectation maximization (EM)
- Hidden Markov Model
- Kalman Filtering, Particle Filtering
- Sequence Modeling using RNN and LSTM
- Autoencoders
- Bayesian and MAP parameter estimation: Probablistic Latent Semantic Analysis (PLSA) and Latent Dirichlet Allocation (LDA)
- Directed vs Undirected models;
- Deep graphical models

- Applications: Character/Object recognition; Skin detection; Speaker and Language recognition; Object Tracking; Document clustering;
- Implementation of Deep Neural Networks in TensorFlow

GRADING

4 Assignments(60%);

Mid sem (20%)
End sem (20%);

TEXT BOOK AND REFERENCES

1. Bishop, Christopher M. *Pattern recognition and machine learning*. Springer, 2006.

2. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

<DS/SP 823: AUTOMATIC SPEECH RECOGNITION>

GENERAL COURSE INFORMATION

Course Name	Automatic Speech Recognition (ASR)
Term	Term II (Jan-May 2020)
Instructor(s)	Dr. V. Ramasubramanian
Course credits	4
Pre-requisite(s)	Maths-for-ML, Machine Learning

COURSE OVERVIEW AND OBJECTIVES

This course is a specialized course on algorithms for automatic speech recognition (ASR), especially the so-called GMM-HMM paradigm of ASR which constitutes the main framework of ASR that further led to recent deep-learning frameworks such as the DNN-HMM framework. The course comprises of: i) Basics of speech signal processing, ii) Speech recognition based on hidden Markov models (HMM) covering theory and associated algorithms and iii) Large vocabulary continuous speech recognition (LVCSR) with emphasis on acoustic-models (GMM-HMMs) and continuous speech 'decoding' algorithms.

COURSE CONTENTS

1. **Speech Signal Processing:** Basics of speech signal processing leading towards extraction of features for further machine learning algorithms to work on. This will comprise of: Digital representation of speech signals, basics of speech production and hearing, acoustic-phonetics, LTI basics (convolution, impulse response, transfer function), time-domain analysis, frequency domain representation, short-time analysis, spectrogram, STFT, homomorphic processing, short-time feature representation and feature extraction.
2. **Hidden Markov models (HMMs):** Discrete and continuous density HMMs; evaluation problem - forward, backward algorithms; Viterbi algorithm; HMM training – EM algorithm, Baum-Welch algorithm; proof by Q-functions; segmental K-means (SKM) algorithm; HMM based IWR
3. **Decoding Algorithms and Large vocabular continuous speech recognition (LVCSR):** HMM based Connected word recognition (CWR); HMMs with Non-emitting states (NES) for CWR/CSR decoding; Viterbi decoding algorithm; Forced-alignment; Continuous speech recognition (CSR) decoding: Flat-lexicon, Tree-lexicon, Token-passing algorithms, FST frameworks, Language models, N-best decoding, Lattice rescoring, LVCSR issues.
4. **Acoustic models**: Acoustic model training (context-independent monophone and context-dependent triphone models, context clustering by decision trees), Embedded re-estimation; Acoustic sub-word unit approaches.
5. **Current trends:** An introduction to Aug-Dec 2019 course: "Deep Learning based ASR"

GRADING

- 4 Assignments (40%), 3 Projects (30%), Theory (30%) = Mid Sem (15%); End Sem (15%)

TEXT BOOK AND REFERENCES

For Module1 (Speech Signal Processing):

1. L.R. Rabiner and R.W. Schafer, "Digital Processing of Speech Signals", Prentice Hall.
2. T. F. Quatieri, "Discrete Time Speech Signal Processing", Prentice Hall, 2002

For Module 2 (Hidden Markov Models)

1. L. R. Rabiner and B. H. Juang, Fundamentals of speech recognition, Prentice Hall, 1993.

For Modules 3 and 4 (Decoding algorithms, LVCSR, Acoustic Models)

1. HTK Book, Cambridge University Engineering Dept. (CUED), UK.
2. X. Huang, A. Acero and W. H. Hon, 'Spoken language processing: A guide to theory, algorithm and system develoment', Prentice Hall, 2001

For Module 5 (Current Trends): Dong Yu and Li Deng, "Automatic speech recognition: A deep learning approach", Springer – Verlag-London, 2015. (Authors are from Micorsoft Research, Redmond

Course Handbook

Course Name	**Bayesian Methods and Probabilistic Graphical Models (DS/SP 828)**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS / SP-PR
Semester	Spring (Jan-May) - 2018

Pre-Requisites (where applicable, specify exact course names)

- Maths for IT and ML-I
- First Course in Algorithms

*Those opting for this course would require to have got at least a **B** in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

Course Description

This course is intended to be an intense, in-depth course in Bayesian Analysis and Probabilistic Graphical Models. These two are not necessarily dependent on each other but there is a synergy between the two that this course will hope to highlight. Bayesian methods have emerged as a powerful tool in Machine Learning to reason under uncertainty, to have a principled way to deal with (account for) typical strategies in ML like regularization --- in the Bayesian framework these often turn out to be 'natural' consequences and do not appear as an ad-hoc 'bolt-on'. Bayesian methods work very well in low-resource conditions and on-line learning. The first part (about 1/3-rd of the course) of the course does a deep dive into Bayesian methods. The second part (about 2/3-rd of the course) covers probabilistic graphical models in detail including directed and undirected graphical models and an overview of causal analysis.

Primary references for the course would be:

1. Kevin Murphy. **Machine Learning – A Probabilistic Perspective**. The MIT Press 2012. ISBN 978-0-262-01802-9.
2. Daphne Koller and Nir Friedman, **Probabilistic Graphical Models –- Principles and Techniques**, MIT Press, 2009, .
3. David Barber, **Bayesian Reasoning and Machine Learning**, Cambridge University Press, 2012, ISBN 978-0-521-51814-7.

Course Content

1. **Module 1 (Bayesian Theory. Reasoning, Inference)**
   - Bayesian reasoning/inference – Priors, Posteriors, Conjugacy
   - Bayesian Model Selection
   - MAP Estimation
   - Bayesian Decision Theory
   - Revisiting some of the familiar ML problems – regression etc. - in a Bayesian setting
   - Variational Bayes --- Variational Methods in Bayesian Analysis, ELBO (Evidence Lower Bound), Variational Approximations, Latent Dirichlet Allocation
   - Uncertainty and Bayesian Analysis --- look at some of the recent results on uncertainty estimates in deep neural networks using Bayesian Arguments

   Suggested Additional Reading:

   a) James V. Stone, Bayes' Rule – A Tutorial Introduction to Bayesian Analysis, Sebtel Press, 2013, ISBN 978-0-9563728-4-0.
   b) Andrew Gelman et. al., Bayesian Data Analysis, CRC Press, 2014. ISBN-13:978-1-4398-9820-8.
   c) Isabelle Guyon, "Model Selection: Beyond the Bayesian/Frequentist Divide", IJMR 11 (2010) 61-87.
   d) B. Efron. "Why isn't everyone a Bayesian?". The American Statistician, Vol. 40, No. 1 (Feb., 1986), pp. 1-5.
   e) Uncertainty in Deep Learning (2016), Yarin Gal, Ph.D. Thesis. [pdf]
   f) Tutorial on Variational Autoencoders (2016), C. Doersch. [pdf]
   g) Deep neural networks are easily fooled: High confidence predictions for unrecognizable images (2015), A. Nguyen et al. [pdf]

2. **Module 2 (Introduction to Probabilistic Graphical Models)**
   - Basics – Chain rule, conditional independence, Graphs and joint-probabilities, Markov Conditions, Markov Blankets, Factorization, d-separation rule, i-Map

- Markov Networks (undirected) vs Bayesian Networks (directed)
- Marginalization, Variable Elimination
- Inference, Parameter Learning and Structure Learning in PGMs
- Factor Graphs

Suggested Additional Reading:

a) Daphne Koller, Nir Friedman, Lise Getoor and Ben Taskar, **Graphical Models in a Nutshell** [pdf]

b) Kevin P. Murphy, **An Introduction to Graphical Models** [pdf]

c) Michael I. Jordan, **An Introduction to Graphical Models** [pdf].

d) Denis D. Mauá, **Introduction to Probabilistic Graphical Reasoning** [pdf]

3. Module 3 (Directed Graphical Models --- Bayesian Networks)

- Parameter Learning in Bayesian Networks using Conditional Probability Tables
- Template-based Representations - Plate models
- Inference in BBN – Junction Tree Algorithm, Variational Methods, MCMC Method
- Approximate Inference
- MAP inference
- BBN Structure Learning
- Gaussian and Hybrid BBNs
- Dynamic and Temporal Bayesian Networks

Suggested Additional Reading:

a) Richard E. Neapolitan, Learning Bayesian Networks, ISBN-13: 978-0130125347.

b) Kevin Murphy, “Dynamic Bayesian Networks: Representation, Inference and Learning”, Ph.D Thesis, UC Berkeley, 2002.

c) David Heckerman, “A Tutorial on Learning With Bayesian Networks”, MSR Technical Report, 1996.

d) Zoubin Ghahramani, “Learning Dynamic Bayesian Networks” [pdf]

4. Module 4 (Undirected Graphical Models)

- Markov Models, Gibbs Distriution
- Clifford-Hemmersley Theorem
- Markov Random Fields, Conditional Random Fields
- Restricted Boltzman Machines

Suggested Additional Reading:

a) Conditional random fields as recurrent neural networks(2015), S. Zheng and S. Jayasumana. [pdf]

b) Combining Graphical Models and Deep Learning (2017), Mathew James, Deep Learning (DLSS) and Reinforcement Learning (RLSS) Summer School, Montreal 2017, [html]

5. **Module 5 (Causal Analysis)**
   - Causal Models
   - Structural Identifiability
   - Counterfactuals
   - Causal Inference and do-calculus

Suggested Additional Reading:

a) Judea Pearl, "Causality: Models, Reasoning and Inference", 2^{nd} Edition, Cambridge University Press, 2009, ISBN-13: 978-0521895606

Assessments

The evaluation will include three components –- the weightage out of 100 for each component is shown in in brackets.

- A reasonably big project involving graphical models (4**0**)
- Online Quizzes (**30**)
- Take Home Exam (**30**)

DS 707 DATA ANALYTICS
Term I (2016-17)

GENERAL COURSE INFORMATION

Course Name	DS 707 Data Analytics
Instructors	Prof. Chandrashekar R rc@iiitb.ac.in
Course credits	4
Pre-requisite	a) DS 501 Data Management b) Good knowledge of probability and statistics c) Data Modeling (desirable)

COURSE OVERVIEW

Information explosion pervades all spheres of computing. The computational and regulatory need of day-to-day transactional data ranges from a few days to not more than a few months. However, with decreasing costs of data storage, transactional data is being retained for several years now in order to derive additional insights from the transactional data. The process of deriving this additional insight from vast quantities of data is referred to as Data Analytics. This course builds on the knowledge gained in the Data Modeling course by taking a look at some deeper aspects of data warehouses, online analytical processing (OLAP), and data mining.

Outcomes

At the end of the course, the student should be able to:

- Explain the various terminologies associated with Analytics
- Have a good understanding of OLAP techniques
- Learn basic descriptive analytics using spreadsheet and data visualization tools
- Understand and apply data mining algorithms on datasets using R
- Obtain hands-on experience of the end-to-end data analytics process

COURSE CONTENTS

- Introduction
  - What is data analytics
  - Different approaches to analytics
  - Related areas of data analytics
- Online Analytic Processing (OLAP)
  - Review the major features and functions of OLAP
  - Dr. Codd's OLAP guidelines
  - hypercubes, drill-down and roll-up, and slice-and-dice
  - Examine the different OLAP models (ROLAP, MOLAP, etc.)
  - OLAP implementation by studying the steps and the tools
- Data Mining
  - Introduction to Data Mining concepts
  - Preliminaries
    - Review of concepts from statistics
    - Data Preparation and Data Reduction techniques
    - Introduction to R
  - Classification
    - Review of Naive Bayes classifier
    - Decision Tree/Random forests, over fitting, performance evaluation of classifiers

        - Maximum likelihood
        - Rule-based classifiers
        - Support vector machines (SVM)
    - Cluster Analysis
        - Review of K-means algorithm
        - Hierarchical clustering techniques (agglomeative, divisive)
        - Iso-data clustering
    - Association analysis
        - Review of Apriori and FP Growth;
        - Recent advances in efficient frequent itemset generation approaches
        - Handling categorical and continuous attributes
        - Sequential and infrequent patterns

Class projects discussions and demos

GRADING

Final grade will be based on weights given below:
30%: Mid-Term Exam
15%: Tests / assignments
20%: Project
30%: End-Term Exam
5%: Instructor Discretion (Class participation, etc.)

REFERENCE MATERIAL

- Data Warehousing Fundamentals by Paularj Ponniah
- Data Mining by Pang-Ning Tan, Michael Steinbach, Vipin Kumar
- Han, J., and Kamber, M., Data Mining Concepts and Techniques, Morgan Kaufman Publisher, 2001.
- Richard J. R., and Michael W. G., Data Mining: A Tutorial-Based Primer, Addison Wisley, 2003.
- Recent Literature.

CHEATING AND PLAGIARISM

This course has zero tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor.

DEADLINES

Unless noted otherwise, all deadlines are due at date and time indicated in LMS

LATE POLICY

- 4 - 24 hours late submission: 25% penalty
- 24 - 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

ANNEXURE

What is Plagiarism

Many people think of plagiarism as copying another's work, or borrowing someone else's original ideas. But terms like "copying" and "borrowing" can disguise the seriousness of the offense:

According to the *Merriam-Webster OnLine Dictionary*, to "plagiarize" means

1) to steal and pass off (the ideas or words of another) as one's own
2) to use (another's production) without crediting the source
3) to commit literary theft
4) to present as new and original an idea or product derived from an existing source.

In other words, plagiarism is an act of fraud. It involves both stealing someone else's work and lying about it afterward. But can words and ideas really be stolen?

According to U.S. law, the answer is yes. In the United States and many other countries, the expression of original ideas is considered intellectual property, and is protected by copyright laws, just like original inventions. Almost all forms of expression fall under copyright protection as long as they are recorded in some media (such as a book or a computer file).

All of the following are considered plagiarism:

- turning in someone else's work as your own
- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)

Attention! Changing the words of an original source is not sufficient to prevent plagiarism. If you have retained the essential idea of an original source, and have not cited it, then no matter how drastically you may have altered its context or presentation, you have still plagiarized

Most cases of plagiarism can be avoided, however, by citing sources. Simply acknowledging that certain material has been borrowed, and providing your audience with the information necessary to find that source, is usually enough to prevent plagiarism.

Course Proposal Template

Course Name	Image Analysis
Course Proposer Name(s)	Prof. G.S.Raghavan
Course Instructor Name(s)	Prof. Neelam Sinha
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Special Topics
Credits	2
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E –** Networking & Communication and Embedded Systems **SE** – Software Engineering	(Choose at most two areas from the list) DS, NC & E
Semester	Term: II Academic Year: 2017-18
Pre-Requisites (where applicable, specify exact course names)	
Course Description	
Image processing : To understand basic aspects of images; manipulate them and extract simple intuitive features	
Course Content	
Course Contents : Image attributes, Formats, Color models, Histogram, Point-based operations, Hough Transform, Frequency domain analysis – Fourier Transform, Thresholding, Edge map, Canny Edge Detector, LoG, Contour extraction	
Assessments (optional for Special Topics courses)	
Homework assignments, Paper-presentation, Project	
Text Book / References	
1. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods	

Prep Term*: July;* ***Term I****: Aug – Nov;* ***Term II****: Jan – Apr;* ***Term III****: Jun – July;*

Template Version Number	1.6
Template update date	07 Mar 2013

Course Proposal Template

Course Name	Speech Processing
Course Proposer Name(s)	Prof. Dinesh
Course Instructor Name(s)	Prof. V. Ramasubramanian
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	• Special Topics
Credits	2
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	(Choose at most two areas from the list) DS, NC & E
Semester	Term: II Academic Year: 2017-18
Pre-Requisites (where applicable, specify exact course names)	
Course Description	
Speech processing: To cover the basic signal processing techniques specifically applicable to speech signals, leading to understanding of short-time speech feature representation and extraction (e.g. spectral features), that are in turn the starting point for the more specialized treatments on automatic speech recognition (ASR) and deep-learning methods for ASR.	
Course Content	
Course Contents: Digital representation of speech signals, basics of speech production and hearing, acoustic-phonetics, LTI basics (convolution, impulse response, transfer function), time-domain analysis, frequency domain representation, short-time analysis, spectrogram, STFT, homomorphic processing, short-time feature representation and feature extraction.	
Assessments (optional for Special Topics courses)	
Homework assignments, Project, Test	
Text Book / References	
1. Digital Processing of Speech Signals by L.R. Rabiner and R.W. Schafer 2. Discrete Time Speech Signal Processing by T. F. Quatieri, Prentice Hall, 2002	

***Prep Term**: July; **Term I**: Aug – Nov; **Term II**: Jan – Apr; **Term III**: Jun – July;*

Template Version Number	1.6
Template update date	07 Mar 2013

Course Proposal Template

Course Name	Designing Gaming Simulations
Course Proposer Name(s)	Prof. Dinesh Babu J
Course Instructor Name(s)	Prof. Sebastiaan Meijer (Visiting Faculty) Prof. Dinesh Babu J (Faculty)
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	Select one from the following: • Special Topics
Credits	4 (TBD)
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DS – Data Science NCE – Networking , Communication SE – Software Engineering	NCS and DS
Semester	Term: Fall Year:2014

Pre-Requisites (where applicable, specify exact course names)

The students are expected to have functional knowledge of one programming language and have a preliminary knowledge of discrete mathematics and numerical analysis.

Course Description

Gaming Simulations allow the participants to explore the solution space for complex socio-technical problems with the different stake-holders through a visual medium. The non-confrontational, yet realistic environs of games present scenarios that provide for multiple ideas to co-exist. This allows the participants and the creators to understand possible effects of policies. Gaming simulations have been used for training personnel and to create awareness. With the advent of the virtual medium, the power of gaming simulations has increased by allowing to create more analytical tools that can compute and present the participants with more realistic scenarios and feedback to their actions. Computational tools enable the use of gaming simulations in much more complex scenarios and help analyse the results from game sessions for policy design, training, learning and awareness.

At the end of the course each student should be capable of the following:

- Differentiate between gaming simulation and entertainment games.
- Assess what problems can be approached with a gaming simulation.
- Understand and differentiate between gaming simulation for education, design, policy making and hypothesis testing.
- Understand the limitations of gaming simulations and their validity requirements.
- Identify the constituent parts of a gaming simulation.

- Understand the process of conducting game-sessions, the different stages in game sessions, roles of facilitators, players and note-takers in game sessions.
- Understand collection and analysis of data from game sessions for research purposes.
- Draft the design specifications of a gaming simulation.

Course Content

Modules

#	Name	Description	Outline
1	Introduction (2 Lectures)	Games have been an integral part of society for a long time. There are various types of games: board games, card games, computer games, sports etc. Games are generally associated with 'fun' and recreation. The last few decades, however, have seen an increase in the use of games for purposes other than entertainment. Games/Gaming have been used for military purposes (war gaming), policy design, teaching and training, and participatory planning to name a few. The first part of the course will focus on the history of serious games and how they gained recognition.	• History • Uses • Various definitions of games • Different types of serious games • Characteristics of serious games • Problem areas that can be addressed: Wicked problems, Problem definition with multiple stakeholders, Negotiations, Behavioural analysis, Immersive training, Awareness and teaching
2	Design: Game elements and mechanics (6 Lectures)	As with any other fields, there are various ways to approach serious game design. A game framework also includes game elements, mechanics, objectives and the game model/data. Apart from defining the framework, one approach commonly followed is iterative design with play-testing.	• Introduction to different styles of designing serious games • Differences between designing for entertainment games and serious games. • Designing through paper-based prototypes. • Iterative design through play-testing • Objectives of the game • Game elements, mechanics • Involvement of the stakeholders • Documenting the process
3	Verification, Validation &	A good game should model the real world in just the necessary amount of	• Validity and Verification • Differences between

	When to play? (3 Lectures)	detail; simplify it too much and the game loses touch with reality; complicate it too much with various rules, elements etc., and the game becomes hard to play. Often, serious games are built with the dual objectives of research and learning. This can lead to issues around validity of the environment being modelled for the players. The game environment should be credible enough for the players to participate, provide the players with utility in the real-world and should provide them with "reasonably sound" reference points in the real-world. Although games have been used historically to understand problems in various fields, they cannot be used as a tool for every problem. Given any domain/problem, it is the responsibility of the game designer, along with domain experts, to understand whether or not games could be used to address the problem. Games have been used to address problems that involve multiple stakeholders and the interactions and negotiations between them. Training that requires immersive virtual reality could be done through games. Games have also been used widely for classroom teaching purposes. Developing games in each of these areas requires a different skill set.	gamification and serious games • Perception and acceptability
4	Analysing Group Dynamics (4 Lectures)	An integral part of game sessions are small group face-to-face interactions, where groups brainstorm or make decisions. Social psychology and organizational behaviour literature has long studied group dynamics and defined those constructs which define the composition of groups, how they communicate to each other and perform. Recently, thanks to new sensing, signal processing, and	

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		machine learning techniques, automatic analysis of group dynamics is increasingly becoming a reality. In this module, students will be exposed to basics of small group dynamics in face-to-face interactions. Then, some basic tools for audio-visual signal processing and machine-learning will be introduced (without going into details). Finally, some sample automatic analysis results will be shared.	
5	Conducting game Sessions and analyzing results (1 Lecture)	The game facilitator is an integral part of games. In paper-based games, it is the role of the facilitator to inform the players about their roles in the game during briefing session, moderate the game session, and debrief the players about their performance in the game during debriefing session. As serious games are built with the objectives of research and learning, observing game sessions and the data from these observations (qualitative and quantitative) become crucial to the learning outcomes and to further the design of the game itself. For certain computer based games, the computer plays the role of the facilitator. Some computer games do require facilitation and the role of the facilitator varies according to the game.	• Briefing and de-briefing sessions • Moderating game sessions • Observation and notes • Feedback session • Analysis of game results and outcomes

Assessments (optional for Special Topics courses)

#	**Name**	**Assignments**
1	Introduction	• A review of a commercial game • A review of a serious game • Paper-based prototype to modify any game of their choice
2	Design: Game elements and mechanics	• Virtual prototype of the game that was submitted in the previous module • An analysis of two games, one paper based game and a virtual game to describe the game elements, rules and mechanics
3	Verification, Validation	• A 2 page description of the game that will be created by

	& When to play?	them at the end of the course. • Modify an existing serious game
4	Analysing Group Dynamics	
5	Conducting game Sessions and analyzing results	• Play-test the game developed in the previous modul modify the game based on the game sessions. • Submit final game proposal for the course

Final assignment
In the final 6 weeks, the students will create a gaming simulation based on the principles and will have to conduct a minimum of two game sessions for the games developed.

Text Book / References

#	Name	Essential	Additional
1	Introduction	1. Serious Games, Clark Abt, Chapter 1: The Reunion of Action and Thought. 2. The Art of Computer Game Design, Chapter 1 "What is a game?" and 2 "Why do people play games?", Chris Crawford,1982. 3. Rules of Play: Game Design Fundamentals, Chapter 1 "What is this book about?" by Katie Salen, Eric Zimmerman, MIT Press, 2004; 4. Gaming: The future's language, Richard Duke, 1974; Preface and Chapter 1 "The problem". 5. Elverdam, C., & Aarseth, E. (2007). Game Classification and Game Design	1. Chapters 19 and 20, Optimal experience: Psychological studies of flow in consciousness. Csikszentmihalyi, I. S. (Ed.). (1992). Cambridge University Press. 2. History of Gaming from Florian Smolka on Vimeo: http://vimeo.com/18743950. 3. Ratan, R., & Ritterfeld, U. (2009). Classifying serious games. Serious games: Mechanisms and effects, 10-24.
2	Design: Game elements and mechanics	1. Rules of Play: Game Design Fundamentals by Katie Salen, Eric Zimmerman, MIT Press, 2004	1. Zyda, M. (2005). From visual simulation to virtual reality to games. Computer, 38(9),

		2. Triadic Game Design by Casper Harteveld, Springer, 2011. 3. Game Design Workshop: A Playcentric Approach to Creating Innovative Games by Tracy Fullerton, Christopher Swain, Steven Hoffman, Morgan Kaufmann, 2008. 4. Chapter 25: Good games are created through playtesting. The Art of Game Design: A book of lenses by Schell, J. (2008). CRC Press.	25-32. 2. Geurts, J. L., & Joldersma, C. (2001). Methodology for participatory policy analysis. European Journal of Operational Research, 128(2), 300-310. 3. Cecchini, A., & Rizzi, P. (2001). Is urban gaming simulation useful?. Simulation & Gaming, 32(4), 507-521.
3	Verification, Validation & When to play?	1. The gaming of policy and the politics of gaming, Igor Mayer, Simulation and Gaming, 2009 2. Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games. Journal Of Educational Psychology, 105(2), 249-265. 3. Peters, V., Vissers, G., & Heijne, G. (1998). The validity of games. Simulation & Gaming, 29(1), 20-30. 4. Games for participatory planning, FoV white paper, 2012	1. Garson, G. D. (2009). Computerized Simulation in the Social Sciences A Survey and Evaluation. Simulation & Gaming, 40(2), 267-279. 2. Robinson, S. (2008). Conceptual modelling for simulation Part I: definition and requirements. Journal of the Operational Research Society, 59(3), 278-290. 3. Feinstein, A. H., & Cannon, H. M. (2002). Constructs of simulation evaluation.Simulation & Gaming, 33(4), 425-440. 4. Games for Health,

			FoV white paper, 2012 5. Games for Safety, FoV white paper, 2012. 6. Homo Ludens: A Study of the Play-Element in Culture by Johan Huizinga, Routledge, 2003.
4	Analysing Group Dynamics	1. Thiran, Jean-Philippe, Ferran Marqus, and Herve Bourlard. Multimodal Signal Processing: Theory and applications for human-computer interaction. Academic Press, 2009. 2. Gatica-Perez, Daniel. "Automatic nonverbal analysis of social interaction in small groups: A review." Image and Vision Computing 27, no. 12 (2009): 1775-1787. 3. iii. Jayagopi, Dinesh Babu. "Computational modeling of face-to-face social interaction using nonverbal behavioral cues." PhD diss., Ecole Polytechnique Fédérale de Lausanne, 2011.	
5	Conducting game Sessions and analyzing results	1. Chapter 13: Players play games through an interface and Chapter 14: Experiences can be judged by their interest curves. The Art of Game Design: A book of lenses by Schell, J. (2008). CRC Press. 2. Hofstede, G. J., & Meijer, S. (2007). Collecting empirical data	1. Breuer, J. S., & Bente, G. (2010). Why so serious? On the relation of serious games and learning. Eludamos. Journal for Computer Game Culture, 4(1), 7-24. 2. Bergeron, B. (2006). Developing Serious Games (Game

			with games. Organisation and learning through gaming and simulation: Proceedings of ISAGA, 111-121.		Development Series).	
				3.	Crookall, D. (2010). Serious games, debriefing, and simulation/gaming as a discipline. Simulation & Gaming, 41(6), 898-920.	

***Spring Term**: Jan – Apr; **Summer Term**: Jun – July; **Prep Term**: July; **Fall Term**: Aug – Nov*

DS/SE 603 DATA MODELING
TERM II (2016-17)

GENERAL COURSE INFORMATION

Course Name	DS/SE 603 Data Modeling
Instructors	Prof. Chandrashekar R Office No. 116 rc@iiitb.ac.in
Course credits	4
Pre-requisite	a) Database Systems b) Knowledge of Java or any web application development c) A liking for data!

COURSE OVERVIEW

This course will provide an in-depth understanding of data modeling both from a theoretical as well as a practical point of view. Building on the concepts introduced Database Systems core course, this course aims to provide a thorough understanding of advanced data modeling concepts. In particular, the course will cover in detail advanced relational database concepts, XML, object-oriented databases and Data Warehouse concepts. The emphasis is not only on the logical aspects of data modeling but also the physical/implementation aspects of these data models using freely available software.

COURSE CONTENTS

Introduction to Data Models and the basics

- The 'what', 'why' and 'who' of data models
- The Layers: External Schema, Conceptual Schema, Internal Schema
- The Big Picture – Enterprise Architecture

Review of Traditional Data Models

- Hierarchical Data Model
- Network (CODASYL) Data Model
- Relational Data Model

A review of semantic data models (Self-study)

- (ER, EER, TAXIS, SDM, SAM, etc.)
- Popular Tools (TOAD Modeler, ERWin)

More RDBMS

- Codd's Rules
- Review of Normal Forms (3NF,BCNF)
- Other normal forms (4NF, 5NF)
- Review of contemporary Relational Database Literature

Data Modeling for Data Warehousing

- Dimensional data modeling
    - Introduction to data warehousing, OLAP, etc.
    - Concepts: Fact tables, Dimension tables, Snowflaking, Surrogate Keys, Conformed Dimensions, Conformed Facts, Slowly changing dimensions, degenerate dimensions, factless fact tables
- Online Analytic Processing (OLAP)
    - Review the major features and functions of OLAP
    - Dr. Codd's OLAP guidelines
    - hypercubes, drill-down and roll-up, and slice-and-dice
    - Examine the different OLAP models (ROLAP, MOLAP, etc.)
    - OLAP implementation by studying the steps and the tools
    - OLAP through SQL

Data models for BigData

- What is Big Data
- "BigData" versus "big data"
- Data models for BigData
- NoSQL concepts
- BigData architectures and programming models

Semantic Web Concepts

- The vision
- Describing Web Resources using RDF
- Web Ontology Language: OWL

Other Topics (Depending upon availability of time)

- Spatial data models
- Temporal data
- Stream data
- Review of data exchange data models
- Data models for web development
- Data models for the cloud

Class projects discussions and demos

COURSE CALENDAR*

TBD
* Topic schedule subject to change

GRADING

Final grade will be based on weights given below:
30%: Mid-Term Exam
20%: Tests / assignments
15%: Project
30%: End-Term Exam
05%: Instructor discretion

REFERENCE MATERIAL

- Selected chapters from books and papers from the literature
- *The Data Warehouse Toolkit: The Complete Guide to Dimensional Modeling*, 2nd Edition, R. Kimball and M. Ross, John Wiley & Sons
- Other research papers and reference material to be given as needed

CHEATING AND PLAGIARISM

This course has zero tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor.

DEADLINES

Unless noted otherwise, all deadlines are due at **10:00 AM** on the date indicated

LATE POLICY

- 4 - 24 hours late submission: 25% penalty
- 24 - 48 hours late submissions: 50% penalty
- > 48 hours late submissions: 75% penalty

ANNEXURE

What is Plagiarism

Many people think of plagiarism as copying another's work, or borrowing someone else's original ideas. But terms like "copying" and "borrowing" can disguise the seriousness of the offense:

According to the *Merriam-Webster OnLine Dictionary*, to "plagiarize" means

1) to steal and pass off (the ideas or words of another) as one's own
2) to use (another's production) without crediting the source
3) to commit literary theft
4) to present as new and original an idea or product derived from an existing source.

In other words, plagiarism is an act of fraud. It involves both stealing someone else's work and lying about it afterward. But can words and ideas really be stolen?

According to U.S. law, the answer is yes. In the United States and many other countries, the expression of original ideas is considered intellectual property, and is protected by copyright laws, just like original inventions. Almost all forms of expression fall under copyright protection as long as they are recorded in some media (such as a book or a computer file).

All of the following are considered plagiarism:

- turning in someone else's work as your own
- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)

Attention! Changing the words of an original source is not sufficient to prevent plagiarism. If you have retained the essential idea of an original source, and have not cited it, then no matter how drastically you may have altered its context or presentation, you have still plagiarized

Most cases of plagiarism can be avoided, however, by citing sources. Simply acknowledging that certain material has been borrowed, and providing your audience with the information necessary to find that source, is usually enough to prevent plagiarism.

DT 212: Techno-Economics of Networks (TEN)

GENERAL COURSE INFORMATION

Course Name	**Techno-Economics of Networks**
Term	Term II (2020-21)
Instructor(s)	V. Sridhar
Course credits	4
Pre-requisite(s)	None; MTech 1st year, iMTech 3rd and 4th year; MSc (DS) 1st year Eligible
Time of class	Tu, Th: 4:00-5:30 PM

COURSE OVERVIEW AND OBJECTIVES

Information networks of today encompass a wide variety including the traditional telecommunication networks which enable voice and data communication; peer-to-peer social networks that enable messaging and media transfers; content networks that enable linking of web pages and media; and machine-to-machine networks that transfer information across devices.

This course introduces the **technology, business, and economic** aspects of the above networks, reinforced with theories of **network economics, information theory, game theory, auction theory, and theory of contagion**. The course address about **20 practical questions** and provide **stylistic models to analyze the same.**
At the end of the course, the student will be able to understand:

1. The dynamics of the network industry, properties of diverse types of networks, socio economics of networks.
2. The technology architecture and business models of traditional telecom networks, Internet, social and content networks; adoption in networks; diffusion in networks; critical mass formation in networks.
3. The economics of networks, direct, indirect and cross-side network effects and pricing models of information services and network services platforms.
4. Pricing of network services, demand estimation, supply-demand matching.
5. Techno-economics of Intellectual Property such as patents, trademarks, copyright, and domain names.
6. Techno-economics of standards and their adoption
7. Techno-economics of digital goods and services such as digital content, digital finance including digital currencies
8. Privacy economics and economics of information security

COURSE CONTENTS

1. Information Networks Industry and Market Structure
2. Diffusion and virality in Networks
3. Small world networks; social media networks; network distances
4. Demand for network services and associated pricing models
5. Game theoretic modeling of network strategies: Nash equilibrium, different auction methods, sequential games
6. Methods of assigning radio spectrum to Telcos and associated pricing models
7. Properties of characteristics of digital goods and services
8. Economics of networked industry
9. Platform economics and the start-up industry
10. Two-Sided Markets and associated pricing models

11. Techno-economics of Intellectual Property and standards
12. Partnerships amongst network firms
13. Economics of Privacy

COURSE CALENDAR

Week	Topics
1-2	**Information Networks Industry and Market Structure:** **Q1) Is the landline dead?** Basic Economics: Monopoly and Oligopoly markets, price setting equilibrium in competitive and monopoly markets, natural monopoly, Properties and characteristics of Telecommunication Networks: Basic Fixed Line, Cellular Mobile, landline innovations: Digital Subscriber Loop
3-4	**Network Effects and Valuation of Networks** **Q2) Why are Facebook /Whatsapp/ Hike valued so high?** Network effects: direct and indirect; same side and cross side network effects; Sarnoff, Metcalf and Reed's law of diffusion in networks; Bass model of diffusion – intrinsic and imitation effects, S-shape curves, diffusion of telecom services, adopter distribution **Two-Sided and multi-sided markets** **Q3) Why should Amazon and Flipkart give so much discounts?** Characteristics of two-sided markets, analysis of direct and indirect network externalities, cross side network effects, examples from platforms, mobile value added service, pricing asymmetry in two sided markets, price elasticity of demand, pricing in Two-Sided Markets – subsidy and money sides of platforms, surge pricing and its effects, single homing vs. multi homing, water bed effects **Readings:** ***Network Economics*.** Chapter 1 **in** Sridhar, V. (2012). ***Telecom Revolution in India: Technology, Regulation and Policy*.** New Delhi, India: Oxford University Press. **Discussion Papers:** **[1]** Sridhar, V. Malik, A. (2007). Turning Copper in to Gold: Bharti Airtel's Fixed Line Service in India. Asia Case Research Centre, University of Hong Kong, Case Reference No: 07/329C. **[2]** Briscoe, B., Odlyzko, A., & Tilly, B. (2006). Metcalfe's law is wrong-communications networks increase in value as they add members-but by how much?. IEEE Spectrum, 43(7), 34-39.

5	**Game and auction theories** **Q4) How is Game Theory used in solving near-far problem in CDMA networks?** Fundamentals of game theory, Prisoner's dilemma problem, Best Response and Nash Equilibrium, near-far problem in CDMA networks; internalizing noise in CDMA networks for optimal behaviour **Q5) How does Google make money through Advertisements?** Auctions as games, types of auctions, imperfect information and winner's curse, metrics for measuring success of auctions, single product and multi product auctions, sealed bid versus open auctions, Second Price Auction, VCG auction, simultaneous auctions, packaged auction Application of GSP in Google Advertisement auction **Readings:** Games in Normal Form. In Brown, K-L., and Shoham, Y. Essentials of Game Theory: A Concise, Multidisciplinary Introduction. Morgan & Claypoool Publishers. **What makes CDMA work on my Smartphone.** In *Networked Life: 20 Questions and Answers*. **How does Google sell its ad spaces?** In *Networked Life: 20 Questions and Answers*. **Discussion Papers:** **[3] Cusumano, M. (2018). The sharing economy meets reality. *Communications of the ACM*, 61(1), p: 26-28.**
5-7	**Spectrum for Mobile Services:** **Q6) What are the mechanisms used for auctioning radio spectrum for commercial mobile services? How to measure success of auctions?** Technical and economic characteristics of spectrum, history of spectrum auction in India, spectrum allocation: auction, fixed fee, subscriber linked criterion, spectrum management, spectrum charges, productive and allocative efficiency, spectrum liberalization Mobile industry structure, competition levels, spectrum assignment for each operator, licensing arrangements, spectrum and license fees, forthcoming spectrum auction and its implications, trading, sharing and leasing of spectrum Simultaneous Multiple Round Ascending Auction (SMRA) as practiced in India; rules and guidelines; experience from 2012-2016, packaged auction Incentive auction mechanisms: US 700 MHz broadcast spectrum auction. **Readings:** ***Hyper competition and excessive spectrum fragmentation***. Chapter 10 from: Prasad, R., & Sridhar, V. (2013). **Dynamics of Spectrum Management: Technology, Economics and Case of India.** **Discussion Papers:** **[4] Roth, A. E., & Ockenfels, A. (2002). Last-minute bidding and the rules for ending second-price auctions: Evidence from eBay and Amazon auctions on the Internet. American economic review, 92(4), 1093-1103.** **[5] Rosston, G. (2012). Incentive Auctions. *Communications of the ACM*. 55(2), 24-26.**
	Mid Term Exam

9	**Demand for Networked Products and Services:** **Q7) How does Apple manage to continuously increase the price of iPhones over the years?** Demand pricing of networked products and services, network effect and price effect, inverse demand curve, discrete and continuous cases of demand analysis, pricing of telecom services, individual utility maximization versus social welfare maximization, effects of monoply and new entrants **Discussion Papers:** How does Apple price its iPhones?
9	**Smart and Dynamic Data Pricing** **Q8) Is it optimal for mobile operators to charge 4 p / 10 Kbytes or Rs. 149/- unlimited voice calling and data usage of 1.5 GB/day for 28 days?** pricing of voice servces vs. data services, flat rate and usage based pricing, personalized data pricing, Time dependent pricing, models for shifting demand: rewards and capacity cost based pricing schemes, effects on Net Neutrality **Readings:** **Why do AT&T and Verizon Wireless charge me $10 a GB?** In *Networked Life: 20 Questions and Answers*. **How can I pay less for each GB of data?** In *Networked Life: 20 Questions and Answers*. **Discussion Papers:** **[4] Sen, S., Joe-Wang, C., Ha, S., and Chiang, M. (2015). Smart Data Pricing: Using Economics to Manage Network Congestion. Communications of the ACM, 58(12), 86-93.**
11	**Extensive Form Games and Applications in Telecom:** **Q9) Why is there dispute about International Termination Rate? Do the asymmetry in voice calling between countries matter?** Nash Equilibrium in extensive form games, sub game perfect equilibrium, backward induction methods Pure strategy Extensive Form Games, Conversion to Normal Form Games, Backward induction principles, Nash Equilibrium in Extensive form games, Applications in Telecom: Interconnect Pricing, International settlement rates, 2-stage game application, access network pricing, mobile termination rates **Readings** **Shy, Oz. (2011). Chapter on Telecommunications. The economics of networked industries. Cambridge University Press**

12	**Wisdom of the crowd: E-Commerce Ratings, Virality on the Internet, Influence Functions** **Q10) How do Amazon and Flipkart provide ratings?** **Q11) How to viralize your Youtube video?** Rating methods in E-Commerce sites, products review and ratings, ranking influence, average vs. Bayesian rating Information cascade, Bayesian analysis, private and public information, viralization and influencing in social networks, the Tipping phenomenon, critical mass, power of crowds, Emperor's New Cloth phenomenon, Small World Networks **Readings:** **How can I trust an average rating in Amazon?** In *Networked Life: 20 Questions and Answers*. **How do I viralize a YouTube video and tip a Groupon deal?** In *Networked Life: 20 Questions and Answers*.
13	**Human Networks** **Q12) How does information flow through human networks connected by social media? What is the average network distance in social networks? How does communicable diseases such as COVID-19 propagate through human networks? How to lessen and mitigate reproduction numbers in such networks?** Network of individuals and how it shapes power and influence in social networks; degree centrality and eigen vector centrality; application of influencers in micro finance; small world networks; 6-steps to reach any one; comparison of small world in social networks; contagion and diffusion of infectious diseases; reproduction numbers of contagious diseases such as small pox, SARS and Covid-19; externalities of vaccination and lock-down in containment of diffusion; homophily in networks; Schelling's theorems; effect of homophily in segregation of networks; unemployment, inequality as a result of segregation; examples from urbanization; globalization and its effects on removing homophily. **Readings** **Jackson, Mathew. (2019). The Human Network** **Discussion Papers:** **[8] Kleinberg, J. M. (2000). Navigation in a small world. Nature, 406(6798), 845-845.**

14	**Techno-economics of Intellectual Property** **Q13) What is the economics of Intellectual Property Rights? Why is there dispute and litigation on patents? Should firms invest in IPR?** Economics of Intellectual property such as patents, copyrights, trademarks, trade secrets and domain names. Standard Essential Patents and FRAND conditions **Economics of Technology Upgrades and Standardization** **Q14) When should I upgrade my mobile phone? Should I wait or buy now?** Game theory application in adoption of technology advancements, momentum and inertia of technologies Technology standardization and cross border effects **Discussion Papers:** **[9] Schrage, M., & Van Alstyne, M. (2015). Life of IP. Communications of the ACM, 58(5), 20-23.** **[10] Wen, W., & Forman, C. (2016). Do patent commons and standards-setting organizations help navigate patent thickets?. Communications of the ACM, 59(5), 42-43.**
15	**Game theory applications in Broadcasting:** **Q15) Why do all prime shows are broadcast at the same time? How does a landing page in TV affect programme rating?** Overview of the broadcasting sector, scheduling in prime time slots, game theory formulation with 2 and 3 stations and corresponding Nash equilibrium, social welfare equilibrium, one way viewing problem, game theory in program type competition, price based competition, bundling of TV channels, pure and mixed bundling strategies and corresponding equilibria **Shy, Oz. (2011). Chapter on Broadcasting. The economics of networked industries. Cambridge University Press**
16	**Privacy Economics and Economics of Information Security** **Q16) What is privacy economics? What is the trade-off between privacy and personalized services? Why do security breaches occur all the time?** Economics of privacy: Instant gratification, bounded rationality, hyper discounting Market for Lemons of information security products; personalization and price discrimination Game theoretic analysis of privacy policies, purchase history and cookie policies **Discussion Papers:** **[12] Anderson, R., & Moore, T. (2006). The economics of information security. Science, 314(5799), 610-613.**

17	**Economics of Digital Finance** **Q 17) What is impact of digital finance on cash economy? What is the economics of crypto currencies?** Function and Characteristics of Money, Taxonomy of Digital Finance, Cryptocurrencies, Bitcoin economics **[13] Sompolinsky, Y., & Zohar, A. (2018). Bitcoin's underlying incentives. Communications of the ACM, 61(3), 46-53**
17	**Economics of AI** **Q18) What is the economics of AI? What is the impact of autonomous systems on labour markets and wages?** Impact of AI on labour supply & demand, wages, and skilling; AI Marketplace as a multi-sided market **Discussion Papers:** **[14] Krakovsky, M. (2017). The new jobs. Communications of the ACM, 61(1), 21-23.**
18	**End Term Examination**

GRADING

Discussion Papers

To help anchor the concepts more firmly, student groups will be assigned papers of contemporary issue. Groups will present a critical review of the issues discussed in the paper.

Spectrum Auction

There will be a spectrum auction game in which groups will take on the role of telcos, strategize and bid for spectrum auctioned by the government.

Agent Based Modeling Project

Each group will create an Agent Based Model on MESA (https://mesa.readthedocs.io/en/master/index.html) of a techno-economic problem, create a model, simulate and provide visualization of the model and infer critical decisions for technology and business firms. The different components of the grading are described below:

Component	Marks
In-class attendance (attendance and off-line video viewing) >90%: 10%; 85-90%: 7.5%; 80-85%: 5%; 75-80%-2.5%; <75%: 0%	10%
Spectrum Auction Game & Presentation	10%
Discussion Paper Presentation	10% (1 × 10%)
Quizzes & Assignments	15% (3 × 5%)
Mid Term Exam	15%
End Term Exam	20%
Agent Based Modeling Project: First Stage: 5% Final demonstration: 15%	20%
Total	**100%**

TEXT BOOK AND REFERENCES

Reference Books

1. Chiang, M. (2012). *Networked Life: 20 Questions and Answers*. Cambridge University Press. (an abridged version will be made available as pdf file. Two copies of the book will be kept in reserve in the Library)
2. Shapiro, C., and Varian, H. (1999). Information Rules. Harvard Business School Press.
3. Prasad, R., and Sridhar, V. (2014). The Dynamics of Spectrum Management: Legacy, Technology, and Economics. Oxford University Press, ISBN-13: 978-0-19-809978-9; ISBN-10: 0-19-809978-9.
4. Jackson, M.O. (2010). Social and Economic Networks. Princeton University Press.
5. Oz Shy, "The Economics of Network Industries", Cambridge University Press, 2001.
6. Wilensky, U., & Rand, W. (2015). An introduction to agent-based modeling: modeling natural, social, and engineered complex systems with NetLogo. Mit Press.
7. Hamill, L., & Gilbert, G. N. (2016). Agent-based modelling in economics. Chichester: Wiley.

Course Name	**Technology and Society**
Course Branch	M.Sc. (Digital Society)/iMTech/MTech
Course Proposer Name(s)	Bidisha Chaudhuri
Course Instructor Name(s)	Bidisha Chaudhuri
Course Type	Core/Elective
Course Level	Level 2
Credits	4
Grading Scheme	A,A-,B+,B,B-,C+,C,D,F

Pre-Requisites (where applicable, specify exact course names)

NA

Course Description

Technology can be studied in its different dimension as it comprises of facts, artifacts, know-how, processes and last but not the least contexts. The relationship between technology and society is an established field of study within the social sciences and humanities. Different disciplinary affiliations ranging from the sociology of scientific knowledge to science and technology studies, from the history of technology to the philosophy of technology, have analyzed this relationship. Together, such scholastic approaches touch upon wide-ranging and often complex facets of the relationship between technology and society. Leveraging examples of infrastructural technology, everyday use technologies, communication technologies and digital technologies, this course provides a preliminary overview of these approaches across three aspects of technology, design, adoption and consumption.

The course is divided into three modules. The first module begins with views on what technologies are, how they can be defined and how the concept of technology and its meaning evolved historically. The following section in this module introduces the field of Science and Technology Studies (STS), by presenting an overview of how the technology and its relationship with society is analysed within different scholastic traditions.

The second module introduces theoretical approaches to analyse relationship between technology and society. In doing so, we focus on four major themes: Determinism, Social Construction, Materiality and Neutrality. Each theme represents a distinct way of looking at the technology-society relationship. We will cover a range of cases under each theme and will also discuss how these approaches respond to each other.

The last module touches upon contemporary issues of technology seen through the lens of these above approaches. We look at data, algorithms, artificial intelligence in relation to privacy, surveillance, sustainable and inclusive design and ethics

The objective of this course is to understand the complex and multi-dimensional nature of the technology-society relationship. Using a variety of examples and analyses, this course shows how technology and society co-constitute each other in a historically contingent manner.

Course Outline

Module 1: Introduction – History and Overview. Weeks 1-2.

Module 2: Approaches to study the relationship between technology and society – Determinism, Social Construction, Materiality & Neutrality. Weeks 3-12

Module 3: Contemporary issues around technology. Weeks 12-14.

Wrap Up: Week 15.

Course Outcomes

By the end of the course students are expected to Understand and Know:

- Theoretical insights, current discourses and key concepts relating to the study of technology within social sciences and humanities
- The link between a concrete problem of technology and its interpretation and manifestation in the wider social context.

Students are expected to DO:

- Critically appraise non-deterministic ways of thinking about technology.
- Comprehend the need to understand the context of technology design, adoption and consumption.

Course Content

Module 1: Introduction, History and Overview

Week 1

2/9/2020: Introduction to the course &

1. Li-Hua, R. (2012). “Definitions of technology” in Olsen, J. K. B., Pedersen, S. A., & Hendricks, V. F. *A Companion to the Philosophy of Technology*. John Wiley & Sons. (pp. 18-22).
2. “Can we define ‘Technology’?” in Nye, D. E. (2007). *Technology matters: Questions to live with*. MIT Press. (pp. 1-16)

Week 2

7/9/2020: History of Technology

3. Feenberg, A. (2010). Ten paradoxes of technology. Techné: Research in Philosophy and Technology, 14(1), 3-15.
4. Marx, L. (1997). "Technology": The Emergence of a Hazardous Concept. Social Research, (pp. 965- 988)

9/9/2020: Science and Technology Studies: Overview I

5. Kuhn, T. S. (1962). The Structure of Scientific Revolutions. Chicago (University of Chicago Press) 1962. Chapters 2 and 4 (pp. 10-22 and 35-42)
6. Merton, R.K. (1942). Sociology of Science: Theoretical and Empirical Investigations. University of Chicago press. Chapter 13: Normative Structure of Science, pp. 267-27
7. Sismondo, S. (2008). Science and Technology Studies and an Engaged Programme in Hackett, E.J. et al. (ed.) (2008) *The Handbook of Science and Technology Studies, Third Edition*. MIT Press (pp.13-32)
8. Roosth S. & Silbey S. (2009). “Science and technology studies: From controversies to posthumanist social theory” in Turner, B. S. (Ed.) *The new Blackwell companion to social theory*. John Wiley & Sons. (pp. 451- 474)

Week 3

Module 2: Approaches to study the relationship between technology and society

14/9/2020: The Myth of Technology Determinism I

9. “Does Technology Control us” and “Is Technology Predictable?” in Nye, D. E. (2007). *Technology matters: Questions to live with*. MIT Press. (pp. 17-32)
10. Heilbroner, R. L. (1967). Do machines make history? *Technology and culture*, (pp.335-345)
11. Bimber, B. 1990. Karl Marx and Three Faces of Technological Determinism in Social Studies of Science, Vol. 20, No. 2 (May, 1990), pp. 333-351

16/9/2020: The Myth of Technology Determinism II

12. Williams, R. (2003). The technology and the society. *Television: Critical concepts and cultural studies*, *2*, (pp.42-57)

13. Adas, M. (1990). *Machines as the measure of men: Science, technology, and ideologies of Western dominance*. Cornell University Press
14. Ceruzzi, P. E. (2005). Moore's law and technological determinism: Reflections on the history of technology. *Technology and Culture*, *46*(3), (pp.584-593)
15. Harvey, D. (2003). The fetish of technology: Causes and consequences. *Macalester International*, *13*(1), 7.

Week 4

21/9/2020: Reading Presentations 1: 6 Slots (Readings 1-15)

23/9/2020: Social Construction of Technology- I

16. Bijker, W.E. (2001) "Social Construction of Technology" in Smesler, N. J., & Baltes, P. B.(Ed.) International encyclopedia of social and behavioural sciences. Elsevier Science. (pp 15522- 15527)
17. MacKenzie D. & Wacjman J. (2011). "Introductory essay: The Social Shaping of technology" in *The Social Shaping of Technology* (2nd edition). Open University Press, (pp. 3-27)
18. MacKenzie, D. A. (1998). "Introduction" and "Social and Economic Explanations of Technological Change" *Knowing machines: Essays on technical change*. MIT Press. (pp. 1-22, and 49-66)

Week 5

28/9/2020: Social Construction of Technology II

19. Noble, D. (2011). "Social choice in machine design: The case of automatically controlled machine tools" in MacKenzie D. & Wacjman J. (Eds.) The Social Shaping of Technology (2nd edition). Open University Press, (pp 161- 176)
20. David, P. A. (1985). Clio and the Economics of QWERTY. The American economic review, (pp. 332-337)
21. Dyer. R. (2011). "Making 'white' people white" in MacKenzie D. & Wacjman J. (Eds.) The Social Shaping of Technology (2nd edition). Open University Press, (134-137)
22. Abbate, J. (2011). "Cold war and white heat: The origins and meanings of packet switching" in MacKenzie D. & Wacjman J. (Eds.) The Social Shaping of Technology (2nd edition). Open University Press (pp.351-371)
23. Headrick, D. R. (1990). "Imperialism, Technology and Tropical Economies" and "The Railways of India" in The tentacles of progress: technology transfer in the age of imperialism, 1850-1940. OUP Catalogue. (pp 3- 13; 49-81)

30/9/2020: Social Construction of Technology III

24. Sivamalai, L. (2013, June). Using the Lens of "Social Construction of Technology" to Understand the Design and Implementation of Aadhaar (UID) Project. In International Working Conference on Transfer and Diffusion of IT (pp. 633-638). Springer, Berlin, Heidelberg.
25. Ames, M. G. (2014). "Translating Magic: The Charisma of One Laptop per Child's XO Laptop in Paraguay" in Medina, E., da Costa Marques, I., Holmes, C., & Cueto, M. (Eds.). Beyond Imported Magic: Essays on Science, Technology, and Society in Latin America. MIT Press (pp. 369-407)

26. Oreglia, E. (2014). ICT and (Personal) Development in Rural China. Information Technologies & International Development, 10(3), (pp. 19- 30)
27. "Introduction" in Gitelman, L. (2013). *Raw data is an oxymoron*. MIT Press. (pp. 1-14)
28. Crawford K (2013) The hidden biases in Big Data. Harvard Business Review. 1 April. Available at: https://hbr.org/ 2013/04/the-hidden-biases-in-big-data
29. Bowker, G., & Star, S. L. (1999). "The ICD as Information Structure" *Sorting things out. Classification and its consequences*. MIT Press (pp. 107- 134)

<u>Week 6</u>

5/10/2020: Reading Presentations 2: 6 Slots (Reading 16-29)

7/10/2020: Idea of Materiality: Actor-Network Theory I

30. Johnson, J. (1988). Mixing humans and nonhumans together: The sociology of a door-closer. *Social problems*, *35*(3), (pp.298-310)
31. Akrich, M, (1992). The de-scription of technical objects in Shaping technology / building society: studies in sociotechnical change. Bijker. W.J.and J.Law (ed.), MIT press, Cambridge, MA (pp. 205-224)

<u>Week 7</u>

12/10/2020: Idea of Materiality: Actor Network Theory II

32. Walsham, G., & Sahay, S. (1999). GIS for district-level administration in India: problems and opportunities. *MIS quarterly*, (pp.39-65)
33. Chaudhuri, B., Dasgupta, P., Hoysala, O., Kendall, L., & Srinivasan, J. (2017, May). Actor-networks and "practices" of development: impact of a weather information system in West Bengal. In *International Conference on Social Implications of Computers in Developing Countries* (pp. 809-815). Springer, Cham.

14/10/2020: Group Activity 1
<u>Mid-Term Break (19/10/2020-26/10/2020)</u>

<u>Week 8</u>

28/10/ 2020: Idea of Materiality: Sociomateriality I

34. Blanchette, J. F. (2011). A material history of bits. Journal of the American Society for Information Science and Technology, 62(6), 1042-1057.
35. Orlikowski, W. J. (2007). Sociomaterial practices: Exploring technology at work. *Organization studies*, 28(9), (pp.1435-1448)
36. Leonardi, P. M. (2011). When flexible routines meet flexible technologies: Affordance, constraint, and the imbrication of human and material agencies. *MIS quarterly*, *35*(1), 147-167.

<u>Week 9</u>

2/11/2020: Idea of Materiality: Sociomateriality II

37. Scott, S. V., & Orlikowski, W. J. (2014). Entanglements in Practice. *MIS Quarterly*, *38*(3), 873-894.

38. Willson, M. (2017). Algorithms (and the) everyday. Information, Communication & Society, 20(1), 137-150.
39. Dourish, P. (2016). Algorithms and their others: Algorithmic culture in context. *Big Data & Society*, *3*(2), 2053951716665128.

04/11/2019: Reading Presentations 3: Slots 6 (Readings 30-39)

Week 10

09/11/2020: Politics of Technology I

40. Winner, L. (1980). Do artifacts have politics? *Daedalus*, (pp.121-136)
41. Berg, A. & M.Lie (1995). Feminism and Constructivism: Do Artifacts Have Gender? In Science, Technology, & Human Values, Vol. 20, No. 3, Special Issue: Feminist and Constructivist Perspectives on New Technology (Summer, 1995), pp. 332-351

11/11/2020: Politics of Technology II

42. Standage, T. (2014). "The Rise of Mass Media: The Centralization Begins" Bloomsbury Publishing USA. pp. 170 -188;
43. Trouiller, P., Torreele, E., Olliaro, P., White, N., Foster, S., Wirth, D., & Pécoul, B. (2001). Drugs for neglected diseases: a failure of the market and a public health failure?. Tropical Medicine & International Health, 6(11), 945-951.
44. Sadowski, J., & Bendor, R. (2019). Selling smartness: Corporate narratives and the smart city as a sociotechnical imaginary. *Science, Technology, & Human Values*, *44*(3), 540-563.

Week 11

16/11/2020: Politics of Technology III

45. De Filippi, P., & Loveluck, B. (2016). The invisible politics of bitcoin: governance crisis of a decentralized infrastructure
46. Ruppert, E., Isin, E. and Bigo, D. (2017). Data Politics. Big Data and Society. July–December 2017: 1–7
47. Burrell, J. (2016). How the machine 'thinks': Understanding opacity in machine learning algorithms. Big Data & Society, 3(1), 2053951715622512.
48. Rosenblat, A., & Stark, L. (2016). Algorithmic labor and information asymmetries: A case study of Uber's drivers. *International Journal of Communication*, *10*, 27.

18/11/2020: Reading Presentations 4: Slots 6 (Readings: 40-48)

Week 12

Module 3: Contemporary Issues within Science and Technology Studies

23/11/2020: Data, Privacy and Surveillance

49. Iliadis, A., & Russo, F. (2016). Critical data studies: An introduction. *Big Data & Society*, *3*(2), 2053951716674238.
50. Van Dijck, J. (2014). Datafication, dataism and dataveillance: Big Data between scientific paradigm and ideology. *Surveillance & Society*, *12*(2), 197-208.

51. David, L. (2003). Surveillance as social sorting: Computer codes and mobile bodies. Surveillance as social sorting: Privacy, risk, and digital discrimination, Londres, Routledge, (pp.13-30)
52. Esposito, E. (2017). Algorithmic memory and the right to be forgotten on the web. Big Data and Society. January–June 2017: 1–11

25/11/2020: Digital Labour

53. Zia, Sarah (2019). Not knowing as pedagogy: Ride-hailing drivers in Delhi http://blog.castac.org/2019/07/not-knowing-as-pedagogy-ride-hailing-drivers-in-delhi/
54. Graham, M., Hjorth, I., & Lehdonvirta, V. (2017). Digital labour and development: impacts of global digital labour platforms and the gig economy on worker livelihoods. Transfer: European Review of Labour and Research, 23(2), 135-162.
55. Irani, L. (2015). Difference and dependence among digital workers: The case of Amazon Mechanical Turk. *South Atlantic Quarterly*, *114*(1), 225-234.
56. Drahokoupil, J., & Fabo, B. (2016). The platform economy and the disruption of the employment relationship. *ETUI Research Paper-Policy Brief*, *5*.

<u>Week 13</u>

30/11/2020: Postcolonial Computing

57. Philip, K., Irani, L., & Dourish, P. (2012). Postcolonial computing: A tactical survey. *Science, Technology, & Human Values*, *37*(1), 3-29.
58. Sultana, S., & Ahmed, S. I. (2019, May). Witchcraft and HCI: Morality, modernity, and postcolonial computing in rural bangladesh. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-15).
59. Mainsah, H., & Morrison, A. (2014, October). Participatory design through a cultural lens: insights from postcolonial theory. In *Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium papers, and Keynote abstracts-Volume 2* (pp. 83-86).
60. Wyche, S., Dillahunt, T. R., Simiyu, N., & Alaka, S. (2015, September). "If god gives me the chance i will design my own phone" exploring mobile phone repair and postcolonial approaches to design in rural Kenya. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 463-473).

2/12/2020: Repair and Non-Use of Technology

61. Jackson, S. J. (2014). Rethinking repair. Media technologies: Essays on communication, materiality, and society. (pp. 221- 240)
62. Jackson, S. J., Ahmed, S. I., & Rifat, M. R. (2014, June). Learning, innovation, and sustainability among mobile phone repairers in Dhaka, Bangladesh. In *Proceedings of the 2014 conference on Designing interactive systems* (pp. 905-914).
63. Satchell, C., & Dourish, P. (2009, November). Beyond the user: use and non-use in HCI. In *Proceedings of the 21st Annual Conference of the Australian Computer-Human Interaction Special Interest Group: Design: Open 24/7* (pp. 9-16).
64. Baumer, E. P., Burrell, J., Ames, M. G., Brubaker, J. R., & Dourish, P. (2015). On the importance and implications of studying technology non-use. interactions, 22(2), (pp.52-56)

<u>Week 14</u>

7/12/2020: Technology and Ethics

65. Mitcham, C. & Waelbers, K. (2012), "Technology and Ethics: Overview" in Olsen, J. K. B., Pedersen, S. A., & Hendricks, V. F. (Eds). A Companion to the Philosophy of Technology. John Wiley & Sons. (pp. 367 – 383)
66. Ananny, M. (2016). Toward an ethics of algorithms: Convening, observation, probability, and timeliness. Science, Technology, & Human Values, 41(1), 93-117.
67. Taylor, L. (2017). What is data justice? The case for connecting digital rights and freedoms globally. *Big Data & Society*, *4*(2), 2053951717736335.
68. Floridi, L., Cowls, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., ... & Schafer, B. (2018). AI4People—An ethical framework for a good AI society: opportunities, risks, principles, and recommendations. *Minds and Machines*, *28*(4), 689-707.

9/12/2020: Reading Presentations 5: Slots 6 (Readings: 49-68)

Week 15

14/12/2020: Activity 2
16/12/2020: Sum up

Assessments (optional for Special Topics courses)

We will expect students to have read assigned reading material and come to class prepared to discuss this material.

Class participation will count for 10% of the grades.

Individual Reading Response (10%): Students will be required to present at 1 sessions of reading responses (out of 5 pre-designated sessions). These will be short responses to questions that test whether students have read assigned material and made an effort to engage with it in preparing for class.

Participation in two group activities (2x15%): This will take the form of storyboard-based group assignments conducted at the end of each of the three modules of instruction. Student groups will be presented storyboards ahead of time and asked to present their ideas in class on the designated activity day. These storyboards may include texts as well as audio visual mediums.

Writing (50%): Two Term Papers - one 750 words paper (20%) before mid-term break and one 3000 words paper (30%) before end-term break will have to be submitted. Topics for these papers will be discussed in the class well in advance.

Last Date of Submission for Mid-term Paper: 16th October 2020

Last Date of Submission for End-term Paper: 12th December 2020

Course Syllabus

Course Code / Course Name	CS 513 / DT 110 Software Systems - Enterprise Software Development	
Course Instructor Name(s)	Chandrashekar Ramanathan	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	2	Lecture (1hr = 1 credit)
	0	Tutorial (1hr = 1 credit)
	0	Practical (2hrs = 1 credit)
	L:T:P = 2:0:0	**Total Credits = 2**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

X	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning		Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch

Course is restricted to the following programmes / branch(es):
(Place X appropriately. More than one is okay)

Programme:

	iMTech
X	M.Tech
X	M.Sc.

Branch:

X	CSE
X	ECE
X	Digital Society

Course Category

Select **one** from the following:
(Place X appropriately)

	Basic Sciences
	CSE Core
	ECE Core
X	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
	HSS/M
	General

Course Pre-Requisites

(Where applicable, state exact course code/name)
None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	The course focuses on full-stack application development. This approach to software development is followed extensively by the industry and hence enhances employability.
Focus on skill development	Yes	This course provides skills in Javascript, SQL, Twitter Bootstrap, jQuery, REST, AngularJS
Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview

[*Provide introduction to the course*]

Two major components of CS513 Software Systems are a) System Software and b) Enterprise Software Development. The “System Software” module covers the rudiments of Operating Systems. This module is on Enterprise Software Development. As part of this module, students will get to understand what Enterprise Software is and how it is different from other software. The course will give exposure to the students to different architectural considerations for addressing the complexities associated with Enterprise Software. The course provides an in-depth insight into three-tier architecture and the software programming elements of developing software applications using three-tier architecture. At the end of this course, students are expected to have sufficient proficiency and skills in implementing the front-end, middleware and backend components of enterprise software.

Course Outcomes and Competencies

[Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Differentiate between design and architecture	P03	U	C	1.5	
CO2	Explain the different options for implementing services in service-oriented-architecture	PO3	U	C	1.5	
CO3	Define all the terms in the terminology associated with object-oriented programming	P03	R	F	1.5	
CO4	Design components of n-tier architecture for a given application requirements	P03	A	P	1.5	

CO5	Design and implement relational database schema using conceptual modeling	P03	A	P	3	1.5
CO6	Design web application for a given n-tier architecture	PO1, P03	A	P		1.5
CO7	Explain different components of mobile application development	P03	U	C	1.5	
CO8	Develop specific programs in Javascript, SQL, Twitter Bootstrap, jQuery, REST, AngularJS for solving specific problems.	PO1, P03	A	P	4.5	12
CO9						
CO10						

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

[Provide topic-wise list]

Topic 1: Fundamentals of Object-oriented Analysis and Design

- Design vs Architecture
- OO concepts
- Unified Modeling Language (UML)

Topic 2: Software Architectures

- Understanding large scale systems – n-Tier architectures.
- Understanding quality attributes of architectures

Topic 3: Database application development

- Database Design through Conceptual Modeling
- Database Implementation through SQL
- Database Programming through Hibernate

Topic 4: Web application development

- MVC for Web - Twitter Bootstrap (rendering view), jQuery, Ajax (from jQuery) and servlets (controller), REST service, back-end model - MySql, Java programming and concepts of key value pair (like mongo DB – implemented using MySql)

Topic 5: Mobile application development

- Connectivity, security, online/offline modes, integration of sensors, location services, responsiveness.
- AngularJS and related frameworks

Instruction Schedule

[Provide session-wise schedule]

S. No.	Date	Topic
1	Session 1	Introduction
2	Session 2	Handson - Environment setup
3	Session 3	Enterprise Software Elements
4	Session 4	Database Design
5	Session 5	Handson - Frontend development
6	Session 6	HOLIDAY
7	Session 7	OR Mapping
8	Session 8	Handson - SQL
9	Session 9	N-Tier Architecture
10	Session 10	Handson - OR Mapping with hibernate
11	Session 11	Service Oriented Architecture
12	Session 12	Handson - REST services
13	Session 13	Deployment Architecture
14	Session 14	Software Testing
15	Session 15	Handson - Full-stack Integration
16	Session 16	Handson - Basic Devops

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

1. Software Architecture in Practice by Bass and Clements, Addison Wesley.
2. Ajax - https://www.youtube.com/watch?v=f46WEeM8HTA
3. REST Services - https://www.youtube.com/watch?v=xkKcdK1u95s
4. Jquery Tutorial - https://www.youtube.com/watch?v=8mwKq7_JlS8

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

25%: Tests / assignments
40%: Project
35%: End-Term Exam

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Database Design using Conceptual Modeling	CO5
2	Develop a web application use the principles of full-stack software development	C04, C05, CO6, CO8
3	Write a program to implement CRUD operations using JDBC	C05
4	Write a program to implement CRUD operations using Hibernate	C05

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Late submission will be handled as noted in the respective assignment problem statements.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention "Not applicable" if section is not applicable to the course]

Not applicable

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

As per institute policy

DT 216 News Media Literacies in a Digital Society
(August - December 2020)

Instructor: Preeti Mudliar
Tuesday/Thursday: 4:00 pm - 5:30 pm

Course Description:
The purpose of this course is to introduce students to news media processes and media literacies of news and digital platforms. Over the last few years the proliferation of digital platforms, changes in news distribution and organizational revenue streams, and the rapidly fragmenting discourse of public life have combined to transform the production, circulation, and consumption of news. Not only has the production and distribution of news changed from traditional news gathering and gatekeeping models, but it has also led to concerns about bias and accuracy in news production. This has often compromised people's abilities to verify and discern news from misinformation circulating on digital platforms, sometimes with repercussions of societal violence. These changes around news media have led to serious concerns about the implications and challenges they pose to being an informed citizen of a democracy. This course hence seeks to equip students with a news media sensibility that will allow them to become perceptive, critical, and analytical consumers of news. Through readings and practical assignments, students will be exposed to the intersection of news practices and digital platforms that will help them approach and appreciate news from a more literate and knowledgeable vantage point. The course draws from and acknowledges contributions from a workshop on disinformation and fake news organized by the Digital Asia Hub in Jakarta, Indonesia in August 2018 and the news literacy program at the Centre for News Literacy at the State University of New York (SUNY), Stony Brook.

Course Outcomes:
By the end of the course students are expected to understand and know:
- The processes of the production and consumption of news
- How do digital platforms interact with and shape the way we encounter news
- Understanding the challenges posed to news literacy
- Place news and digital media in their historical context

Students are expected to DO:
- Critically evaluate news for trustworthiness, accuracy, and bias

Critically evaluate and problematize the intersection of news with digital technology

Evaluation and Grading:
Class Participation: 20%
News Reflection: 10%
You Be the Editor: 20%
Researching news - Individual assignment: 25% Due March 29th
Compare and Contrast -

Or

Write a research report on a topic of your choice
Final project - Group project: news habits on campus - 25% -

Syllabus and Readings

Class 1. January 2, Thursday: Class selection

Theme 1: Society, Information, and the Media

Class 2. January 7, Tuesday
Introduction to News Literacies - Discussion

Class 3. January 9, Thursday:
Democracy and Information
Readings:
1. Sen, Amartya Kumar. Chapters 15 - Democracy as public reason and Chapter 16 - The practice of democracy (pages 321-354). From The Idea of Justice. Harvard University Press, 2009.

Additional Readings:

2. N. Ram. (1990). An Independent Press and Anti-hunger Strategies: The Indian Experience. Chapter 6. (pages 146-190). In Jean Dreze and Amartya Sen (eds), The Political Economy of Hunger.

Class 4. January 14, Tuesday:
The press' role for democracy
Readings:
1. McQuail Dennis. "Normative Theory of Media and Society" - Chapter 7. In McQuail's Mass Communication Theory.
2. Schudson, Michael. "Six or seven things news can do for democracy." Chapter 2. Why Democracies Need An Unlovable Press (2008): 11-26.

Additional Readings:

3. Kovach, B., & Rosenthiel, T. (2014). Introduction and Chapter 1 - What is Journalism for? The elements of journalism: What newspeople should know and the public should expect. New York: Three Rivers Press.
4. Hanitzsch, T. et al. (2011). Mapping journalism cultures across nations. Journalism Studies, 12(3), 273-93.

Class 5. January 16, Thursday:
Questioning the press' role for democracy
Readings:
1. Merrill, John C. "Democracy and the press: the reality and the myth." Media Asia 27.4 (2000): 197-199.
2. Huang, Chengju. "From control to negotiation: Chinese media in the 2000s." (2007): 402-412.
3. Lynch, Marc. (2006). Iraq and the new Arab Public. Chapter 1.(pp. 1 - 28) From Voices of the new Arab public: Iraq, Al-Jazeera, and Middle East politics today. Columbia University Press.

Additional Reading

4. Dobelli, Rolf.. 2013. News is bad for you – and giving up reading it will make you happier. The Guardian. https://www.theguardian.com/media/2013/apr/12/news-is-bad-rolf-dobelli

Class 6. January 21, Tuesday
The political economy of news media
Readings:

1. Nielsen, Rasmus Klein. (forthcoming). The changing economic contexts of journalism. In T. Hanitzsch and K. Wahl-Jorgensen (eds.), Handbook of journalism studies. https://rasmuskleisnielsen.files.wordpress.com/2018/05/nielsen-the-changing-economic-contexts-of-journalism-v2.pdf.
2. Dev, A. & Donthi, P. (2016). Our man in the studio. The Caravan. https://caravanmagazine.in/reportage/man-studio-rajat-sharma-india-tv
3. Subramaniam Samanth. (2012). How Samir Jain created the modern Indian newspaper industry. The Caravan. https://caravanmagazine.in/reportage/supreme-being
   Also see:
   Auletta, Ken. (2012). Citizens Jain. Why India's Newspaper Industry is Thriving. The New Yorker. https://www.newyorker.com/magazine/2012/10/08/citizens-jain

Additional Readings

4. Schudson, M. (2002). The news media as political institutions. Annual review of political science, 5(1), 249-269. On LMS.
5. Ashley, S., Poepsel, M., & Willis, E. (2010). Media Literacy and News Credibility: Does knowledge of media ownership increase skepticism in news consumers?. Journal of Media Literacy Education, 2(1), 3. On LMS

Theme 2: The production of news

Class 7. January 30, Thursday
News as a literary genre
Readings:

1. Bird, S. Elizabeth, and Robert W. Dardenne. (2009). Rethinking news and myth as storytelling." *The handbook of journalism studies* : 205-217. On LMS

Additional Readings:

2. Van Dijk, Teun. 2009. News, Discourse, and Ideology. *The Handbook of Journalism Studies* : 205-217: 191-204. On LMS
3. Lule, Jack. (1989). "News as Drama: The Study of News Language." On LMS.

Class 8. February 4, Tuesday
News selection and Gatekeeping
Readings:

1. O'Neill, D., & Harcup, T. (2009). News values and selectivity. In *The Handbook of Journalism Studies* (pp. 181-194). Routledge. Please refer to the handbook previously uploaded on LMS on January 30
2. Bhushan Sandeep. (2014). How the television news industry scripted the Indian elections. The Caravan. https://caravanmagazine.in/vantage/television-scripted

Additional Reading:

3. Shoemaker, Pamela., Vos Tim, Reese Stephen. (2009). Journalists as Gatekeepers. In *The handbook of Journalism Studies* (pp. 73-87). Routledge. Please refer to the handbook previously uploaded on LMS on January 30

Class 9. February 6, Thursday
Framing News
Readings:

1. Entman, Robert., Matthes, Jorg., Pellicano, Lynn. (2009). Nature, Sources, and Effects of News Framing. (pp. 175-190). In *The Handbook of Journalism Studies* (pp. 73-87). Routledge. Please refer to the handbook previously uploaded on LMS on January 30
2. Dev, Atul. (2018). Same Old News: History Repeating at Shobhana Bhartia's Hindustan Times. The Caravan. https://caravanmagazine.in/media/history-repeating-shobhana-bhartias-hindustan-times

Additional Reading:

3. De Vreese, Claes H. "News framing: Theory and typology." *Information design journal & document design* 13.1 (2005). On LMS

Class 10. February 11, Tuesday
The Medium is the Message - I (Print and Radio)
Readings:

1. Meltzer, Kimberly. "The hierarchy of journalistic cultural authority: Journalists' perspectives according to news medium." *Journalism Practice* 3, no. 1 (2009): 59-74. On LMS.
2. Serial. (2014). Albi. Season 1, Episode 1. Serialpodcast.org. (LISTEN - 50 minutes) https://serialpodcast.org/season-one/1/the-alibi
3. Sowmya Rajaran and Barkha Kumari. (2019). Peace in a pod. Bangalore Mirror. May 27, 2019. https://bangaloremirror.indiatimes.com/opinion/sunday-read/peace-in-a-pod/articleshow/69500995.cms
4. Indulekha Aravind. (2019). Is podcast the latest trend among millenials in India? The Economic Times. January 8, 2019. https://economictimes.indiatimes.com/magazines/panache/podcasting-growth-is-slowly-picking-up-in-india/articleshow/67398243.cms

Additional Readings:

5. Jessica Abel and Ira Glass. (2012). Radio, An Illustrated Guide. WBEZ Alliance. On LMS.
6. Marshall McLuhan. (1964). The Medium is the Message. From Understanding Media: The Extensions of Man. On LMS.

Class 11. February 13, Thursday
In Class Screening. Watch: All the President's Men
Reading:

1. Perrry James. Watergate Case Study. http://www.columbia.edu/itc/journalism/j6075/edit/readings/watergate.html

Class 12. February 18, Tuesday
The Medium is the Message - II (Television and the Internet)
Readings:

1. Schlesinger, Philip. "Newsmen and their time-machine." *British Journal of Sociology* (1977): 336-350. On LMS.
2. Newman, Nic, Richard Fletcher, Antonis Kalogeropoulos, and Rasmus Nielsen. *Reuters institute digital news report 2019*. Vol. 2019. Reuters Institute for the Study of Journalism, 2019. Available here. (Read the Executive Summary)

Additional Readings:

3. Levy, Mark R. "Watching TV news as para-social interaction." *Journal of Broadcasting & Electronic Media* 23, no. 1 (1979): 69-80. On LMS.

Class 13. February 20, Thursday

Guest lecture - Ms. Kanchan Kaur, Dean, Indian Institute of Journalism and New Media, Bangalore.
Crime Reporting - Talk title and abstract forthcoming

Class 14. February 25, Tuesday
You Be the Editor - Assignment
Instructions
You are in charge of bringing out the Bangalore edition of a four-page news paper. The pages will be Page 1, Page 2 National, Page 3 International, Page 4 Sports and Entertainment. You have a strict deadline and a limited amount of space. Use the news values that we have learned about and your own editorial judgment to select the news that will make it to your paper. Write headlines, choose your lead image from an online search and show us your paper.

You will use the following resources to get your news. Do not consult any news site other than these for the purpose of the assignment:

1. https://twitter.com/PTI_News
2. http://www.ptinews.com/
3. https://twitter.com/ReutersIndia
4. https://in.reuters.com/
5. https://twitter.com/Reuters
6. https://in.reuters.com/news/world
7. https://twitter.com/AFPphoto
8. https://twitter.com/AFP
9. https://www.afp.com/en

You will use the following site for newspaper templates. Please create a username and familiarise yourself with the templates before February 25th so that you know how things work.
https://www.makemynewspaper.com/

Schedule the publishing of your newspaper for February 26, 2020, 3 am, on workplace.

Class 15. February 27, Thursday
You Be the Editor - Presentations
Instructions:
Each team will describe their process and decisions for the selection of news:

1. Present your newspaper and talk about why you did what you did. What stories did you select? What did you leave out? What guided your layout decisions? Where did you get your ideas from? How did you decide what stories need pictures, what did not?
2. Include the following points in your presentation:
a. How does your news selection compare to other groups in terms of story selection/headlines/layout?
b. How does your news selection compare to the Bangalore editions of The Hindu and The Times of India?
c. What did they do better than you? What did you do better than others? What decisions do you agree/disagree with that other groups took?
3. What were you takeaways and learning from the project?

4. Anything else that you want to talk about

Class 16. March 10, Tuesday
Information neighbourhoods: News, advertising, publicity, entertainment, propaganda

Class 17. March 12, Thursday
Propaganda
Readings:

1. Jowett, Garth S., and Victoria O'donnell. 2018. Chapter 3 (Propaganda Institutionalized) and Chapter 6 (How to analyse Propaganda). *Propaganda & Persuasion*. Sage Publications, 2018. Dropbox link to PDF
2. Flora Carmichael and Abid Hussain. December 16, 2019. Pro-Indian ‘fake websites targeted decision makers in Europe. Retrieved from https://www.bbc.com/news/world-asia-india-50749764

Additional Readings:

3. Jowett, Garth S., and Victoria O'donnell. 2018. *Propaganda & Persuasion*. Sage Publications, 2018. On Dropbox. (Read the entire book)

Class 18. April 2, Thursday
Evaluating Sources
Readings:

1. Jodi Kantor and Meghan Twohey. 2019. *She Said. Breaking the Sexual Harassment Story that Helped Ignite a Movement.* Preface, Chapter 1 and Chapter 2. Penguin Press, New York. On LMS.
2. Brandtzaeg, Petter Bae, Marika Lüders, Jochen Spangenberg, Linda Rath-Wiggins, and Asbjørn Følstad. 2016. "Emerging journalistic verification practices concerning social media." *Journalism Practice* 10, no. 3: 323-342. On LMS.

Additional Readings:

3. Ronan Farrow. 2019. Catch and Kill: Lies, Spies, and a Conspiracy to Protect Predators. On LMS.

For class discussion please watch the video and read the text
https://www.nytimes.com/2016/02/13/nyregion/success-academy-teacher-rips-up-student-paper.html

Class 19. April 7, Tuesday
Content Analysis
Readings:

1. Krippendorff, Klaus. (1989). Content analysis. In E. Barnouw, G. Gerbner, W. Schramm, T. L. Worth, & L. Gross (Eds.), International encyclopedia of communication (Vol. 1, pp. 403-407). New York, NY: Oxford University Press. On LMS
2. Rauchfleisch, Adrian, Xenia Artho, Julia Metag, Senja Post, and Mike S. Schäfer. 2017. "How journalists verify user-generated content during terrorist crises. Analyzing Twitter communication during the Brussels attacks." *Social Media+ Society* 3, no. 3 Available here.

Additional Readings:

3. Mudliar, Preeti, and Joyojeet Pal. "ICTD in the Popular Press: Media Discourse Around Aakash, the “World’s Cheapest Tablet”." *Information Technologies & International Development* 11, no. 1 (2015): pp-41. On LMS

4. Shahin, S., Zheng, P., Sturm, H.A. and Fadnis, D., 2016. Protesting the paradigm: A comparative study of news coverage of protests in Brazil, China, and India. *The International Journal of Press/Politics*, *21*(2), pp.143-164. On LMS
5. Taylor, Mary Anne, and Danee Pye. "Hillary Through TIME: The (Un) Making of the First Woman President." *American Behavioral Scientist* (2017): 0002764217711801. On LMS

Class 20. April 9, Thursday
Research Ethics
Readings:

1. Sveningsson Elm, Malin. 2009. "How do various notions of privacy influence decisions in qualitative internet research?'." In Internet Inquiry: Conversations about Methods. Annette Markham and Nancy Baym (Eds.) pp. 69-87. On LMS.
2. Garimella, Kiran, and Gareth Tyson. "Whatapp doc? A first look at whatsapp public group data." In *Twelfth International AAAI Conference on Web and Social Media*. 2018. Available here.
3. Rosenfeld, Avi, Sigal Sina, David Sarne, Or Avidov, and Sarit Kraus. "WhatsApp usage patterns and prediction models." In *ICWSM/IUSSP Workshop on Social Media and Demographic Research*. 2016. Available here.
4. Watch: Milgram Experiment https://www.youtube.com/watch?v=xOYLCy5PVgM

Additional Readings:

5. Silverman, David (2013). Chapter 10. Ethical Research. In *Doing Qualitative Research.* Fourth edition. Sage Publications. On LMS.
6. Sugiura, Lisa, Rosemary Wiles, and Catherine Pope. "Ethical challenges in online research: Public/private perceptions." *Research Ethics* 13, no. 3-4 (2017): 184-199. Available here.
7. Association of Internet Researchers. 2019. Internet Research: Ethical Guidelines 3.0 Association of Internet Researchers. Available here.

Class 21. April 14, Tuesday
Truth and Verification
Readings:

1. Richard Hornik, Jonathan Anzalone, and Michael A. Spikes. (2018). Get News Smart: A Guide to Understanding the Key Concepts of News Literacy. Chapters 3 and 4. Available here.

Additional Readings:

2. Brandtzaeg, Petter Bae, Marika Lüders, Jochen Spangenberg, Linda Rath-Wiggins, and Asbjørn Følstad. "Emerging journalistic verification practices concerning social media." *Journalism Practice* 10, no. 3 (2016): 323-342. https://goo.gl/uqoP7Z
3. Salmon, Felix (2015). Why you can't trust journalism. *Splinter News.* Retrieved from https://splinternews.com/why-you-cant-trust-journalism-1793849489

Class 22. April 16, Thursday
Balance and Bias
Readings:

1. Richard Hornik, Jonathan Anzalone, and Michael A. Spikes. (2018). Get News Smart: A Guide to Understanding the Key Concepts of News Literacy. Chapters 7, 8, 9. Available here.

Additional Readings:

2. Jack Shaffer. (2016). The Case Against Journalistic Balance: When campaigns complain about "fairness," beware. Here's what they're really after. *Politico Magazine.* Retrieved from https://www.politico.com/magazine/story/2016/09/journalism-balance-fairness-false-equivalence-hillary-clinton-donald-trump-2016-214242
3. Liz Spayd. (2016). The Truth about False Balance. *The New York Times.* Retrieved from https://www.nytimes.com/2016/09/11/public-editor/the-truth-about-false-balance.html
4. Robert Eshelmann. The danger of fair and balanced. *The Columbia Journalism Review.* Retrieved from https://archives.cjr.org/essay/the_danger_of_fair_and_balance.php

Class 23. April 21, Tuesday
Fake News and Misinformation
Readings:

1. Tandoc Jr, Edson C., Zheng Wei Lim, and Richard Ling. "Defining "fake news" A typology of scholarly definitions." *Digital journalism* 6, no. 2 (2018): 137-153. Available here
2. Sibal, Pratik. 2019. Can Independent Journalism thrive under pawalls? Economic and Political Weekly. Vol. 54, Issue No. 4, 26 Jan, 2019. Available here
3. Bakir, Vian, and Andrew McStay. "Fake news and the economy of emotions: Problems, causes, solutions." *Digital journalism* 6, no. 2 (2018): 154-175. Available here.

Additional Readings:

4. Waisbord, Silvio. "Truth is what happens to news: On journalism, fake news, and post-truth." *Journalism studies* 19, no. 13 (2018): 1866-1878. Available on LMS.
5. Resende, Gustavo, Philipe Melo, Julio CS Reis, Marisa Vasconcelos, Jussara M. Almeida, and Fabrício Benevenuto. "Analyzing textual (mis) information shared in WhatsApp groups." In *Proceedings of the 10th ACM Conference on Web Science*, pp. 225-234. 2019. Available here.
6. Data and Society Library https://datasociety.net/library/?topic=5_manipulation

Class 24. April 23, Thursday
Audience Verification of News
Readings:

1. Edgerly, Stephanie, Rachel R. Mourão, Esther Thorson, and Samuel M. Tham. "When Do Audiences Verify? How Perceptions About Message and Source Influence Audience Verification of News Headlines." *Journalism & Mass Communication Quarterly* (2019): 1077699019864680. On LMS.
2. Tandoc Jr, Edson C., Richard Ling, Oscar Westlund, Andrew Duffy, Debbie Goh, and Lim Zheng Wei. "Audiences' acts of authentication in the age of fake news: A conceptual framework." *New Media & Society* 20, no. 8 (2018): 2745-2763. Available here.
3. Marwick, Alice E. "Why do people share fake news? A sociotechnical model of media effects." *Georgetown Law Technology Review* 2, no. 2 (2018): 474-512. Available here

Additional Readings:

4. Edgerly, Stephanie, and Emily K. Vraga. "That's not news: Audience perceptions of 'news-ness' and why it matters." *Mass Communication and Society* just-accepted (2020). On LMS.
5. Nelson, Jacob L., and Harsh Taneja. "The small, disloyal fake news audience: The role of audience availability in fake news consumption." *New media & society* 20, no. 10 (2018): 3720-3737. Available here.

Class 25. April 28, Tuesday
Social Media Groups and News
Readings:

1. Swart, Joëlle, Chris Peters, and Marcel Broersma. "Shedding light on the dark social: The connective role of news and journalism in social media communities." *New media & society* 20, no. 11 (2018): 4329-4345. Available [here]
2. Molyneux, Logan. "Mobile news consumption: A habit of snacking." *Digital Journalism* 6, no. 5 (2018): 634-650. Available [here].
3. Sohini Sengupta. 2019. How WhatsApp Truths Thrive on Middle Class Anxieties. Vol. 54. Issue 37. Retrieved from https://www.epw.in/engage/article/how-whatsapp-truths-thrive-middle-class
4. Sohini Sengupta. 2020. How to Stir Confusion Amidst a Pandemic: COVID-19 and Misinformation on WhatsApp. Retrieved from https://www.epw.in/engage/article/how-stir-confusion-amidst-pandemic-covid-19-and

Additional Readings.

5. Leavitt, Alex, and John J. Robinson. "Upvote My News: The Practices of Peer Information Aggregation for Breaking News on reddit. com." *Proceedings of the ACM on Human-Computer Interaction* 1, no. CSCW (2017): 1-18. Available here.
6. Vázquez-Herrero, Jorge, Sabela Direito-Rebollal, and Xosé López-García. "Ephemeral Journalism: News Distribution Through Instagram Stories." *Social Media+ Society* 5, no. 4 (2019): 2056305119888657. Available here
7. Swart, Joëlle, Chris Peters, and Marcel Broersma. "Sharing and Discussing News in Private Social Media Groups: The social function of news and current affairs in location-based, work-oriented and leisure-focused communities." *Digital Journalism* 7, no. 2 (2019): 187-205. Available here.

Class 26. April 30, Thursday.

Storytelling with Data I: Guest Lecture: Surbhi Bhatia, Mint.

Class 27. May 5, Tuesday.

Storytelling with Data II: Guest Lecture: Sriharsha Devulapalli, Mint.

Class 28. May 7, Thursday.

Assignment discussion.

Class 29. May 12, Tuesday.

Techno- Journalism: Design and Computation - where are we headed next?

Readings:

1. Ananny, Mike, and Kate Crawford. "A liminal press: Situating news app designers within a field of networked news production." *Digital Journalism* 3, no. 2 (2015): 192-208.
2. Thurman, Neil, Seth C. Lewis, and Jessica Kunert. "Algorithms, Automation, and News." (2019): 980-992. Available here.

Additional Readings:

3. Bernat Ivancsics and Mark Hansen. 2019. Actually it's about ethics, AI, and Journalism: Reporting on and with computation and data. Tow Center of Digital Journalism, Columbia University. Available [here.]
4. NYT Open Desk. April 30, 2020. To Apply Machine Learning Responsibly, We Use it in Moderation. https://open.nytimes.com/to-apply-machine-learning-responsibly-we-use-it-in-moderation-d001f49e0644

DT 306: Privacy in the Digital Age

Term 1, 2019-20

International Institute of Information Technology, Bangalore

COURSE OVERVIEW AND OBJECTIVES

Privacy is becoming ever more important in today's context due to the extensive digitization of various dimensions of our lives. Technological advancements have intensified our capacity to create, collect, disseminate, and analyse digital information. Digital businesses thrive on leveraging our personal information to track preferences, identify potential clients and provide better services. Governments collect and analyze personal information to improve service provision and in the name of national security. While personal information may well be utilized to improve customer/citizen services, increase revenues, and lower business costs, it can also be easily misused and lead to violations of privacy. Important legal, regulatory, and ethical issues have emerged, prompting the need for an urgent and consistent response by societies awash in digitized data. This course seeks to highlight some of these concerns and their implications for students of Information Technology. It will do so by providing an overview of the technology, economics, business, regulatory, and socio-political dimensions of personal information and privacy.

After this course, the students are expected to know:

1. The history and evolution of privacy;
2. The technology evolution in the area of private information collection, distribution and analysis;
3. The day-to-day life use cases of privacy violation of digital footprints of individuals;
4. The economics and value of information;
5. Markets for information;
6. Regulatory and legal dimensions of privacy;
7. The societal response to privacy
8. Technical approaches to managing and protecting privacy

COURSE CONTENTS

For a detailed syllabus from 2018, see https://iiitbcourses.wordpress.com/home/privacy-in-the-digital-age/privacy-in-the-digital-age-2018/syllabus/

Briefly, the course will consist of lectures, class discussions, student presentations and projects covering the following aspects of privacy"

1. **History of Privacy:** A look at key historical moments when 'privacy' has been discussed, concepts intertwined with privacy in these discussions (surveillance, security), the technologies involved
2. **Taxonomy of Privacy:** Definition of privacy, different dimensions of privacy including secondary use, aggregation, breach of confidentiality (with examples)
3. **Technologies of Privacy: Data Collection, Anonymity, Re-identification**: Techniques by which user data is collected, tracked and aggregated. Challenges with anonymizing personal data and re-identification

4. **Privacy for different demographics:** What does privacy mean and how is it negotiated in different geographies and by different demographic groups and classes?
5. **Value of privacy, privacy and human behaviour, economic of personal data, privacy and behavioural economics**
6. **Privacy by design:** Introduction to cryptographics tools. Approaches to designing databases, data access and data aggregation with a focus on protection of privacy
7. **Privacy and Ethics: Societal dimension:** Ways/regimes of understanding privacy (individual, universal, relational, contextual) and how to achieve it (informed consent, privacy harms)
8. **Privacy and Ethics: Technical dimension:** Technology frameworks and mechanisms to enable users to manage privacy and reduce risks of breach of privacy
9. **Contemporary developments:** Implications of IoT, ML, automation; upcoming cases in domains of health, demographic info, social media, finance

INSTRUCTORS

Prof. Janaki Srinivasan, Prof. V. Sridhar, Prof. T. K. Srikanth

Assessments

The course will contain one project and one quiz in each half of the term, as well as a final written exam. The grades will be based on the following weightage:

2 Projects: 40%
2 Exams: 50%
Class participation and presenting discussion papers: 10%

Course Syllabus

Course Code / Course Name	**DT 308: Quantitative Data Analysis for Public Policy (QDAPP)**	
Course Instructor Name(s)	Amit Prakash & V Sridhar	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits = 4**
Grading Scheme *(Choose by placing X against appropriate box)*	X	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)
(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data		Networking and Communication
	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): *(Place X appropriately. More than one is okay)* *Programme:* *Branch:*

	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)*

	Basic Sciences
	CSE Core
	ECE Core
	CSE Branch Elective
	ECE Branch Elective
	Engineering Science and Skills
X	HSS/M
	General

Course Pre-Requisites	*(Where applicable, state exact course code/name)* None

Additional Focus Areas

Focus Area	Yes / No	Details
Direct focus on employability		
Focus on skill development	Yes	Provides students expertise in applying data analysis tools and techniques for prescribing public policy solutions.
Focus on entrepreneurship		
Provides value added / life skills (language, writing, communication, etc.)		

Course Context and Overview

As data from various facets of life ranging from individuals, communities, societies, industry and government become ubiquitous and available, careful analysis of such data Is becoming relevant. At the same time, regulators and policy makers are also using data from various sources to make informed decisions on important regulatory and policy issues. It is in this context that this course lays the foundation of data analysis for public policy. The course covers various techniques and methodologies in data life cycle including capturing and collecting data, transforming data for public consumption, and analyzing data. Further the course will also involve tools and methodologies on using data for public policy decisions in the area of Information and Communication Technologies.

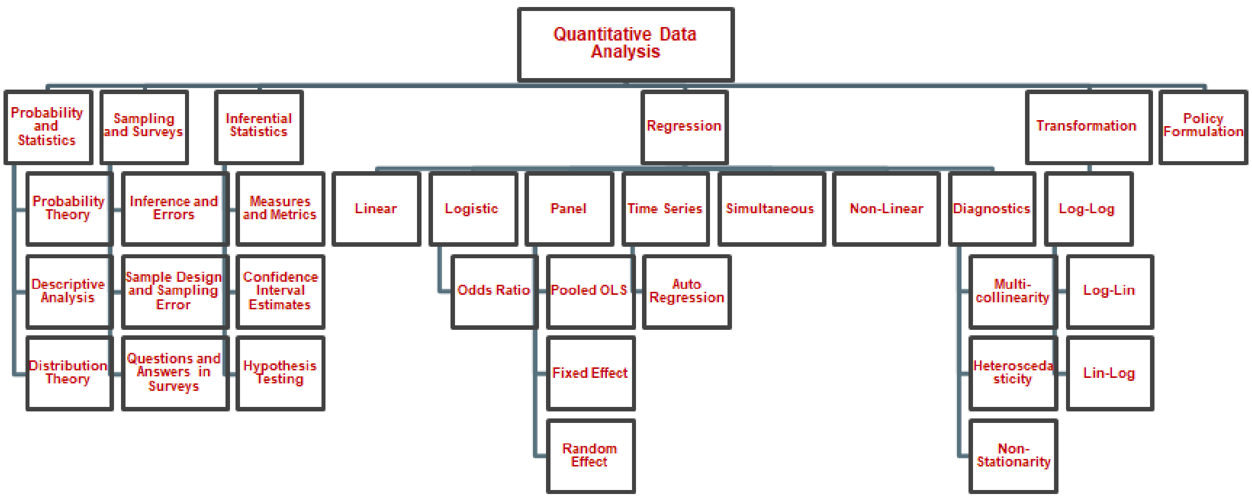
Course Outcomes and Competencies

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)
CO1	Understand basics of probability theory, descriptive analysis and distribution theory	PO2	U	C, P	9	3
CO2	Understand basics of survey design, inferences and errors in surveys and survey instruments	PO2	U	C,P	6	2
CO3	Familiarity with some public survey datasets (NSSO, NFHS) and their relationship with state policies	PO2	U	C,P	3	1
CO4	Understand different statistical measures to infer patterns in underlying data	PO2	An	C, P	6	2
CO5	Construct and test hypothesis relevant to public policy questions using the associated data sets	PO2	An	C, P	6	2

CO6	Apply appropriate regression methodologies (linear, logistic, panel, time series), functional transformations (log-log, log-lin, lin-log) and regression diagnostics to infer correlations between different variables of interest in the underlying data sets	PO2	An	C, P	15	5
	Total				45	15

Legend: *<u>PO/PSO</u>: Programme Outcomes / Programme Specific Outcomes; <u>CL</u>: Cognitive Level (from Revised Bloom's Taxonomy); <u>KC</u>: Knowledge Category (from Revised Bloom's Taxonomy); <u>Class (Hrs)</u>: Number of hours of instruction; <u>Tut (Hrs)</u>: Number of hours of tutorial session (where applicable)*

Concept Map of the Course



Course Content

1. Probability and Statistics
2. Sampling and Surveys
3. Introduction to Public Datasets and Policy Dimensions
4. Inferential Statistics, Experimental Design and Measures of Association
5. Data Analysis: Linear Regression
6. Functional Transformation
7. Logistic Binomial Regression
8. Regression diagnostics
9. Time series regression
10. Panel data regression

Instruction Schedule

Week	Topics
1,2,3	**Probability and Statistics [AP]** Probability theory overview - Probability law— Interpretation of probability, Axioms of probability, Conditional probability, Prior/Posterior probability Descriptive analysis – Units of analysis and variables, Level of measurement, Frequency distribution and graphical representation, Central tendency, Dispersion, Distributional shape Distribution theory – Discrete and Continuous random variables, Binomial distribution, Normal distribution
4,5	**Sampling and Surveys [AP]** Inference and Errors in Surveys: Constructs, measurement, response, observational gap, measurement error, processing error, sampling error etc. Target Population and Sampling Frames: Coverage properties of sampling frames, common target populations and their frame issues, coverage error Sample Design and Sampling Error: Simple random sampling, cluster sampling, stratified sampling Questions and Answers in Surveys: Cognitive processes in answering questions, problems associated with encoding, misinterpretation, judgement etc. in answering questions, guidelines for writing good questions
6	**Introduction to Public Data Sets and Policy Dimensions [AP]** NSSO, NFHS datasets on employment, household expenditure, healthcare etc. and research reports and policy briefs based on these datasets
7-9	**Inferential Statistics, Experimental Design and Measures of Association [VS]** Point estimation, Sampling versus population, Confidence intervals/levels, Need for experiment design, comparison of experiments and sampling, taxonomy of Design of Experiments (DoE), Full and Fractional Factorial Design, Randomized Control Tests (RCTs), Types of RCT designs., Randomized Block Design. Matched Pair Design Hypothesis testing, One-sample/Two-sample tests: z-test, Student's T-test, comparison of means of control and treatment groups, within group and across group means, testing for means, one and two-way ANOVA tests, taxonomy of ANOVAs: ANCOVA, MANOVA, MANCOVA, Omnibus and post-hoc tests, Bonferroni adjustments in post-hoc tests
10-11	**Data Analysis: Linear Regression [VS]**

	Simple linear regression using OLS, parameter estimation, parameter confidence intervals and hypothesis testing, test for model fit, dummy variable regression for categorical variables, Type I and Type II errors and implications **Functional Transformation:** Log-Log, Lin-Log and Log-Lin regression models and estimator interpretations
12	**Logistic Binomial Regression**: logistic function, relation to classification, odd's ratio, interpretation of estimators
13	**Regression diagnostics**: Multicollinearity: Variance Inflation Factor test, Heteroscedasticity: Breusch Pagan and White'sTest; tests and corrections for the same;
14	**Time series regression:** tests for stationarity: Unit Root Test, test for auto and serial correlation: Durbin Watson test, Auto Regressive Integrated Moving Average (ARIMA) models, estimation of p and q using Auto Correlation and Partial Auto Correlation Functions
15	**Panel data regression**: Pooled OLS, Fixed Effect and Random Effect models, test for model fit, Hausman Test for FEM vs. REM

Learning Resources

1. Amemiya, T. (1994). Introduction to statistics and econometrics. Harvard University Press.
2. Fung, B. C., Wang, K., Fu, A. W. C., & Philip, S. Y. (2010). Introduction to privacy-preserving data publishing: Concepts and techniques. Chapman and Hall/CRC.
3. Groves, R. M., Fowler Jr, F. J., Couper, M. P., Lepkowski, J. M., Singer, E., & Tourangeau, R. (2011). Survey methodology. John Wiley & Sons.
4. Gujarati, D. (2012). Econometrics by example. Macmillan.
5. Hanneman, R. A., Kposowa, A. J., and Riddle, M. D. (2013), Basic statistics for social research. John Wiley & Sons, San Francisco.
6. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). *An introduction to statistical learning* (Vol. 112, p. 18). New York: Springer.
7. Levin R., and Rubin, D. (1998). Statistics for management (7th Edition), Pearson.
8. R-Tutorial on Elementary Statistics. Available at: http://www.r-tutor.com/elementary-statistics

Assessment Plan

Component	Marks
Quizzes/ Assignments: 6 @ 10 marks for each	60%
Group Project:	
Stage 1 – Data Exploration	10%
Stage 2 – Data analysis	10%
Final Project Report	20%
Project Total	**40%**
Total	***100%***

Assignments / Projects

S. No.	Focus of Assignment / Project	CO Mapping
1	Groups of students work on **data set Assignments** and analyze them using techniques that they have learnt in the course.	PO3, PO5
2	Student groups are assigned a **semester long project** that involves collection of data and building statistical models to analyze the same; test stated hypothesis and prescribe policy solutions for overcoming any challenges and short comings.	PO3, PO5

Evaluation Procedures

The course uses one or more of the following evaluation procedures as part of the course:

1. Automatic evaluation of MCQ quizzes on Moodle or other online platforms
2. Manual evaluation of essay type / descriptive questions

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

Not Applicable

Make-up Exam/Submission Policy

One make-up quiz is given to accommodate anyone who missed one of the quizzes due to unavoidable circumstances. There are no make-ups for mid or end term exams.

Citation Policy for Papers (if applicable)

Not Applicable

Academic Dishonesty/Plagiarism

As per institute policy

Accommodation of Divyangs/Persons with Disabilities (PwDs)

As per institute policy

ESD 502 Analog CMOS VLSI Design

Some current areas of research

- Power regulator ICs
- Wireless communications
- Precision analog to digital converters
- Very low power circuits
- Energy harvesting

Why this course

- All natural signals are analog. They must be amplified and converted to digital signals for processing.
- So all electronic systems will have a front-end that is analog and mixed-signal.

Goals of the course

- **Learn to analyze and design CMOS amplifiers.**
- **Learn some advanced amplifier design techniques.**

Why Amplifiers? (1/3)

- **Amplifier design encompasses most of the design principles that are applicable to a large number of analog circuits and systems.**
- **Amplifiers are the most widely used analog circuits.**

Why amplifiers? (2/3)

- **Basic building blocks of a large number of electronic systems:**
  - **Audio and video amplifiers**
  - **ADCs and DACs**
  - **Bio-medical instrumentation systems**
  - **Cellular phones and base stations**
  - **Sensors of all kinds: Temperature, pressure, humidity, etc.**
  - **Computer monitors**

Why Amplifiers? (3/3)

- **Filters**
- **Semiconductor memories**

- **Hard-disk drives**
- **Automotive electronics**
- **Oscillators**
- **Voltage references**
- **I-to-V and V-to-I converters**
- **Precision measurement instruments**

Broader purposes of the course

- **Acquire knowledge**
- **Develop deep thinking processes**
  - **Learn to analyze and think, not merely pass exams**
  - **Learn to ask questions**

Textbooks

Design of Analog CMOS Integrated Circuits, by Behzad Razavi

References:

- **Microelectronic Circuits, by Sedra and Smith**
- **CMOS: Design, Layout and Simulation, by Baker, Boyce and Li**
- **Analog Integrated Circuit Design, by Johns and Martin**
- **CMOS Analog Circuit Design, by Allen and Holberg**

Course contents – Amplifiers

- **MOS transistor: Physics and modelling (Ch. 2)**
- **Single-stage amplifiers; differential amplifiers; current mirrors (Chs. 3 – 5)**
- **Frequency response of amplifiers (Ch. 6)**
- **Operational amplifiers (Ch. 9)**
- **Stability and frequency compensation (Ch. 10)**
- **Advanced amplifier concepts (from research papers, if time permits)**
  - **High-resistance; low-resistance; high slew-rate; rail-to-rail.**

Evaluation scheme

- **Evaluation components**
  - **In-sem tests (5): 5*20 = 100**
  - **Spice projects (4): 4*15 = 60**
  - **Final exam 40**

- TOTAL 200

- **Must get 80 to pass the course**

In-semester tests

- **Dates: Aug. 9, Aug. 30, mid-term week (Sept. 18-23), Oct. 18, Nov. 8**
- **Format for tests:**
  - You will write the test
  - You will solve the test again at home and make sure you solve it all correctly
  - You will correct your own answer-books, find the mistakes you made and give marks
  - I will then check and give final marks

First test

Syllabus (Revision of basic electric circuits)

- Nodal and mesh analyses.
- Thevenin's theorem and its application to circuits, with and without independent and dependent sources.
- Sinusoidal steady-state analysis of circuits: Phasors, magnitude and phase calculations of voltages and currents.
- Bode plots, and calculation of phase margins.

Spice design projects

1. MOSFET parameter extraction
2. Common-source amplifier design
3. Cascode amplifier design
4. Two-stage amplifier design
5. Assessment may include a viva
6. Designs will be done individually

Rules

- Do not copy!
- Do not use of mobile phones, laptops, etc. in class.

Course Proposal Template

Course Name	Principles of Embedded Systems
Course Proposer Name(s)	Prof. Poonacha
Course Instructor Name(s)	Prof. Sachit Rao
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	• Core
Credits	2
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	NC & E
Semester	Term: I Academic Year: 2015-16

Pre-Requisites (where applicable, specify exact course names)

Course Description

Everyday devices, both consumer and industrial-grade, contain computing devices, which are viewed as embedded systems. This course is designed to understand existing architectures of embedded systems and also understand principles involved in designing such systems. Various issues involved in designing embedded systems that meet performance, cost, physical size and weight, as well as power consumption requirements will be highlighted.

Course Content

Week-wise breakdown:

Week 1: Relay circuits, Boolean Algebra, Gates

Week 2: Shift Registers, CPUs, Memories and Busses, Complex systems and Microprocessors

Week 3: Instruction sets, CPU and Memory, I/O Devices and Component Interfacing

Week 4: Embedded system design process and Formalisms for design, Analysis and Optimization

Week 5: Operating systems with real time constraints, Design Methodologies and Architecture design

Week 6: Multi-core Embedded systems, Power management techniques for single and multi-core systems

Week 7: Future Embedded systems, Neural computers and Quantum computers

Week 8: Programming project on DSPs

Assessments (optional for Special Topics courses)

Mid-term, Finals, Homework assignments.

Text Book / References

1. Computers as Components, Principles of Embedded Computing System Design, Wayne Wolf, Princeton University, Morgan Kauffman Publishers, Academic Press, 2001
2. IEEE Papers as required
3. Published material from TI, ADI, ARM, Intel and others
4. Software Development for Embedded Multi-core Systems: A Practical Guide Using Embedded Intel Architecture, Max Domeika

Course Proposal Template

Course Name	ESD 505 Principles of Embedded Systems
Course Proposer Name(s)	Prof. Poonacha
Course Instructor Name(s)	Prof. Sachit Rao
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	• Core
Credits	2
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	NC & E
Semester	Term: I Academic Year: 2015-16
Pre-Requisites (where applicable, specify exact course names)	
Course Description	
Everyday devices, both consumer and industrial-grade, contain computing devices, which are viewed as embedded systems. This course is designed to understand existing architectures of embedded systems and also understand principles involved in designing such systems. Various issues involved in designing embedded systems that meet performance, cost, physical size and weight, as well as power consumption requirements will be highlighted.	
Course Content	

Week-wise breakdown: Week 1: Relay circuits, Boolean Algebra, Gates Week 2: Shift Registers, CPUs, Memories and Busses, Complex systems and Microprocessors Week 3: Instruction sets, CPU and Memory, I/O Devices and Component Interfacing Week 4: Embedded system design process and Formalisms for design, Analysis and Optimization Week 5: Operating systems with real time constraints, Design Methodologies and Architecture design Week 6: Multi-core Embedded systems, Power management techniques for single and multi-core systems Week 7: Future Embedded systems, Neural computers and Quantum computers Week 8: Programming project on DSPs
Assessments (optional for Special Topics courses)
Mid-term, Finals, Homework assignments.
Text Book / References
1. Computers as Components, Principles of Embedded Computing System Design, Wayne Wolf, Princeton University, Morgan Kauffman Publishers, Academic Press, 2001 2. IEEE Papers as required 3. Published material from TI, ADI, ARM, Intel and others 4. Software Development for Embedded Multi-core Systems: A Practical Guide Using Embedded Intel Architecture, Max Domeika

***Prep Term**: July; **Term I**: Aug – Nov; **Term II**: Jan – Apr; **Term III**: Jun – July;*

Course Proposal Template

Course Name	ESD 517 Digital Control Systems
Course Proposer Name(s)	
Course Instructor Name(s)	Sachit Rao
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Special Topics
Credits	4
Grading Scheme	4-point scale: (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CSE** – Computer Science and Engineering **DS** – Data Sciences **NCS** – Networking & Communication and Signals **ES** – Embedded Systems **SoC** - System on Chip	(Choose at most two areas from the list) Embedded Systems Computer Science and Engg.
Semester	Term: II Academic Year: 2016-17

Pre-Requisites (where applicable, specify exact course names)

Control Systems at the B.Tech level—Laplace Transforms, PID controllers, Root Locus and Bode Plots
Linear Algebra—matrices, eigenvalues and eigenvectors, positive definiteness etc.

Course Description

The typical control systems courses are generally studied in the continuous time domains. This assumption becomes invalid when these systems have to be implemented on microprocessors in the digital domain. The primary reason for digital implementation is the flexibility offered in changing controller parameters and even algorithms to suit the

Course Content

<u>Week-wise breakdown:</u>

Week 1: Introduction

Week 2-3: Sampling, Aliasing, Quantization, Zero and First-order Holds

Week 4-5: Transform from continuous time to discrete time, Laplace to Z-domain transforms

Week 5-7: Jury Stability test, Unit circle mapping of poles and zeros, transient and steady-state analysis, discrete PID controllers and their implementation

Week 8: Buffer

Week 9-10: State-space models in discrete time, linear algebra concepts

Week 11-12: State feedback, observers, multi-rate sampling

Week 13-14: Stability analysis, LQR and LQG control

Week 15: Buffer

Assessments (optional for Special Topics courses)

Mid-term, Finals, Homework assignments.

Text Book / References

1. Karl Johan Astrom and Richard M. Murray, ``Feedback Systems: An Introduction for Scientists and Engineers", electronic version accessible from http://www.cds.caltech.edu/\~murray/amwiki
2. Charles L. Phillips and H Troy Nagle, ``Digital Control System Analysis and Design (Third Edition)", Prentice-Hall
3. Other curated material which will be shared on LMS

ESD 853/VL 853 Advanced ARM Architectures

About the Course

Course Outline

1. Basic concepts behind ARM
2. Processor Architecture
3. Memory Architecture and low level addressing method
4. Cortex Instruction set (ARM assembly Language)
5. Floating point
6. Stacks and subroutine
7. Interrupt service routine
8. Memory Management
9. ARM V8 Arch and Neon
10. AMBA Bus Architecture
11. Writing C programs for ARM (bare metal C)
12. Projects and Assignment

Pre-Requisites

1. You should know C programming, other programming languages like python may be helpful for projects.

2. You should be willing to do lot of coding and debugging, all assignment, projects, etc needs to write in Machine Language/Assembly Language. There will be situation where you need to work at Binary level

3. Willing to experiment and be adventurous with learning and programming.

4. Exploratory approach to learning will help you a lot

5. Background in electronics will help in projects

6. You should come to class with your laptop. (No excuses about that).

Assessment

No	Activity	Comments
1	Assignments	There will be around 5 assignments (number not decided exactly)
2	**Quiz** 1. Mini Quiz (Surprise) 2. Planned Quiz (periodic)	You can expect Mini Quiz almost daily. Planned quiz will be once a month or twice. But will be informed in advance.
3	Hackathon	One or two
4	Projects	One

Grading

They all carry equal weightage so Average of scores will be considered to compute your final Grade

Final Assessment will be done based on your scores in Assignments, Hackathon, Project and Quiz

Attendance and discipline will be 10% of the total marks.

Grading

100 to 91 will get A

90 to 81 will get A-

80 to 71 will get B+

70 to 65 will get B

64 to 51 will get B-

50 to 45 will get C

Attendance and discipline

No	Activity	Score
1	Assignment-1	91
2	Assignment-2	95
3	Assignment-3	100
4	Mini Quiz (average)	96
5	Assignment-4	85
6	Planned Quiz (all avg)	98
7	Hackathon	97
8	Project	100
9	Average	95.25% (Qualify for A Grade)
10	Who scored well in attendance & discipline	95.25%
11.	Who did not score well with attendance and discipline	95.25 -10 = 85.25 (Qualify for A -ve)

Schedules

On Tuesdays and Thursday from 2 PM to 3 :30 PM

I am not a full time faculty, I have other professional commitments too. There may be situations where, I may not able to stick to these timings. In which case I will inform you in advance and reschedule the class to a suitable time. I will discuss it with you and select a time slot such that it does not impact existing schedules.

Text Books & Reference Material

1. **CORTEX M4 User Guide**
2. **Cortex M4 Technical Reference Manual**

High Level Synthesis and Optimization of Digital Circuits (4 Credits) (SKR)

Topics :

Logic Optimization and Synthesis : Combinational Logic Synthesis : Two Level – Multiple input & multiple output minimization by exact and heuristic algorithms; Symbolic Minimization and Encoding Problems; Multiple level logic synthesis; Technology mapping; Sequential Logic Synthesis : State minimization, State assignment – For two level and multiple level logic, Multiple FSM realization, Hierarchical FSMs;

High Level Synthesis : Architectural Models, Quality Measures, Design Description Languages, Register Transfer Components, Design Representation, Design Transformations, Design Partitioning, Scheduling, Allocation, Resource Sharing and Binding, Data-path and Control generation, Design Flow in High Level Synthesis, Design Methodologies in High Level Synthesis,

System Level Design and Synthesis :

INTRODUCTION : System-Design Challenges, Abstraction Levels, Y-Chart, Processor-Level Behavioral Model , Processor-level structural model, Processor-level synthesis, System-Level Behavioral Model, System Structural Model, System Synthesis, System Design Methodology, Missing semantics , Model Algebra, System-Level Models, Platform Design, System Design Tools.

SYSTEM DESIGN METHODOLOGIES : Bottom-up Methodology, Top-down Methodology, Meet-in-the-middle Methodology, Platform Methodology, FPGA Methodology ,System-level Synthesis, Processor Synthesis ,Summary; MODELING : Models of Computation, Process-Based Models , State-Based Models, System Design Languages , Netlists and Schematics , Hardware-Description Languages, System-Level Design Languages, System Modeling , Design Process , Abstraction Levels, Processor Modeling, Application Layer, Operating System Layer, Hardware Abstraction Layer, Hardware Layer, Communication Modeling, Application Layer, Presentation Layer, Session Layer, Network Layer, Tran*SYSTEM SYNTHESIS*sport Layer, Link Layer, Stream Layer , Media Access Layer, Protocol and Physical Layers, System Models , Specification Model, Network TLM, Protocol TLM, Bus Cycle-Accurate Model (BCAM), Cycle-Accurate Model (CAM).

SYSTEM SYNTHESIS : System Design Trends, TLM Based Design, Automatic TLM Generation, Application Modeling, Platform Definition, Application to Platform Mapping , TLM Based Performance Estimation, TLM Semantics, Automatic

Mapping, GSM Encoder Application, Application Profiling, Load Balancing Algorithm, Longest Processing Time Algorithm, Platform Synthesis, Component data models, Platform Generation Algorithm, Cycle Accurate Model Generation;

SOFTWARE SYNTHESIS : Preliminaries, Target Languages for Embedded Systems, RTOS, Software Synthesis Overview, Example Input TLM, Target Architecture, Code Generation, Multi-Task Synthesis, RTOS-based Multi-Tasking, Interrupt-based Multi-Tasking, Internal Communication, External Communication , Data Formatting, Packetization, Synchronization, Media Access Control, Startup Code, Binary Image Generation, Execution.

SYSTEM DESIGN PRACTICE: System Level Design Tools, Academic Tools, Commercial Tools, Outlook, Embedded Software Design Tools, Academic Tools, Commercial Tools, Outlook, Hardware Design Tools, Academic Tools, Commercial Tools , Outlook , Case Study, Embedded System Environment, Design Driver: MP3 Decoder.

References:

1. G. De Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill - International Students Edition.
2. D. D. Gajski, N. D. Dutt, A.C.H. Hu and S. Y. Lin, High Level Synthesis : Introduction to Chip and System Design, Kluwer Academic Publishers.
3. Embedded System Design : Modeling, Synthesis and Verification – D. D. Gajski, S. Abdi, A. Gerstlauer, G. Schriner, Springer
4. Introduction to Embedded Systems : A Cyber-Physical Systems Approach – Edward Ashford Lee, Sanjit Arunkumar Seshia.
5. Embedded System Design – Embedded Systems Foundations of Cyber-Physical Systems : Dr. Peter Marwedel, Springer.

Additional Resources :

1. High Level Synthesis - From Algorithms to Digital Circuit : Philippe Coussy and Adam Morawiec (Editors).
2. Specification and Design of Embedded Systems – D. D. Gajski, F. Vahid, S. Narayan, J. Gong; Prentice Hall, Englewood Cliffs, NJ 07632.
3. Co-Synthesis of Hardware and Software For Digital Embedded Systems – Rajesh Kumar Gupta, Kluwer Academic Publishers.
4. Embedded Systems : Architecture, Programming and Design – Raj Kamal, 2nd Edition, Tata McGraw Hill.
5. The Design of the Unix Operating System, Maurice Bach, Pearson-Prentice Hall India.

6. Real Time Systems Design and Analysis : Tools for the Practitioner – Phillip A. Laplante & Seppo J. Ovaska, Fourth Edition, IEEE Press-Wiley Student Edition (India).
7. Real Time Systems – Jane W. S. Liu, Pearson Education.
8. Real-Time Systems - Scheduling, Analysis and Verification : Albert M. K. Cheng, Wiley Student Edition.

Journals : Design and Test of Computers, IEEE / ACM Journal on Electronic Design Automation / IEEE Transactions on CAD, Computers and VLSI Systems.
Conference Proceedings : International VLSI Conference/ Design Automation Conference (DAC) / International Conference on Computer Aided Design (ICCAD) / Asia South Pacific Design Automation Conference (ASPDAC).

This is a project based elective. There will be regular lectures though alongside. The overall grading mechanism will be arrived at in the first lecture along with those students who register for the course.

ESD 703 Principles of Intelligent Systems

GENERAL COURSE INFORMATION

Course Name	Principles of Intelligent Systems
Term	Term II (2014-15)
Instructor(s)	P.G.Poonacha
Course credits	4
Pre-requisite(s)	First Semester at IIITB

COURSE OVERVIEW AND OBJECTIVES

It is believed that machines with computational intelligence will soon become ubiquitous and change the world forever. This course is a small step in that direction with focus on understanding principles and tools which help in designing intelligent machines. We call a system intelligent if it has the ability to,

1. Develop behaviors based on input data from sensors or databases
2. Recognize complex patterns and make intelligent decisions
3. Understand and interact with the environment and learn to survive and improve its performance.
4. Repair, reconfigure and adapt to new environments.
5. Listen to other machines or humans and communicate well.
6. Learn from the environment and develop ability to navigate like humans.

Purpose of this course is to work and learn along with students to get a good exposure to the area in terms of concepts and tools to design such systems in the future.

COURSE CONTENTS

1. Discussion on the nature of human intelligence.
    a. Behaviorism - All behavior is caused by external stimuli
    b. Cognetivism - Brain designed as an Information processor
    c. Constructivism - Learning is an active, constructive process.
    d. Humanism - Learning is a personal act to fulfill one's potential.
2. Discussion on Artificial Intelligence and computational learning
3. Concepts and tools for creating artificially intelligent machines:
    a. Linear classifiers, Perceptrons and support vector machines
    b. Decision trees and Random forests
    c. Artificial Neural networks
    d. Evolutionary computing and Stochastic algorithms for learning

GRADING : Assignments(2) : 20%, Class Tests(2) : 20% Mid sem exam : 30% End sem exam : 30%

TEXT BOOK AND REFERENCES

1. Pattern Classification, Richard O. Duda, Peter E. Hart, David G. Stork, 2001,2nd Ed.
2. R. Rojas: Neural Networks, Springer-Verlag, Berlin, 1996

Course Template (Syllabus)

Course Code / Course Name	**ESS 111 - C programming**
Course Instructor Name(s)	Yashavant Kanetkar/ Srinivas Vivek

Credits (L:T:P)

(Lecture : Tutorial : Practical)

Select <u>one</u> from the following:

(Place X appropriately)

Hours	Component
1	Lecture (1hr = 1 credit)
0	Tutorial (1hr = 1 credit)
2	Practical (2hrs = 1 credit)
L:T:P = 1:0:1	**Total Credits = 2**

Grading Scheme	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)

(Choose by placing X against appropriate box)		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)

(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication
	Artificial Intelligence and Machine Learning			Digital Society
	VLSI Systems			Cyber Security
	General Elective			

Programme / Branch

Course is restricted to the following programmes / branch(es):

(Place X appropriately. More than one is okay)

Programme: *Branch:*

X	iMTech
	M.Tech
	M.Sc.

	<table><tr><td>X</td><td>CSE</td></tr><tr><td>X</td><td>ECE</td></tr><tr><td></td><td>Digital Society</td></tr></table>
Course Category	Select **one** from the following: *(Place X appropriately)* <table><tr><td></td><td>Basic Sciences</td></tr><tr><td></td><td>CSE Core</td></tr><tr><td></td><td>ECE Core</td></tr><tr><td></td><td>CSE Branch Elective</td></tr><tr><td></td><td>ECE Branch Elective</td></tr><tr><td>X</td><td>Engineering Science and Skills</td></tr><tr><td></td><td>HSS/M</td></tr></table>

		General

Course Pre-Requisites (where applicable, specify exact course names)
None

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	Yes	Jobs in industry including the software industry expect candidates to possess the knowledge of the contents of this course.
Focus on skill development	Yes	C coding

Focus on entrepreneurship	No	
Provides value added / life skills (language, writing, communication, etc.)	No	

Course Context and Overview
This knowledge area includes those skills and concepts that are essential to C programming practice independent of the underlying specialization. As a result, this area includes units on fundamental C programming concepts, basic data structures, algorithmic processes, and basic security. These units, however, by no means cover the full range of programming knowledge that an IT undergraduate must know. It is expected that a second programming course is taught that reinforces these concepts.
Concept Map of the Course (Optional)
Course Outcomes and Competencies *Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*

	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Lab (Hrs)
CO1	Understand the UNIX shell environment.	PO1	U	F C	3	6
CO2	Write simple expressions involving basic data types including char, int, float, bool in C and control flow statements including if-else, for loops, while loops.	PO1 PSO1	Ap	F C P	3	6
CO3	Write modular programs using functions, recursion and pointers.	PO1 PO5 PSO1 PS04	Ap	C P	5	10
CO4	Write programs using designed abstract data types with structures, unions and file operations.	PO1 PO5 PO9 PSO1 PSO4	Ap	C P	4	8
	Total				**15**	**30**

** PO/PSO - Programme Outcome / Programme Specific Outcomes*

** CL - Cognitive Level*

** KC - Knowledge Category*

Course Content (List of Topics)

Contents

- Introduction to computer problem-solving.
- Fundamental data structures (Data types, representation of numeric data, strings, etc.)
- Fundamental algorithms.
- Factoring methods. Array techniques.
- Merging, sorting and searching.
- Text processing and pattern searching.
- Dynamics data structure algorithms.
- Recursive algorithms.

The topics to be covered at a fundamental level with focus more on practice.

All the sessions of the C Programming Lab will end with the description of a stretch exercise that students can work on outside of the lab hours. The C Programming Labs are structured based on specific themes for each lab session. Each lab session is divided into multiple lab exercises.

Instruction Schedule

Provide session-wise schedule

Theory/Lab 1: Preliminaries.

– Objective: The objective of this lab is to familiarize the students with the C programming environment.

– Exercises:

- Introduction to Unix.
- Basic I/O program 1.
- Basic I/O program 2.
- Basic I/O program 3.

- Basic I/O program 4.

– Comment: Lab 1 is intentionally kept light because the basic objective is to familiarize the student with the programming environment, which includes Unix operating system, editor, compilation, execution, etc.

Theory/Lab 2: Data Types and Expressions.

– Objective: The objective of this lab is to start using variables of various primary data types in the C language and use them as part of various expressions.

– Exercises:

- Variables and data types.
- Type casting and data. Expression evaluation.

Theory/Lab 3: Control Flow.

– Objective: The objective of this lab is to provide an introduction to control structures in C language.

– Exercises:

- Control: if statement.
- Control: if-else statement.
- Control: switch-case statement.
- Iterative: for loop.
- Iterative: while loop.
- Iterative: do-while loop.

Theory/Lab 4: Functions.

– Objective: The objective of this lab is to introduce modular software development using functions.

– Exercises:

- Function exercise #1 (prototypes, void return and void parameters).
- Function exercise #2 (parameters and return values).
- Function exercise #3 (global variables).
- Function exercise #4 (static variables).
- Function exercise #5 (multi-file programming).
- Introduction to built-in libraries (math.h, string.h, etc.).

Theory/Lab 5: Recursion.

– Objective: The objective of this lab is to understand recursion in C programming language.

– Exercises:

- Recursion exercise #1.
- Recursion exercise #2.

Theory/Lab 6: Arrays.

– Objective: The objective of this lab is to introduce the students to arrays in C programming language.

– Exercises:

- 1-d array exercise #1.
- 1-d array exercise #2.
- 2-d array exercise #3.
- n-d array exercise #4.

Theory/Lab 7: Pointers.

– Objective: The objective of this lab is to learn about pointers in C language.

– Exercises:

- Pointers and addresses.
- Pointers and function arguments.
- Pointers and arrays.
- Address arithmetic.
- Character pointers and functions.

Theory/Lab 8: More on Pointers.

– Objective: The objective of this lab is to learn about advanced concepts about pointers in C language.

– Exercises:

- Pointer arrays.
- Pointers to pointers.
- Pointers to functions.

Theory/Lab 9: Structures.

– Objective: The objective of this lab is to learn about structures in C programming language.

– Exercises:

- Basics of structures.
- Structures and functions.
- Arrays of structures.

Theory/Lab 10: Advanced Structures and Unions.

– Objective: The objective of this lab is to learn about advanced concepts in structures and unions in C programming language.

– Exercises:

- Pointers to structures.
- Self-referential structures.
- Unions.
- Bit-fields.

Theory/Lab 11: File I/O.

– Objective: The objective of this lab is to learn how to do File I/O using C programming language.

– Exercises:

- Text I/O sequential access.
- Binary I/O sequential access.
- Binary I/O random access.

Theory/Lab 12,13: C Programming Project

– Objective: The objective of the last two lab sessions is to do a non-trivial programming project that tries to make use a majority of the C programming language constructs and paradigms. The project can be a group project with 6 members each. The size of the project should be such that completion of the project should be possible in about 8 hours of collective programming (about 48 person hours).

Theory/Lab 14, 15: Practice problems

Learning Resources

Mention text books, reference books and other learning resources required as part of the course

- **The C Programming language** by Kernighan and Ritchie.
- **Let us C** by Yashavant Kanetkar
- **How to solve it by Computers** by Dromey (Reference textbook)
- **Code Complete** by McConnell (Reference textbook)

Assessment Plan

List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)

30% - Assignments and Project

20% - Quizzes

25% - Mid-term exam

25% - Final exam

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1	Assignment 1: **Preliminaries**	CO1
2	Assignment 2: **Data Types and Expressions**	CO2
3	Assignment 3: **Control Flow**	CO2
4	Assignment 4: **Functions**	CO3
5	Assignment 5:**Recursion**	CO3
6	Assignment 6:**Arrays**	CO3
7	Assignment 7:**Pointers**	CO3
8	Assignment 8: **Structures**	CO4
9	Assignment 9: **Unions**	CO4
10	Assignment 10: **File I/O**	CO4
11	C Project:	CO4

10 Assignments in total - each consisting of writing C programs that involves concepts learnt in the theory class of that week

5 quizzes in total - each consisting of MCQs

Project - work in groups of 6 to develop a simple software implemented in C for real world utility including passenger reservation system, image format conversion.

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

The course uses one or more of the following evaluation procedures as part of the course:

- Automatic evaluation of MCQ quizzes on Moodle or other online platforms
- Manual evaluation of essay type / descriptive questions
- Automatic evaluation of programming questions
- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Late submissions will be permitted only upon prior approval.

Make-up Exam/Submission Policy *State if any specific policy derived from institute policy is applicable. Otherwise leave it as given*
[As per institute policy]
Citation Policy for Papers
NA
Academic Dishonesty/Plagiarism *State if any specific policy derived from institute policy is applicable. Otherwise leave it as given*
[As per institute policy]
Accommodation of Divyangs *State any special action taken to accommodate Divyangs*
[As per institute policy]

GEN101: English
iMTech 2020: Term I – 2020-21

November 2020 /March 2021
Class Timings/ Venue: 11 a.m. to 1 p.m. Wednesdays, Online
Instructor: Dr. Radha M. Parikh
Email: rmparikh@iiitb.ac.in

Office hours: Email /web

Structure: 2-0-0-2

Overview: To add to students' understanding of literature, along with a brief review of Grammar and practice in language skills through selected texts and class discussions /assignments.

Objectives:

i) The students will read literary texts analytically and discuss in class (with ensuing Grammar review and vocabulary building)
ii) Students will have an opportunity to be creative and learn to write poetry and appreciate a few modern and classic poets
iii) They may present their discussions through skits written by them based on assigned socially relevant topics/ readings

Evaluation:

Participation: 40 % - Students will be expected to attend class having completed the assigned readings/written assignments and prepared to contribute to discussions. Missing class and not contributing to discussions will result in loss of points as there will be ongoing in-class assessment.

Attendance: 10%

Final exam: 50 %

Required readings:

i) Swami Vivekananda Power capsules; ii) I am Malala; iii) Metamorphosis (Kafka) ; iv) Frankenstein; v) The Dying Detective (Sherlock Holmes); vi) The Cactus (O'Henry)

General Requirements:

1. Regular Attendance is required for all scheduled class meetings in that the student is responsible for information covered in assigned readings, lecture notes in the lecture folder, discussions, and activities. Attendance is stressed because students will have opportunities to (a)

improve their knowledge base through discussions, (b) practice skills needed to engage in professional dialogue/exchange with colleagues, (c) practice skills required to present information to others, (d) acquire information from lectures and presentations, (e) participate in activities, and (f) submit required assignments.

2. Like the instructor, students are expected to attend class meetings thoroughly prepared. “Thoroughly prepared” is defined as having read the selections to verbally and in writing (a) discuss concepts and ideas with insight, (b) relate this information to content presented in previous classes or readings. It also implies that students have reviewed information from previous readings and class meetings. It will be the students’ responsibility to pose questions when information from readings or class meetings is unclear.

3. All assignments must be submitted on or before the assigned due date.

4. All assignments must be prepared in a professional manner, clearly typed.

5. Do your own work. Ask your instructor when you need help. Avoid copying others’ work; it may be inaccurate and land you in trouble for plagiarizing!

Grades: As per the system

Course Proposal Template

Course Name	GEN 503 Probability Theory and Statistics
Course Proposer Name(s)	Prof. V. N. Muralidhara
Course Instructor Name(s)	Prof. Neelam Sinha Prof. Jaya Sreevalsan Nair,
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	• Core
Credits	2
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	(Choose at most two areas from the list)
Semester	Term: I Academic Year: 2015-16
Pre-Requisites (where applicable, specify exact course names)	
Course Description	
This course provides an introduction to concepts in Probability Theory and Statistics, which are used widely in designing engineering systems in Information Technology.	
Course Content	

Sample space, axioms of Probability theory, random variables, distribution function and density function, mean, variance, characteristic function and central limit theorem.
Law of large numbers, introduction to stochastic processes with examples
Statistical estimation, parametric distribution estimation, non-parametric distribution estimation, optimal detector design and hypothesis testing, Chebyshev and Chernobounds.

Week-wise breakdown:

Week 1 : Introduction - Basic set theory, axioms of Probability theory, events, independence

Week 2 : Random variables, Distributions (Continuous, Discrete) - Binomial, Poisson, Hypergeometric, Normal

Week 3 : Mean, Variance calculations of Distributions

Week 4 : Distribution of several random variables, Central Limit theorem

Week 5: Statistics - Random Sampling

Week 6: Confidence Intervals, Hypothesis testing

Week 7: Goodness of fit test, Linear regression

Week 8: Chebyshev and Chernobounds

Assessments (optional for Special Topics courses)

Mid-term, Finals, Homework assignments.

Text Book / References

1. Kreyzing "Advanced Engineering Mathematics" 9th Edition, Wiley-India.
2. Hoel-Port-Stone, Introduction to Probability Theory, Houghton Mifflin
3. Sheldon Ross, “A first course in Probability & Statistics", Prentice Hall.

<GEN 504: LINEAR ALGERBRA>

GENERAL COURSE INFORMATION

Course Name	Linear algebra
Term	Term I (Aug 2017)
Instructor(s)	Dr. V. Ramasubramanian
Course credits	2
Pre-requisite(s)	-Nil -

COURSE OVERVIEW AND OBJECTIVES

This is a 2 credit course in linear algebra (3 hours / week over 2 months (Oct & Nov 2017)), providing the foundational aspects of vector spaces, linear transforms and matrix theory, as relevant for a wide range of engineering problems, data sciences and machine learning.

COURSE CONTENTS

1. Vector spaces, subspaces and bases, norms, inner product spaces, Gram Schmidt orthogonalization, linear transformations.
2. Matrices, Eigenvalues and Eigen vectors, LU and QR factorization, trace and determinant, quadratic forms and canonical forms, singular value decomposition (SVD), least squares problem and Moore Penrose inverse.

GRADING

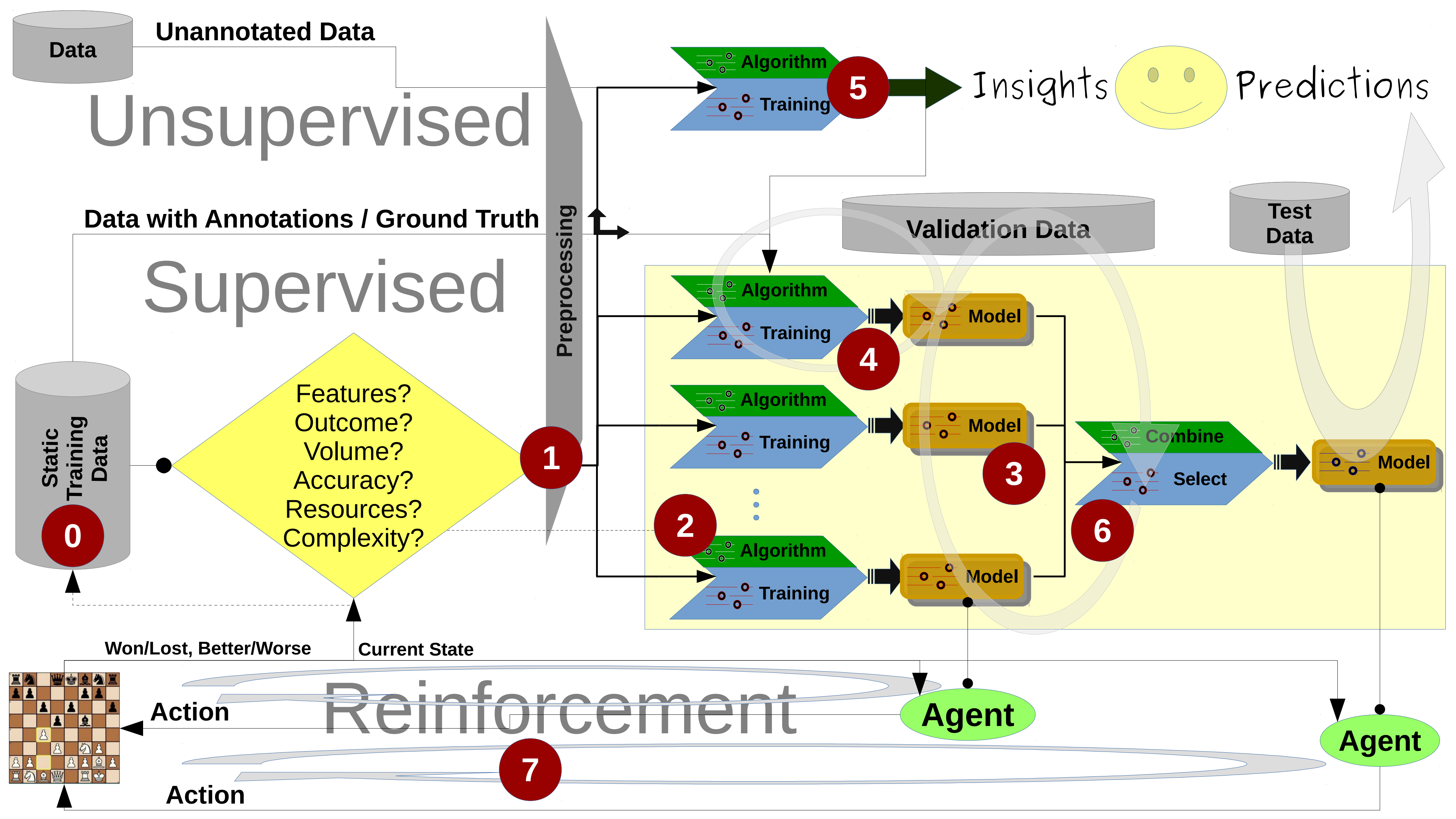
- 2 Assignments (20%)
- Theory (80%) – Mid Sem Test (40%); End Sem (40%)

TEXT BOOK AND REFERENCES

1. David C. Lay, Stephen R. Lay and J. J. McDonald, “Linear algebra and its applications”, Pearson, 5th edition (Global Edition), 2016.

VIDEO LECTURES

- Nil -



Data
Unannotated Data
Unsupervised
Algorithm
Training
5
Insights
Predictions
Data with Annotations / Ground Truth
Preprocessing
Validation Data
Test Data
Supervised
Algorithm
Training
Model
4
Algorithm
Training
Model
3
Combine
Select
Model
Static Training Data
0
Features?
Outcome?
Volume?
Accuracy?
Resources?
Complexity?
1
2
Algorithm
Training
Model
6
Won/Lost, Better/Worse
Current State
Action
Reinforcement
Agent
Agent
7
Action

Data Handling & Preprocessing 0 1

- Learning from Data - Introduction
- Basic Protocol – Training vs Test
- Generalizability
- Preprocessing – Need, Types

Training and Validation 4

- Optimization and Loss Functions
- Max Likelihood Models
- Gradient Descent, SGD
- Validation, Convergence

Model Selection and Ensembling 6

- Bagging vs Boosting vs Stacking
- Random Forest
- XG Boost, AdaBoost
- Model Selection, Cross Validation
- Bias-Variance Tradeoff

Phase	Hrs
0 1	3
2 3	29
4	3
5	5
6	6
7	4
Total	**50**

Supervised Learning 2 3

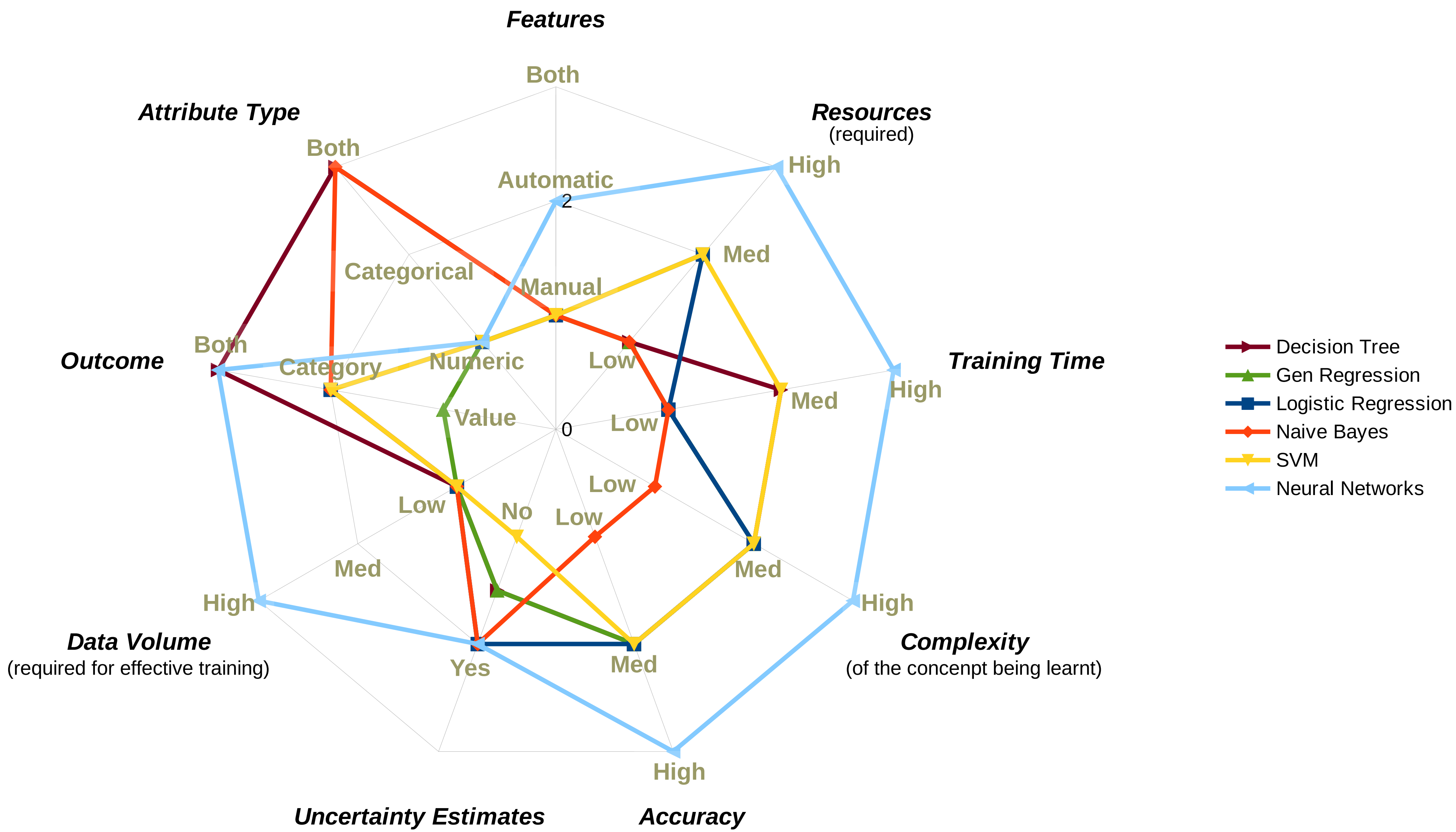
- Decision Trees
- General Regression
- Logistic Regression, LR as NN
- Naive Bayes
- Expectation Maximization
- SVM and Kernels
- Neural Networks
  - Basic Architectures
  - Back Propagation

Unsupervised 5

- Clustering -- K-Means
- Gaussian Mixtures
- Autoencoders
- PCA

Reinforcement Learning 7

- Basic Dynamic Programming based Learning
- TD Learning
- Reinforcement Learning and Neural Networks



Features
Both
Automatic
2
Manual
Resources
(required)
High
Med
Low
Training Time
High
Med
Low
0
Complexity
(of the concenpt being learnt)
High
Med
Low
Accuracy
High
Med
Low
Uncertainty Estimates
Yes
No
Data Volume
(required for effective training)
High
Med
Low
Outcome
Both
Category
Value
Attribute Type
Both
Categorical
Numeric
Decision Tree
Gen Regression
Logistic Regression
Naive Bayes
SVM
Neural Networks

Supervised Algorithms and Models 2 3

Topic	Hrs
Decision Trees	3
General Regression	3
Logistic Regression, LR as NN	3
Naive Bayes	2
Expectation Maximization	3
SVM and Kernels	5
Neural Networks - Basic Architectures	2
Neural Networks - Back Propagation	4
Building Neural Network Models	4
Total	**29**

Course Proposal

Course Name	**Advanced Scientific Computing**
Course Proposer Name(s)	**Prof. Jaya Sreevalsan Nair,** **Prof. Shiva Kumar Malapaka**
Course Instructor Name(s)	**Prof. Jaya Sreevalsan Nair,** **Prof. Shiva Kumar Malapaka**
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Select one from the following: • Core • **Elective (Level 3)** • Preparatory-Mandatory • Preparatory-Optional • Special Topics
Credits	**4**
Grading Scheme	• **4-point scale (A,A-,B+,B,B-,C+,C,D,F)** • Satisfactory/Unsatisfactory (S / X)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	(Choose at most two areas from the list) N/A – GEN category
Semester	Term: **I** Academic Year: **2016-17**

Pre-Requisites (where applicable, specify exact course names)

Algorithms, Programming (C/Matlab), numerical analysis, calculus and matrix operations (linear algebra) are assumed, GEN601 (strongly recommended).

Course Description

This course, intended for M.Tech. 3rd semester and iMTech. 7th semester, is an advanced course, after the introductory GEN601, in lines with the our experiences with teaching GEN601 and proposal for introducing a course on high performance computing.

The goal of this course is numerical computation for mathematical, computational, and engineering problems of complex nature. These problems include optimization and differential equations. There will be emphasis on specific classes of problems, such as elliptic solutions for Navier Stokes equations, and nearest neighbor problems, using applications in computational physics and visualization. The outcome of this course is to bring up the knowledge and practice of scientific computing in students to requirements of large-scale problems. The students work on use-cases of high performance computing.

Course Content

Module 1: Optimization
…

Module 2: Ordinary Differential Equations – initial value problems
…

Module 3: Ordinary Differential Equations – boundary value problems -
…

Module 4: Partial Differential Equations -
…

Module 5: Applications -
Computational fluid dynamics (Navier Stokes equations), nearest neighbor problems or n-body problems, volume visualization

Module 6: Parallel Algorithms -

Module 7: Message Passing -
OpenMP, MPI

Module 8: General purpose GPU computing
…

Module 9: Advances in high performance computing –
Heterogeneous computing

Assessments (optional for Special Topics courses)

Programming assignments, Mid-term, Finals

Text Book / References

- Michael T. Heath, “Scientific Computing: An Introductory Survey,” Second Edition, McGraw-Hill, 2002.
- Ananth Grama, George Karypis, Vipin Kumar, Anshul Gupta, “Introduction to Parallel Computing,”2003, Addison-Wesley.
- David B. Kirk, Wen-mei Hwu, “Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series),”1E, 2010, Morgan Kaufmann.
- Other relevant publications and articles.

Course Plan
Distributed Systems and Control

Vittal Prabhu, Professor, Penn State

November 13, 2018

The details of the course are as follows:

- **Course Name**: Distributed Systems and Control
- **Course Branch**: ECE, CSE (IMTech, MTech)
- **Course Proposer Name(s)**: Sachit Rao
- **Course Instructor Name(s)**: Vittal Prabhu
- **Course Type**: Open Elective
- **Course Level**: NA
- **Course Category**: Elective
- **Credits (L:T:P)**: 3:1:0; 4 credits in total
- **Grading Scheme**: 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
- **Pre-Requisites**: Familiarity with high-level programming. Students are expected to be proficient in undergraduate level analysis pertaining to differential equations
- **Course Description**: The objective of this course is to study current research and engineering challenges in distributed systems and control in the context of manufacturing and service enterprises, and supply chains. Emphasis will be placed on understanding the dynamics and computational aspects of decision making and control algorithms in integrated enterprises. This course deals with the multidisciplinary aspects of controls, computing, and communication in this rapidly evolving area. Assignments and projects in this course will include designing, programming, and integrating distributed control systems.

  Evaluation will be based on programming and lab assignments, literature review and class presentation, a semester project, in-class mid-term exam, and class participation. There is no text book for the course; several papers will be assigned as reading and students are expected to review the papers before attending the corresponding class period.
- **Course Content**:

  The weekly break-up of the course is as follows:

Week	Topic
1	**Introduction and Motivation for Distributed Control**: Characteristics of centralized, hierarchical and distributed systems. Approaches for distributed control in different applications.
2	**Simulation of Distributed Systems**: Various simulation techniques including discrete-event simulation, continuous time simulation, parallel/distributed simulation will be reviewed briefly. Distributed time-scaled simulation will be studied in some detail.
3	**Architectures for Distributed Control**: Computing and communication architectures suitable for real-time control at the plant and enterprise levels such as symmetric multi-processors, clusters, and reconfigurable computing will be studied. Introduction to communication issues such as determinism, response times, bandwidth, and scalability will be studied.
4–8	**Distributed Control Algorithms**: Distributed discrete-event timing control will be introduced. Mathematical techniques for modeling real-time dynamics of such systems will be reviewed. Techniques from discontinuous differential equation theory, nonlinear control theory will be used for analysis and synthesis of such systems.
10–14	**Applications of Distributed Control**: Algorithms for a variety of distributed control applications will be studied such as adaptive machine capacity control, production scheduling, maintenance scheduling, inventory control, and supply chain control.
15	In class presentations of literature review and project

- **Assessments/Grading**:
  - Programming assignments–20%
  - Literature review and class presentation–15%
  - Mid-term Exam–25%
  - Project–30%
  - Class participation–10%

Course Plan
Interdisciplinarity in Robotics, IIIT-B

Sachit Rao

November 5, 2019

The details of the course are as follows:

- **Course Name**: Interdisciplinarity in Robotics
- **Course Branch**: ECE, CSE, DS, M.S., Ph.D.
- **Course Proposer Name(s)**: Sachit Rao
- **Course Instructor Name(s)**: Sachit Rao
- **Course Type**: Open Elective
- **Course Level**: NA
- **Course Category**: Elective
- **Credits (L:T:P)**: 4:0:0; 4 credits in total
- **Grading Scheme**: 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
- **Pre-Requisites**: Master's level in courses in chosen areas of specialisation
- **Course Description**: This course is primarily targeted to research students of any programme: IMTech, MTech, MSc, MS, or PhD. The objective is to explore the interdisciplinary nature of robotics and apply concepts in the chosen area of research and develop a robotics application. For example, the development of a smart wheelchair requires the implementation of concepts from
  - Signal Processing, such as images or from ultrasonic sensors, to enable safe movement;
  - Speech Recognition, to translate verbal commands to movements of the wheelchair;
  - Wireless Communication, to communicate with other devices on the network or for localisation in indoor environments using WLAN beacons;
  - Real-time embedded software design, to implement feedback and path planning algorithms; and
  - Human Computer Interaction, to understand user needs and enable inclusive design.

  Other applications in robotics include: swarm robotics using decentralised architectures; teleoperated robotics over the Internet; scene recognition using stereo cameras; real-time implementation of statistical classification techniques using on-board hardware.

  Students are expected to choose 2 robotics-related projects and understand how crucial the implementation of concepts from their specialised domains becomes in a robotics application. Concepts from robotics, such as dynamics and kinematics, will be introduced as needed.
- **Course Outcomes**:

1. Understand challenges in implementing concepts from other disciplines in a robotics application
2. Identify the criticality of meeting real-time constraints
3. Propose alternative implementations of existing algorithms for implementation in resource-constrained systems
4. Understand the importance of software design architectures.

- **Course Content**: Please see the table in the following pages.

  Students will be introduced to latest review papers in the domain of robotics which also focus on concepts from other disciplines, for example, computer vision. They will select **two** papers and implement the algorithms proposed in these papers on robotic kits, such as Lego or by SP Robotics. The use of simulation environments is also encouraged, if the application demands their use.

  As the target audience is formed by research students, they are expected to implement their domain knowledge quickly.

- **Assessments/Grading**: 2 projects (50% each): Presentation, report, and demonstration. Attendance in each class is mandatory as students can discuss challenges they may face.

- **Text Book/References**:

  1. Review papers, which will be shared on LMS.
  2. Bruno Siciliano *et al*, "Robotics: Modelling, Planning and Control", Springer, 2009
  3. Gerald Cook, "Mobile Robots: Navigation, Control and Remote Sensing", Wiley-IEEE, 2011

The weekly break-up of the classes is as follows:

	Week of	Topic
1	Jan 1st	Introduction to the Course
2	Jan 6th	Discussion of Review Papers
3	Jan 13th	Selection of the first project and brief presentation by the students
4	Jan 20th– March 2nd	Execution of the first project and presentation during mid-term exam week
5	March 9thth– May 4th	Selection and execution of the second project and presentation during finals week

Course Hand Book – Quantum Computing and Quantum Information

Course Name	Quantum Computing and Quantum Information
Course Proposer Name(s)	Brijesh Kumar Mishra
Course Instructor Name(s)	Brijesh Kumar Mishra
Course Type *(Select one)* *"Special Topics" course proposals to be shared with faculty members for any feedback; but Academic Senate approval is not needed. All other course types need Academic Senate approval.*	Special Topics
Credits	4
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Sciences **NC&E –** Networking & Communication and Embedded Systems **SE** – Software Engineering	General
Semester	Term: (II) Academic Year: 2019 - 2020
Pre-Requisites (where applicable, specify exact course names)	

Course Description
The field of quantum computation and quantum information has grown rapidly in recent years. In this course the students will be introduced to fundamental concepts of Quantum Computing and Quantum Information. Starting with introduction to quantum mechanics, topics of quantum algorithms, quantum information and quantum error-correction will be covered.
Course Content
1) Introduction to Quantum bits, Quantum Computations, Quantum Algorithms, Quantum Information 2) Introduction to Quantum Mechanics, Linear Algebra, The Postulates of Quantum Mechanics, The Density Operator, EPR and the Bell inequality 3) Quantum circuits, Universal quantum gates, Simulation of quantum systems 4) The quantum Fourier transform and its applications 5) Quantum search algorithms 6) Quantum computers: physical realization 7) Quantum information 8) Distance measures for quantum information 9) Quantum error-correction 10) Entropy and information
Assessments (optional for Special Topics courses)
The tentative assessment includes: 1. Mid-term exam 2. Final Project
Text Book / References
Quantum Computation and Quantum Information by Isaac Chuang and Michael Nielsen, 10th edition, Cambridge University Press

***Prep Term**: July; **Term I**: Aug – Nov; **Term II**: Jan – Apr; **Term III**: Jun – July;*

GEN601: Introduction to Scientific Computing

International Institute of Information Technology, Bangalore

Term II 2014-15

General Course Information

Course Name	Introduction to Scientific Computation
Instructors	Prof. Jaya Sreevalsan-Nair jnair@iiitb.ac.in
Course Credits (Level)	4 (Level-2)
Grading	9-point scale (A, A-, B+, B, B-, C+, C, D, F)
Pre-requisites	GEN501: Mathematics for IT (specifically the module on "Linear algebra & Matrix theory"), CS501: Algorithms, Working knowledge of programming (C/Matlab), Working knowledge of numerical analysis, calculus, and matrix operations.

Course Overview

This course aims at giving an introduction to the fundamental issues and techniques of numerical computation for mathematical, computational, and engineering problems. This lays the background for students who would like to solve a problem using a computational approach. Scientific Computation draws on many parts of mathematics and computer science. Beyond this knowledge, it requires discipline and practice. A problem-solving code is built and tested procedure by procedure. Algorithms and program design are chosen based on considerations of accuracy, stability, robustness, and performance. Modern software development tools are complex and include programming environments and debuggers, visualization, profiling, and performance tools, and high-quality libraries. The training, as opposed to just teaching, is in integrating all the knowledge and the tools and the habits to create high quality computing software "solutions."

The outcome of this course is to bring up the knowledge and practice of scientific computation in students to requirements of a graduate level course. Hence while first half of the course can be broadly seen as an advanced undergraduate level course, the second half of the course ramps up to the more advanced concepts such as introduction to high performance computing. The lectures cover the fundamentals of numerical analysis, and parallel programming, with a focus on message passing model. A brief introduction to CUDA (Compute Unified Device Architecture) and GPGPU (General Purpose GPU) computing will also be covered.

Course Contents

1. Topics from textbook by Michael T. Heath, "Scientific Computing: An Introductory Survey", 2E, 2002, McGraw-Hill Higher Education:
   (a) Basics: Scientific Computing, IEEE floating point arithmetic, sources of computational errors, well-posed problems, stability, conditioning, matrix decompositions (LU factorization, Cholesky decomposition, singular value decomposition), Gaussian elimination, matrix-vector multiplication, pivoting, banded matrices.
   (b) Iterative Methods for Linear Systems: Jacobi, Gauss-Seidel, Conjugate gradient, power method, Multigrid methods, Software for linear systems – LINPACK, LAPACK, etc.
   (c) Data fitting and discrete approximation: Interpolation, least-squares, discrete methods, splines.
   (d) Numerical integration and differentiation: Rectangle, trapezoid and Simpson's rules, Gauss quadrature, finite difference formulas.
   (e) Numerical solution to initial value problems: Euler's method, Implicit vs. Explicit methods, Runge-kutta methods, Multi-step methods.
   (f) Numerical solution to eigenvalue problems: Characteristic polynomial, Power method, Rayleigh quotient.
   (g) Nonlinear Equations: Solutions, convergence rates, solutions in one dimension, equation systems.
   (h) Optimization: Problems, Existence and uniqueness, optimization in one dimension, nonlinear least sqyares.
2. Topics from textbook by Ananth Grama, George Karypis, Vipin Kumar, and Anshul Gupta, "Introduction to Parallel Computing," 2003, Addison-Wesley.
   (a) Introduction to parallel computing – motivation and scope.
   (b) Parallel Programming Platforms – explicit parallelism, dichotomy of parallel computing platforms, physical organization.
   (c) Principles of parallel programming design – decomposition, load balancing techniques.
   (d) Basic communication operations – broadcast, reduction, scatter, gather.
   (e) Performance metrics for parallel systems – execution time, speedup.
   (f) Programming using message passing paradigm – blocking and non-blocking communications, topologies and embedding.
3. Topics from textbook by David B. Kirk and Wen-mei Hwu, "Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series),"1E, 2010, Morgan Kaufmann.

(a) Introduction to GPGPU computing.
(b) GPU architecture.
(c) CUDA architecture.

Grading

- Programming Assignments: 40% (Individual breakdown given in the assignment booklet).
- Homework Assignments: 30% (Individual breakdown given in the assignment booklet).
- Midterm: 15%
- Final: 15%

Specifics on the assessment:

- **Academic Plagiarism:** This course has zero tolerance for cheating and plagiarism. Any violation may result in an F grade and further disciplinary action may be initiated as per the Institute's policies. Ignorance of what constitutes cheating and plagiarism is not an excuse! If you have any doubts, contact your instructor. All material that will be used for assessment of the student's performance must be original work.
- **Assignments:** An assignment booklet will be provided to the students in the first class which will give a complete description and logistics of all the assignments for the course. There will be biweekly homework sets and four programming assignments. "*Start early and finish on time*" is the guiding principle for all assignments in this course.
- Rules on implementation:
  - All programming assignments should be implemented as per the instructions provided in the assignment booklet.
- Rules on submissions:
  - The list of submission deadlines will be provided in the assignment booklet.
  - Several submissions can be made for the programming assignments and the technical report. Only the last submission will be considered for evaluation.
  - To incentivize early submissions and discourage late submissions the following bonus scheme will be used on the total for final grade:
    - $+1$ for submission before the designated Sunday, -0.5 for submission on the subsequent Monday or Tuesday, -1 for submission before the next Sunday, -3 any later.
  - All submissions must be sent to the instructor via e-mail.
  - Submissions should be named in the format: <RollNumber>_Assignment<Number>.* where * is tar.gz or pdf
  - Submission for a programming assignment would be a tarred-gzipped folder comprising of the source files, header files, README, subfolder containing screenshots and a Makefile.

    * There will be penalty for submissions containing intermediate files (e.g., *.o, *.C , etc.).
    * README files should contain information on sources referred to for help on the assignment, instructions on how to compile and run the application, expected input-outputs, and any notable defects/effects when running the application.

- **Examinations:** There will be a written examinations for mid-term and finals.
  - The examinations will be based on the topics covered in the class until the date of the examination.

References/Reading Material

Textbooks:

1. Michael T. Heath, "Scientific Computing: An Introductory Survey", 2E, 2002, McGraw-Hill Higher Education: Online: `http://www.cs.illinois.edu/~heath/scicomp/`
2. David Bindel and Jonathan Goodman, "Principles of Scientific Computing," 2009: Online: http://www.cs.nyu.edu/courses/spring09/G22.2112-001/book/book.pdf
3. Ananth Grama, George Karypis, Vipin Kumar, Anshul Gupta, "Introduction to Parallel Computing," 2003, Addison-Wesley.
4. Peter Pacheco, "Parallel Programming with MPI," 1E, 1996, Morgan Kaufmann.
5. David B. Kirk, Wen-mei Hwu, "Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series),"1E, 2010, Morgan Kaufmann.

Others:

- Cleve Moler, "Numerical Computing with Matlab," Electronic Edition, http://www.mathworks.in/moler/chapters.html

Course Plan
Introduction to Robotics, IMTech, IIIT-B

Sachit Rao

June 19, 2018

The details of the course are as follows:

- **Course Name**: Introduction to Robotics
- **Course Branch**: **TBD**
- **Course Proposer Name(s)**: Sachit Rao
- **Course Instructor Name(s)**: Sachit Rao
- **Course Type**: **TBD**
- **Course Level**: **TBD**
- **Course Category**: **TBD**
- **Credits (L:T:P)**: 3:0:2; 4 credits in total
- **Grading Scheme**: 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
- **Pre-Requisites**: NA
- **Course Description**: This course introduces the fundamentals of robotic systems–a topic that would be of interest to both ECE and CSE streams. With the widespread use of robots in new areas such as medicine and transportation, their successful implementation, which requires interdisciplinary knowledge, also necessitates the understanding of their construction and the limitations which arise in engineering them. The course will focus on Industrial Manipulators–which form the basis for surgical robots, as well as abstractions of Unmanned Vehicles–as seen in the Autonomous Car. The initial part of the course will introduce the mathematical aspects of modeling robots, from a kinematics and dynamics perspective, with some elements of feedback control. It will also introduce the commonly used sensors as well as how these can be used to define the intelligence components in robots.
- **Course Outcomes**:
  1. Identify the broad categories of robot construction–manipulators formed using links and wheeled robots
  2. Derive the forward and inverse kinematic relations as well as simple dynamic models of these robots
  3. Understand the sensors and computing requirements needed to use these robots in different applications
  4. Able to program intelligence in these machines based on their on-board hardware

- **Course Content**: Please see the table in the following pages.

  A Teaching Assistant is required to conduct the tutorials as well as the laboratory content–which may be significant–of this course. It is preferable to have at least two hours of these sessions in a week. Simulation tools, such as Scilab/Matlab and other environments, will be extensively used to demonstrate concepts like path and trajectory planning as well as control implementation.

  Commercially available robot kits will be used to test the concepts introduced in the course. Depending on the progress of the course, a mini-project may be assigned on these platforms.

- **Assessments/Grading**: 4 in-class quizzes (15%), 2 closed-book exams (80%), Involvement in tutorials (5%).

- **Text Book/References**:

  1. John J Craig, "Introduction to Robotics: Mechanics and Control (Third Edition)", Pearson/Prentice Hall, 2005
  2. K S Fu, R C Gonzalez, and C S G Lee, "Robotics: Control, Sensing, Vision, and Intelligence", McGraw-Hill, 1987
  3. Stephen M Lavalle, "Planning Algorithms", accessible from `http://planning.cs.uiuc.edu/`
  4. Material from `https://www.eng.yale.edu/grablab/roboticscourseware/courses.html`

The weekly break-up of the lectures is as follows:

	Week of	Topic	[Reference]
1	Aug 1st	Introduction	[1–4]
2	Aug 6th	Kinematics of Manipulators and Wheeled Robots	[1–3]
3	Aug 13th	Continuation of Kinematics	
4	Aug 20th	Differential Kinematics (Jacobians)	[1, 2]
5	Aug 27th	Trajectory and Motion Planning	[1,4]
6	Sep 3rd	Continuation of Motion Planning	
7	Sep 10th	Sensors	[2]
8	Sep 17th	Review; Buffer of one class	
9	Oct 1st	Computer Vision	[2]
10	Oct 8th	Dynamics and Control	[1,2]
11	Oct 15th	Continuation of Dynamics and Control	
12	Oct 29th	Interaction with the Environment (Force Control)	[1]
13	Nov 5th	Robot Programming	[1,2]
14	Nov 12th	Robot Intelligence	[2,4]
15	Nov 19th	Continuation of Robot Intelligence	
16	Nov 26th	Review; Buffer of one class	

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INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
26/C Electronics City, Bangalore - 560100
Instructor: **Balaji Parthasarathy**

(January – April 2021; Tuesday, Friday 4:00 PM-5:30 PM)

Course Content: Even as technology has enabled us to communicate and travel over long distances with increasing ease, the human race has become predominantly urban with little likelihood of this phenomenon witnessing a reversal. India, too, is becoming an increasingly urban nation. Cities are more than just administrative jurisdictions. Cities offer opportunity, livelihoods, and freedom (of different kinds). More importantly, it offers serendipitous and face-to-face encounters with events and people possessing a variety of expertise, skills and talent, that communication over a distance can never duplicate. Cities can, therefore, be crucibles of information exchange and innovation, and studying them and the process of urbanization is often to study a large and important part of all that is grand and loathsome about human life. This course will draw on historical cases from around the world to help students understand *where* and *when* great urban centers were formed, and their importance to the spread of information and innovation.

Course Requirements: For each class, there are assigned readings that are chosen to highlight the important themes of the class. Students will be expected to read the assigned reading material and come prepared to discuss it in class. Students are expected to actively participate in class discussion to enhance the value of the class to everyone.

There will be a mid-term exam and a final exam. The mid-term exam will test the students on the material covered from the start to the mid-term and the final exam will test the students on the material covered from the mid-term to the end of the class.

In addition, students will be required to conceptualise an individual project based on the theme of the course and write a 10-15-page paper on the project. These papers are due at the end of the course.

Grading Pattern:	Class Participation:	25 points
	Mid-term exam:	20 points
	Final Exam:	20 points
	Term Paper:	35 points (30+5)

1. **Introduction to the Course** (Tuesday, 5 January)

Video: *The City and Technology* https://www.youtube.com/watch?v=hRY-ZUlJXY0

2. Thinking about Cities (Friday, 8 January)
• Joseph Friedman. 2008. Mahatma Gandhi's vision for the future of India: The role of enlightened anarchy. *Penn History Review.* 16(1): 1-11.
• Edward Glaeser. 2011. Our urban species. In *Triumph of the City: How our Greatest Invention makes us Richer, Smarter, Greener, Healthier, and Happier*. New York, NY: Penguin Press. pp.1-15 (Introduction)
• Edward Glaeser. 2011. What do they make in Banglaore?. In *Triumph of the City: How our Greatest Invention makes us Richer, Smarter, Greener, Healthier, and Happier*. New York, NY: Penguin Press. pp.17-40 (Chapter 1)

Video: *Edward Glaeser speaks at the Vancouver Urban Forum - Part 1*
https://www.youtube.com/watch?v=2xkZ8vjvA2Y

3. Can Cities be too Big or Small? (Tuesday, 12 January)
• N.V.Sovani. 1962. The analysis of "over-urbanization". *Economic Development and Cultural Change.* 12(2):113-122.
• Raju J Das and Ashok K Dutt. 1993. Rank-Size distribution and primate city characteristics in India: A temporal analysis. *GeoJournal*. 29(2):125-137.

Video: *Primate Cities/Rank-Size Rule*
https://www.youtube.com/watch?v=B17ah_jUWUA&list=PL_KTY9qZXUv46vls10n85euAHmSMmtYct&index

4. Democracy and Cities: From Athens to Beijing (Friday, 15 January)
• Sir Peter G Hall. 1998. The fountainhead, Athens 500-400 BC. In *Cities in Civilization*. New York, Pantheon Books. pp.24-58 (Chapter 2)

Video: *It happened in Tiananmen Square by Al Jazeera*
https://www.youtube.com/watch?v=VbKroPF3W5Q

5. Imperial Rome (Tuesday, 19 January)
• Sir Peter G Hall. 1998. The imperial capital Rome, 50BC to AD100. In *Cities in Civilization*. New York, NY: Pantheon Books. pp. 621-645 (Chapter 22).

Video: *What the Ancients Knew – Rome*
https://www.youtube.com/watch?v=BNbGjI-MEXE

6. The Medieval City in Europe (Friday, 22 January)
• Mark Girouard. 1985. Church and state. In *Cities and People: A Social and Architectural History.* New Haven, CT and London, UK: Yale University Press. pp.41-66 (Chapter 3).
• Mark Girouard. 1985. The texture of life. In *Cities and People*: *A Social and Architectural History.* New Haven, CT and London, UK: pp.67-84 (Chapter 4).

Video *Power of the Church in the Middle Ages*
https://www.youtube.com/watch?v=sJH0V_Uhp5E&t=2016s

Tuesday, 26 January, no class – Republic Day

7. **Renaissance Urbanism** (Friday, 29 January)
• Peter Burke. 2002. Early modern Venice as a center for information and communication. In John Martin and Dennis Romano (eds.). *Venice Reconsidered: The History and Civilization of an Italian City-State, 1297-1797*. Baltimore, MD: John Hopkins University Press. pp. 389- 419 (Chapter 12)
• Internet in a cup. 2003. *The Economist*, 18 December.
http://www.economist.com/node/2281736

Video: *The Renaissance - the Age of Michelangelo and Leonardo da Vinci - I*
https://www.youtube.com/watch?v=BmHTQsxxkPk

8. Medieval Urbanism in India (Tuesday, 2 February)
• Renu Thakur. 2002. Mechanisms of urban growth in India:AD 600-120. *Urban History*. 29(2):187-196.
• Vibhuti Sachdev and Giles Tillotson. 2002 (3rd ed.). A time and a place. In *Building Jaipur: The Making of Indian City*. London, UK: Reaktion Books. pp.33-53 (Chapter 2)

Video: *Built Spaces: Living Legacies: Chola Temples of Thanjavur and Kumbakonam*
https://www.youtube.com/watch?v=-qAkHGN62mk

9. The Origins of Money (Friday, 5 February)
• Glyn Davies. 2002 (3rd ed.). The nature and origins of money and barter. In *History of Money*: *From Ancient Times to the Present Day*. Cardiff, UK: University of Wales Press. pp.1-33 (Chapter 1)

Video: *The Ascent of Money – Part I* https://www.youtube.com/watch?v=JAbVltqySrA

10. Amsterdam and the Emergence of Global Trade (Tuesday, 9 February)
• Mark Girouard. 1985. Amsterdam. In *Cities and People*: *A Social and Architectural History*. New Haven, CT and London, UK: Yale University Press. pp.151-166.

Video: *The Ascent of Money (Part III) – Blowing Bubbles*
https://www.youtube.com/watch?v=KHZ2hnDGsEc

11. Manchester and the Rise of the Industrial City (Friday, 12 February)
• Mark Girouard. 1985. Manchester and the industrial city. In *Cities and People*: *A Social and Architectural History*. New Haven, CT and London, UK: Yale University Press. pp.257-270 (Chapter 12)

Video: *Industrial Revolution*
https://www.youtube.com/watch?v=GYln_S2PVYA&ab_channel=BBCDocumentary

12. Motor City – Detroit (Tuesday, 16 February)
• Sir Peter Hall. 1998. The mass production of mobility, Detroit 1890-1915. In *Cities in Civilization.* New York, NY: Pantheon Books. pp. 396-422 (Chapter 13).

Video: *Henry Ford Biography – The Model T Ford (Documentary) First Ford* https://www.youtube.com/watch?v=Knpi3ZEf928

13. Great Cities of the US: Chicago and New York (Friday, 19 February)
• Mark Girouard. 1985. America and the birth of the skyscraper. In *Cities and People*: *A Social and Architectural History.* New Haven, CT and London, UK: Yale University Press. pp. 301-324 (Chapter 15).
• *The Economist.* 2017. New lift technology is reshaping cities. 19 December. https://www.economist.com/news/christmas-specials/21732705-elevators-may-soon-gosideways-well-up-new-lift-technology-reshaping-cities

Video: *Building The Skyscraper* https://www.youtube.com/watch?v=nBhK9q4B71I (3:40 to 42:30)

14. Colonial Urban Development in India (Tuesday, 23 February)
• Anthony D. King. 2007. Towards a theory of colonial urban development. In *Colonial Urban Development: Culture Power and Social Environment.* London, UK: Routledge. (Chapter 2).
• Anthony D. King. 2007. The transformation of a pre-industrial city, 1857–1911. In *Colonial Urban Development: Culture Power and Social Environment.* London, UK: Routledge. (Chapter 9)

Video: *BBC Empire Episode 2 - Making Ourselves at Home* https://www.youtube.com/watch?v=JJg8MX5QStc

15. The City as Post-Colonial Identity (Friday, 26 February)
• James C Scott. 1998. The high modernist city: an experiment and a critique. In *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed*. Yale University Press.
• Barbara Högner. 2011. Chandigarh's buildings and spaces are vividly brought to life by its residents. *Architectural Review*. 29 June.
• Jim Antoniou. 2003. Chandigarh: Once the future city. *Architectural Review*. 16 June.

Video: *What remains of the utopia of Brasilia?*
https://www.youtube.com/watch?v=61rlorlUJac
Chandigarh: Le Corbusier's urban design and planning (1-4)
https://www.youtube.com/watch?v=PCmdimGNp4w;
https://www.youtube.com/watch?v=BcYwQVyiD5g;
https://www.youtube.com/watch?v=f9kvwZ07m5w;
https://www.youtube.com/watch?v=5w6CPrfOqAE

ASSESSSMENT CYCLE 1: MID TERM EXAMINATION (1-6 March)

MID-TERM BREAK (7-14 March)

16. World Cities (Tuesday, 16 March)
• Saskia Sassen. 2009. Cities in today's global age. *SAIS Review of International Affairs*, 29(1):3-34.
• Richard Florida. 2005. The world is spiky. *The Atlantic Monthly*. October: pp.48-51.

Video: *Globalization* https://www.youtube.com/watch?v=x1wLbJoSmR0

17. Information Technology Eldorado: Silicon Valley (Friday, 19 March)
• Annalee Saxenian. 1996. Inside-Out: Regional Networks and Industrial Adaptation in Silicon Valley and Route 128. *Cityscape*. 2(2):41-60.
• Annalee Saxenian. 2007. The international mobility of entrepreneurs and regional upgrading in India and China. In Andres Solimano (ed.). *The International Mobility of Talent: Types, Causes, and Development Impact*. WIDER Studies in Development Economics. Oxford, UK: Oxford University Press. Pp.117-144 (Chapter 5).
• *Economist*. 2018. Silicon Valley is changing, and its lead over other tech hubs narrowing. 1st September.

Video: *Silicon Valley: East Meets Tech* https://www.youtube.com/watch?v=H5_jk9fgRTw

18. Global Aspirations in Bangalore (Tuesday, 23 March)
• Balaji Parthasarathy. 2010. Envisioning the future in Bangalore. *Seminar*. 612:39-43.
• John C Stallmeyer. 2010. The image made manifest: Electronics City. In *Building Bangalore: Architecture and Urban Transformation in India's Silicon Valley*. New York, NY: Routledge.49-70 (Chapter 4).

19. Migrating to the City (Friday, 26 March)
• Chinmay Tumbe. 2012. Migration persistence across twentieth century India. *Migration and Development*. 1(1):87-112.
• Ram B Bhagat and Soumya Mohanty. 2009. Emerging pattern of urbanization and the contribution of migration in urban growth in India. *Asian Population Studies*. 5(1):5-20.

Video: *Urbanization, Demographic Transition and the Growth of Cities in India, 1870-2020* https://www.youtube.com/watch?v=gIM2DF8-Cdo (0:45 to 52:16)

20. Working in the City: The Informal Sector (Tuesday, 30 March)
• Martha Alter Chen. 2013. The informal economy: Recent trends, future directions. *New Solutions: A Journal of Environmental and Occupational Health Policy*. 26(2):155-172.
• Jason Miklian. 2013. Rough cut. *Foreign Policy*. http://foreignpolicy.com/2013/01/02/roughcut/
• Steven D. Levitt and Stephen J. Dubner. 2009. Why do drug dealers still live with their moms? In *Freakonomics: A Rogue Economist Explores the Hidden Side of Everything*. New York, NY: Harper Perennial. pp.89-116 (Chapter 3)

Video: *Robert Neuwirth: The Power of the Informal Economy* https://www.youtube.com/watch?v=ONM4JupBz_E

Friday, 2 April, Institute holiday - Good Friday

21. Feeding the City (Tuesday, 6 April)
• Sara Roncaglia, 2013. Bombay-Mumbai and the *dabbawalas*: Origin and development of a parallel economy. In *Feeding the City: Work and Food Culture of the Mumbai Dabbawalas.* Cambridge, UK: Open Book Publishers. pp 1-36 (Chapter 1).
• Stigt Toft Madsen and Geoffrey Gardella. 2012. Udupi hotels: Entrepreneurship, reform and revival. In Krishendu Ray and Tulasi Srinivas (eds.) *Curried Cultures: Globalization, Food and South Asia.* Berkeley, CA: University of California Press. Pp.91-109 (Chapter 5).
• Pradyumna Taduri. 2019. *Delivering Consent: Work Games in Online Food Delivery Platforms.* Unpublished MSc (Digital Society) thesis, International Institute of Information Technology Bangalore. pp.1-10, 20-69 (Chapters 1, 3-6).

Video: *TEDxSSN - Dr. Pawan Agrawal - Mumbai Dabbawalas*
https://www.youtube.com/watch?v=N25inoCea24

22. Cleaning and Recycling the City (Friday, 9 April)
• Anjor Bhaskar and Poornima Chikarmane. 2012. The story of waste and its reclaimers: Organzing waste collectors for better lives and livelihoods. *Indian Journal of Labour Economics.* 55(4):595-619.
• Assa Doron. 2016. Unclean, unseen: Social media, civic action and urban hygiene in India. *South Asia: Journal of South Asian Studies.* 39(4):715-739.
• Julia Eleanor Corwin. 2018. "Nothing is useless in nature": Delhi's repair economies and value-creation in an electronics "waste" sector. *Environment and Planning A: Economy and Space.* 50(1):14-30.

Video: *The Manual Scavengers of Mumbai*
https://www.youtube.com/watch?v=5gRwdDfxVL8

Tuesday, 13 April, Institute holiday - Ugadi

23. Living in the City (Friday, 16 April)
• Yue Zhang. 2018. The credibility of slums: Informal housing and urban governance in India. *Land Use Policy.* 79:876-90.
• Gautam Bhan. 2013. Planned illegalities: Housing and the 'failure' of planning in Delhi, 1947-2010. *Economic and Political Weekly.* 48(24):58-70.
• Janice E. Perlman. 2006. The metamorphosis of marginality: Four generations in the favelas of Rio de Janeiro. *Annals of the American Association of Political and Social Science.* 606:154-177.

Video: *Robert Neuwirth: The "Shadow Cities" of the Future*
https://www.youtube.com/watch?v=_2Js_g7M60M

24. Building Urban Infrastructure and Governing the City (Tuesday, 20 April)
• Govind Gopakumar. 2020. Infrastructurescapes of privilege. In *Installing Automobility: Emerging Politics of Mobility and Streets in Indian Cities.* Cambridge, MA: MIT Press. pp.99-135 (Chapter 4).
• Rashmi Sadana. 2018. "We are visioning it": Aspirational planning and the material landscapes of Delhi's metro. *City and Society.* 30(2):186-209.
• Isher J Aluwalia. 2019. Urban governance in India. *Journal of Urban Affairs.* 41(1):83-102.

Video: *Social Life of a Bus* https://vimeo.com/118098906

25. The Rise of the Suburban and the Peri-Urban (Friday, 23 April)
• The Economist. 2014. A planet of suburbs: Places apart. 6 December. http://www.economist.com/suburbs
• V.Gajendran. 2016. Chennai's peri-urban: Accumulation of capital and environmental exploitation. *Environment and Urbanization ASIA.* 7(1)1-19.
• Michael Levien. 2013. Regimes of Dispossession: From Steel Towns to Special Economic Zones. *Development and Change.* 44(2)381-407.
• Mathew Idiculla. 2013. New regimes of private governance: The case of Electronics City in per-urban Bengaluru. *Economic and Political Weekly.* 51(17):102-109.

Video: *Water Security Issues in Periurban Areas of Hyderabad, India* https://www.youtube.com/watch?v=AwCghjBTv38

26. Smart Cities (Tuesday, 27 April)
• Sama Khan Persis Taraporevala and Marie-Helene Zerah. 2018. Mission impossible: Defining Indian smart cities. *Economic and Political Weekly.* 53(49):80-88.
• Balaji Parthasarathy and Brinda Sastry. 2019. Intelligence for place-making and social inclusion: Critiques and alternatives to India's Smart Cities Mission. In Tridib Banerjee and Anastasia Loukaitou-Sideris (eds.). *The New Companion to Urban Design.* Abingdon, UK and New York, NY: Routledge. pp.571-581 (Chapter 43)
• Shannon Mattern. 2017. A city is not a computer. *Places Journal.* https://doi.org/10.22269/170207

Video: *India Smart Cities Challenge* https://www.youtube.com/watch?v=GOqYMzEVE_g

27. The Temporary City (Friday, 30 April)
• Amita Baviskar. 2011. Spectacular events, city spaces, and citizenship: The Commonwealth Games in Delhi. In Jonathan Shapiro Anjaria and Colin McFarlane (eds.) *Urban Navigations: Politics, Space and the City in South Asia.* New Delhi, India: Routledge. pp.138-161 (Chapter 5).
• Kirsten McConnachie. 2016. Camps of containment: A genealogy of the refugee camp. *Humanity: An International Journal of Human Rights, Humanitarianism, and Development*. 7(3):379-412.

Video: *The Architectural Wonder of Impermanent Cities*
https://www.youtube.com/watch?v=Kc6hkHGHQQc
Syrian Refugee Camps Becoming Established Cities
https://www.youtube.com/watch?v=86mFVcc0dXw

Course Outline

Course Name	E-Governance Application Design
Course Proposer Name(s)	Amit Prakash
Course Instructor Name(s)	Amit Prakash
Course Type	Elective (HSS/M; ITS)
Credits	4
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) **CS** – Computer Science **DBIS** – Database and Information Systems **NC&E** – Networking & Communication and Embedded Systems **SE** – Software Engineering	NA
Semester	iMTech VII Semester/ MTech III Semester - (Aug-Dec)

Pre-Requisites (where applicable, specify exact course names)

NA

Course Description

While the promise of ICT use leading to better delivery of public services has been discussed for quite some time now, the relatively recent thrust of the Government of India through its National e-Governance Plan (NeGP) and the Digital India programme has led to an increased level of interest and activity in the area of e-Governance in the country.

E-Governance projects often portray characteristics of complex socio-technical systems. They are technical not only in the sense of the widespread use of various Information and Communication technologies but also of other techniques involving management science models, software engineering practices, procedures and organization of work. They are social in that their design and implementation process requires effective interaction amongst diverse stakeholder groups - designers, technology providers, organizational users, policy planners and beneficiaries. They are complex as they are often part of broader governance reforms programmes, wherein the multiple stakeholders mentioned above, can have divergent priorities and perspectives on what constitute development.

Amidst increasing instances of e-Governance projects ending up with sub-optimal results, it is being felt that they need to draw upon design approaches and theoretical frameworks from diverse disciplines which may include information and communication technology, management, sociology, public policy and development economics. An interdisciplinary approach can lead to a better appreciation of the primary work systems, whole organization systems and the macro-social environment of e-Governance projects.

This course on 'E-Governance Application Design' derives from such an understanding. It seeks to overlay the introduction of good principles in designing ICT solutions with an understanding of the context of development, governance and public policy within which e-Governance solutions are embedded. This can be useful in a better appreciation of the problem context and capacities of prospective users and beneficiaries, which are critical to designing effective and responsive ICT solutions.

Course Content

1. Development and the State – evolving nature of development thought and practice, role of the state and markets, notions of inclusive growth

2. Governance and Public Policy – policy making, public service delivery, development programmes, decentralization and other reforms

3. e-Governance Policy and Programmes – policy objectives, programme design and components, standards and frameworks

4. e-Governance Case Studies – case studies of 4-6 e-Governance projects to highlight design approaches, use patterns and potential outcomes/impact for different stakeholder groups

5. Designing e-Governance Applications – project implementation involving understanding users' requirements and embedding them into broader governance contexts and realities to develop a requirements specifications document and a design prototype for an e-Governance application

Assessment

Students will be assessed based on their participation in class discussions, presentation of assigned readings and/or cases, submission of written assignments, performance in class quizzes and an end-term exam. They will also be required to work on a project. The tentative weightage for various components is as follows:

Class participation	10%
Presentation of assigned readings/cases	10%
Class quizzes/assignments	20%
Project	40%
End-term exam	20%

Text Book / References

1. Development and the State

- Amit Bhaduri (2006). *Development with dignity: a case for full employment*. National Book Trust – Chapters IV,V, VI (pp. 32-104)
- D. Gasper (2004). The *Ethics of Development: From Economism to Human Development*. Edinburgh University Press, Edinburgh.
- Uma Kothari and Martin Minogue (Eds.) (2002). *Development Theory and Practice: Critical Perspectives*. Palgrave, Hampshire.
- Arturo Escobar (2011). *Encountering Development: The Making and Unmaking of the Third World (New in Paper)*. Princeton University Press.
- D. Simon (1997). Development Reconsidered: New Directions in Development Thinking. *Geografiska Annaler*. 79B:4, pp 183-201.

2. Governance and Public Policy

- Amartya Sen (1999). Democracy as a universal value. *Journal of democracy,* 10(3), pp. 3-17.
- Amartya Sen (2003). Democracy and its global roots. *New Republic*, pp. 28-35.
- R.A.W. Rhodes (1996). The New Governance: Governing without Government. *Political Studies,* XLIV, pp. 652-667.
- Vinod Vyasulu (2004). Transformation in Governance since 1990s: Some Reflections. *Economic and Political Weekly*, 5 June 2004.
- Mitu Sengupta (2008). How the State changed its Mind: Power, Politics and the Origins of India's Market Reforms. *Economic and Political Weekly*, 4 May 2008.
- Stuart Corbridge, Glyn Williams, Manoj Srivastava and René Véron (2005). *Seeing the State: Governance and Governmentality in India*. Cambridge University Press, Cambridge, UK , pp. 151-187.
- R.V. Vaidyanatha Ayyar (2009). *Public Policymaking in India*. Pearson Education, New Delhi.

3. e-Governance Policy and Programmes

- S.S. Dawes (2008). The evolution and continuing challenges of e-governance. *Public Administration Review*, *68*(s1), S86-S102.
- Claudio Ciborra (2005). Interpreting E-government and Development: Efficiency, Transparency or Governance at a Distance? *Information Technology and People*. (18:3), pp. 141-159.
- Shirin Madon (2009). *E-Governance for Development*. Palgrave Macmillan. (pp. 9-52).
- Rahul De and Jang B. Singh (2011). Scarcity, exit, voice and violence: the state seen through e-government. In *Electronic Government: 10th International Conference, EGOV 2011, Delft, The Netherlands, August 29--September 1, 2011, Proceedings* (Vol. 6846, p. 273). Springer Science & Business Media.

- e-Governance policy and programme documents of Government of India, available at http://deity.gov.in/content/national-e-governance-plan; e-Governance standards and guidelines approved by Government of India, available at https://egovstandards.gov.in/; in addition, policies of a few other relevant countries and those brought out by international agencies such as the United Nations and the World Bank will also be used.

4. e-Governance Case Studies

[Health, nutrition and food security]

- Sundeep Sahay and Geoff Walsham (2006). Scaling of health information systems in India: challenges and approaches. *Information Technology for Development,* Vol. 12(3), pp. 185-200.
- Shirin Madon, S. Krishna and Edwin Michael (2010). Health information systems, decentralization and democratic accountability. *Public Administration & Development.* Vol. 30, pp. 247-260.
- Amit Prakash (2016). E-Governance and public service delivery at the grassroots: a study of ICT use in health and nutrition programmes in India. *Information Technology and Development,* Vol. 22 Issue 2, pp. 306-319.
- Silvia Masiero (2015). Redesigning the Indian food security system through e-governance: the case of Kerala. *World Development,* Vol. 67, pp. 126-137.

[Property registration, land management and local governance]

- Jonathan Caseley (2004). Public sector reform and corruption: CARD façade in Andhra Pradesh. *Economic and Political Weekly*, Vol. 39 No. 11, pp. 1151-1156.
- Satish K. Puri (2007). Integrating scientific with indigenous knowledge: Constructing knowledge alliance for land management in India. *MIS Quarterly*. 31(2), pp. 355-379.
- Amit Prakash and Rahul Dé (2007). Importance of development context in ICT4D projects: a study of computerization of land records in India. *Information Technology & People*, 20(3), pp. 262-281.
- Klaus Deininger and Aparajita Goyal (2012). Going digital: credit effects of land registry computerization in India. *Journal of Development Economics*, Vol. 99, pp. 236-243.
- Anjali K. Mohan, Edward Cutrell and Balaji Parthasarathy (2013). Instituting credibility, accountability and transparency in local service delivery? Helpline and Aasthi in Karnataka. In *Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers-Volume 1* (pp. 238-247). ACM.

Case studies in other areas of governance may also be introduced depending on the preference of course participants.

Course Syllabus Template

Course Code / Course Name	DT 213 - ITS 711 Social Media Communication	
Course Instructor Name(s)	Preeti Mudliar	
Credits (L:T:P) **(Lecture : Tutorial : Practical)**	**Hours**	**Component**
	3	Lecture (1hr = 1 credit)
	1	Tutorial (1hr = 1 credit)
		Practical (2hrs = 1 credit)
	L:T:P = 3:1:0	**Total Credits =**
Grading Scheme *(Choose by placing X against appropriate box)*	**X**	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
		Satisfactory/Unsatisfactory (S / X)

Area of Specialization (if applicable)

(Choose by placing X in box against not more than two areas from the list)

	Theory and Systems for Computing and Data			Networking and Communication

	Artificial Intelligence and Machine Learning	X	Digital Society
	VLSI Systems		Cyber Security
	General Elective		

Programme / Branch	Course is restricted to the following programmes / branch(es): (*Place X appropriately. More than one is okay)* *Programme:* *Branch:*

X	iMTech
	M.Tech
X	M.Sc.
	CSE
	ECE
X	Digital Society

Course Category	Select **one** from the following: *(Place X appropriately)* <table><tr><td></td><td>Basic Sciences</td></tr><tr><td></td><td>CSE Core</td></tr><tr><td></td><td>ECE Core</td></tr><tr><td></td><td>CSE Branch Elective</td></tr><tr><td></td><td>ECE Branch Elective</td></tr><tr><td></td><td>Engineering Science and Skills</td></tr><tr><td>X</td><td>HSS/M</td></tr><tr><td></td><td>General</td></tr></table>
Course Pre-Requisites	*(Where applicable, state exact course code/name)*

Additional Focus Areas

Select zero or more from the following and write one sentence explaining the how the focus areas covered as part of the course.[NAAC criteria 1.1.3, 1.3.2].

Focus Area	Yes / No	Details
Direct focus on employability	YES	This course will serve as an introduction to social media technologies and the role they play in contemporary communication practices.
Focus on skill development	YES	The course provides a foundation to understand the role that media plays in contemporary society and to think critically about audiences and media production and consumption practices.
Focus on entrepreneurship	YES	The course will elaborate on the affordances of various social media platforms and locate their use in various contexts such as self-expression, privacy, cyberbullying, branding, culture, crisis communication, civic activism, and politics that would be valuable for students interested in media entrepreneurship
Provides value added / life skills (language, writing, communication, etc.)	YES	Grounded in theoretical literature and drawing from contemporary practical case studies along with guest lectures; students will be trained in understanding and evaluating the production, consumption, and measurement of communication media and specifically social media platforms

Course Context and Overview

This course will serve as an introduction to social media technologies and the role they play in contemporary communication practices. Its aim is to provide a foundation to understand the role that media plays in contemporary society and to think critically about audiences and media production and consumption practices. The course will elaborate on the affordances of various social media platforms and locate their use in various contexts such as self-expression, privacy, cyberbullying, branding, culture, crisis communication, civic activism, and politics. Grounded in theoretical literature and drawing from contemporary practical case studies along with guest lectures; students will be trained in understanding and evaluating the production, consumption, and measurement of communication media and specifically social media platforms.

The student is expected to UNDERSTAND:

- how communication as a practice has evolved through various eras;
- how different mediums, devices, and distribution modes create different audiences;
- the structural affordances of social media and what kind of communication practices it engenders;
- how social media use is harnessed and implemented to serve different societal needs

The student is expected to DO:

- conduct, evaluate, and report on a social media experiment
- research, evaluate, and report on instances of social media use from real world examples.

Course Outcomes and Competencies

[*Course Outcomes are to be stated using appropriate terminology and taxonomy as required by NAAC and/or NBA. For every course credit, about 2-3 outcomes are recommended.*]

Id	Course Outcome	PO/ PSO	CL	KC	Class (Hrs)	Tut (Hrs)

CO1	Learn about contextualizing social media, what makes new media different, responses to new media	PO3 PO4	U, An, App	C	3	1
CO2	Learn about Social media entanglements: Breaking the monolith: how do we understand online spaces, affordances, cultures of use and socialities, economics of connectivities	PO3 PO4	U, An, App	C	6	2
CO3	Learn about social media expressions: virals and memes, being mean online, how do we understand hate speech, responding to online hate speech, selfies	PO3 PO4	U, An, App	C	12	4
CO4	Learn about the realm of the personal: performing identity online, building relationships online, remembering/forgetting, privacy, quitting/non-use of social media	PO3 PO4	U, An, App	C	12	4
CO5	Learn about Publics: activism: governments and regimes, activism: #metoo, politicians and image making, microcelebrities and influencers, parents and children online, social media in the global south, beyond text: designed voice-based social media for the marginalized, finding sociality without the internet	PO3, PO4	U, An, App	C	12	4
Total Hours					45	15

Legend: *PO/PSO: Programme Outcomes / Programme Specific Outcomes; CL: Cognitive Level (from Revised Bloom's Taxonomy); KC: Knowledge Category (from Revised Bloom's Taxonomy); Class (Hrs): Number of hours of instruction; Tut (Hrs): Number of hours of tutorial session (where applicable)*

Concept Map of the Course (Optional)

Course Content

Module 1: (CO1 and CO2)

Theme 1: Outlining Social Media Communication

Module 2: (CO3, CO4, CO5)

Theme 2: Social Media Entanglements: Breaking the Monolith

Module 3: (CO6)

Theme 3: Social Media Expressions

Module 4: (CO7)

Theme 4: In the realm of the Personal

Module 5: (CO8)

Theme 5: Publics

Instruction Schedule

Module I

<u>Theme 1: Outlining Social Media Communication</u>

Introduction
Contextualizing Social Media - Then and Now
What makes new media different? - Part 1

Contextualizing responses to new media

Module II

Theme 2 - Social media entanglements: Breaking the monolith

How do we understand online spaces?
Affordances
Cultures of Use and Socialities
Economics of connectivity

Module III

Theme 3: Expressions

Virals and Memes
Being Mean Online
How do we understand hate speech?
Responding to online hate speech
Selfies

Module IV

Theme 4: The Personal

Performing Identity Online
Building relationships online
Remembering/Forgetting
Privacy
Quitting/Non-use of social media

Module V

Theme 4: Publics

Activism - Governments and Regimes
Activism - Calling out sexual harassment
Politicians and Image making
Microcelebrities and Influencers
Parents and Children online
Social Media in the Global South
Beyond text: Designing voice-based social media for the marginalized
Finding sociality without the Internet
Speculative futures: Where do we go from here?

Learning Resources

[Mention text books, reference books and other learning resources required as part of the course]

Readings for the course draw from various papers and books. These resources are made available to the students through the LMS portal. Some of the suggested readings for the course are mentioned below:

Tom Standage (2013) Writing on the Wall. Chapter 2

Nicole B. Ellison, and Danah M. Boyd. "Sociality through social network sites." *The Oxford handbook of internet studies*. 2013.

Nancy Baym (2013) Personal Connections in the Digital Age. Chapter 1. New Forms of Personal Connection.

Dennis McQuail (2010) McQuail's Mass Communication Theory. Chapter 6. New Media – New Theory?

Papacharissi, Zizi. "The virtual sphere: The internet as a public sphere." *New media & society* 4, no. 1 (2002): 9-27.

Boyd, Danah. "White flight in networked publics." *How race and class shaped American teen engagement with MySpace and Facebook. In L. Nakamura & PA Chow-White (Eds.), Race after the internet* (2013): 203-222.

Davis, Jenny L., and James B. Chouinard. "Theorizing affordances: From request to refuse." *Bulletin of Science, Technology & Society* 36.4 (2016): 241-248.

Miltner, Kate M., and Tim Highfield. "Never gonna GIF you up: Analyzing the cultural significance of the animated GIF." *Social Media+ Society* 3, no. 3 (2017): 2056305117725223.

Donald Norman (2013). The psychopathology of everyday things.

Sheldon, Pavica, and Katherine Bryant. "Instagram: Motives for its use and relationship to narcissism and contextual age." Computers in Human Behavior 58 (2016): 89-97

Boczkowski, Pablo J., Mora Matassi, and Eugenia Mitchelstein. "How young users deal with multiple platforms: The role of meaning-making in social media repertoires." *Journal of Computer-Mediated Communication* 23.5 (2018): 245-259.

Bayer, Joseph B., Nicole B. Ellison, Sarita Y. Schoenebeck, and Emily B. Falk. "Sharing the small moments: ephemeral social interaction on Snapchat." *Information, Communication & Society* 19, no. 7 (2016): 956-977.

Shifman, Limor. (2014). Memes in Digital Cultures. *MIT Press.*

Groshek, Jacob, and Chelsea Cutino. "Meaner on mobile: Incivility and impoliteness in communicating contentious politics on sociotechnical networks." *Social Media+ Society* 2, no. 4 (2016)

Gagliardone, Iginio. "Extreme Speech| Defining Online Hate and Its “Public Lives”: What is the Place for “Extreme Speech”?." International Journal of Communication 13 (2019): 20.

Udupa, Sahana. "Extreme Speech| Nationalism in the Digital Age: Fun as a Metapractice of Extreme Speech." *International Journal of Communication* 13 (2019): 22.

Van Dijck, José. "‘You have one identity’: Performing the self on Facebook and LinkedIn." *Media, culture & society* 35.2 (2013): 199-215.

Marwick, Alice E., and Danah Boyd. "I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience." *New media & society* 13.1 (2011): 114-133

Pitcan, Mikaela, Alice E. Marwick, and Danah Boyd. "Performing a vanilla self: Respectability politics, social class, and the digital world." *Journal of Computer-Mediated Communication* 23.3 (2018): 163-179.

Duguay, Stefanie. "Dressing up Tinderella: Interrogating authenticity claims on the mobile dating app Tinder." *Information, Communication & Society* 20, no. 3 (2017): 351-367.

Brubaker, Jed R., Gillian R. Hayes, and Paul Dourish. "Beyond the grave: Facebook as a site for the expansion of death and mourning." *The Information Society* 29.3 (2013): 152-163.

Haimson, Oliver L., Nazanin Andalibi, Munmun De Choudhury, and Gillian R. Hayes. "Relationship breakup disclosures and media ideologies on Facebook." *New Media & Society* 20, no. 5 (2018): 1931-1952

Hargittai, Eszter, and Alice Marwick. "“What can I really do?” Explaining the privacy paradox with online apathy." *International Journal of Communication* 10 (2016): 21

Sally Wyatt. 2003. Non-users also matter: The construction of users and non-users of the Internet. In Now Users Matter: The Co-construction of Users and Technology, Nelly Oudshoorn and Trevor Pinch (Eds.). MIT Press, 67--79.

Schoenebeck, Sarita Yardi. "Giving up Twitter for Lent: how and why we take breaks from social media." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2014.

Tufekci, Z., & Wilson, C. (2012). Social Media and the Decision to Participate in Political Protest: Observations From Tahrir Square. Journal of Communication, 62(2), 363-379.

Subramanian, Sujatha. "From the Streets to the Web." *Economic & Political Weekly* 50, no. 17 (2015)

Pal, Joyojeet. "The Making of a Technocrat. Social Media and Narendra Modi”. *Global Digital Cultures: Perspectives from South Asia* (2019): 163.

Lalancette, Mireille, and Vincent Raynauld. "The power of political image: Justin Trudeau, Instagram, and celebrity politics." *American Behavioral Scientist* 63, no. 7 (2019): 888-924.

Bravo, Joel Lenin Pinargote, Rafael Beto Mpfumo, Luis Alejandro Madruga Milanés, Ximena Michelle Cueva, Gretel García Gómez, Amalia Gómez Marcheco, Alberto Fernández Oliva, Jeanna Neefe Matthews, and Sam P. Kellogg. "Lessons from El Paquete, Cuba's Offline Internet." In *Proceedings of the 1st ACM SIGCAS Conference on Computing and Sustainable Societies*, p. 11. ACM, 2018.

Assessment Plan

[List grade distribution in terms of % across multiple assessment types (assignments, quizzes, mid-term, end-term, project, etc.)]

1. Class participation: 5%
2. Assignment on hate speech: 20%
3. Leading class: 10%
4. Speculative futures: 10%
5. Social media object analysis: 10%
6. Final paper: 35%

Assignments / Projects

[List exact number of assignments or projects included (provide generic description)]

S. No.	Focus of Assignment / Project	CO Mapping
1.	Class Participation: Students will be expected to contribute their observations, thoughts, and questions based on the assigned readings in class as well as respond to their classmate's reading response	CO 1-CO5
2.	Assignment on hate speech: Identify and report hate speech on social media. What are the tools of reporting on Facebook, Twitter, Instagram, and TikTok? What are their guidelines? How long do the platforms take to respond to you? In what instances do they take action on your report? In what instances do they not act on your report? Are there patterns that you see where action was taken versus where it was not? Why do you think	CO3

	the platforms responded in the way they did on your reports? What suggestions do you have to improve the reporting and action process followed by the platforms? Type of assignment: Group project Mode of submission - Class presentation + Written report	
3.	Leading class: Choose a topic from the syllabus. You will be responsible for starting the class with a 15 - 20 minute presentation. Your presentation will include a summary of the readings, additional research that tells us something that the assigned readings do not - this can include both academic as well as news articles. You will end the presentation with questions that this activity raised for you. Type of assignment: Individual Mode of submission: Class presentation	CO1-CO5
4.	Speculative futures: We will devote the last week of the class debating what the future of social media will look like. We will do this through a workshop format where we will use speculative techniques to envision the future of social media technologies and cultures. As part of this workshop, you will turn in a speculative essay or a speculative fiction on a topic of your choice. Type of assignment: Individual Mode of submission: Written	CO1-CO5
5.	Social media object analysis: You will select two social media artefacts of interest to you and analyse them based on the readings for which they are suitable. In your analysis you will explain how you are making sense of the chosen artefact drawing from the readings in which they can be located. Note these are two separate written assignments of 1,000 - 1,500 words each. One submission before mid term, one before end of semester. Guidelines for the assignment: Select a social media artefact. This can be anything ranging from a tweet, a series of tweets, a meme, an Instagram post (picture/post), a news report on a social media artefact, a viral video, etc… In the essay tell us why you selected the artefact and what it represents. Why is it of interest? What phenomenon is it representing? What will we learn from your meaning-making of the	CO1-CO5,

	artefact? Analyse the artefact in the context of a topic of your choice from the syllabus. You will be expected to do additional readings than those listed on the syllabus in order to build your arguments. This can be both something that we have already done in class or topics that we still have to address. You are also free to pick something not in the syllabus and do your own research to identify scholarly readings on the issue you want to write about. What does your analysis reveal about the object you have picked? What is your conclusion? Please let me know if you have more questions on this assignment. Type of assignment: Individual Mode of submission: Written	
6.	Final paper: You will write a final paper for the class based on a topic of your choice. Your final paper will be based on empirical research that you conduct, which means that you will collect data in some form on your topic and present an analysis. You will approach the research paper in three stages. The key dates for these stages will be as follows: a. October 15, 2019: Last date to declare your tentative research topic on the class sheet b. October 31, 2019: Submission of bibliography and a research question i.e. refine your topic into a question that you will resolve through data collection and analysis c. November 12 and 14: Class presentations on your research progress for feedback d. Final paper submissions: According to final examination date for the class	CO1-CO5

Evaluation Procedures

Provide details of how evaluations will be done, how students can look at the evaluations. Generic evaluation procedures included below. Add additional evaluation procedures / criteria as needed

- Manual evaluation of essay type / descriptive questions

- Automatic plagiarism check using tools

Students will be provided opportunity to view the evaluations done where possible either in person or online

Late Assignment Submission Policy

State any penalty policy for late submission

Students are required to adhere to deadlines. Extensions are granted for exceptional circumstances when ever warranted.

Make-up Exam/Submission Policy

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

As per institute policy

Citation Policy for Papers (if applicable)

[If course includes reading papers and citing them as part of activities, state the citation policy. Mention “Not applicable” if section is not applicable to the course]

Citations will be accepted in any recognized style (APA, MLA, Chicago, ACM etc). The Purdue Writing Lab is a handy resource to check your citation and reference format. https://owl.purdue.edu/owl/purdue_owl.html

Academic Dishonesty/Plagiarism

State if any specific policy derived from institute policy is applicable. Otherwise leave it as given

Plagiarism is a serious misdemeanor in the research community. The class discusses plagiarism and its consequences through the course. Attribution of ideas and scholarship is a critical research practice. There will be zero tolerance for plagiarism and will result in zero grade on the assignment. In addition, regular IIIT-Bangalore policies on plagiarism will be enforced.

Accommodation of Divyangs

[State any enabling mechanisms for accommodating learners with special needs]

Students requiring special accommodations owing to any special needs will be served to the best of the instructor's abilities and in keeping with institute policy. In the past, students with visual challenges have taken the course and the instructor is familiar with their needs. Students are encouraged to discuss their specific accessibility challenges with the instructor.

Course Proposal

Course Name	**Machine Learning – I (Statistical Learning)**
Course Proposer Name(s)	G. Srinivasaraghavan
Course Instructor Name(s)	G. Srinivasaraghavan
Course Type	Elective – Special Topics
Credits	4
Grading Scheme	A, A-, B+, B, B-, C+, C, D, F Points as per IIIT-B Default Scheme
Area of Specialization (if applicable) **CS** – Computer Science **DS** – Data Science **ES** – Embedded Systems **ITS** – IT & Society **NC** – Networking & Communication **SE** – Software Engineering	CS / DS
Semester	Autumn (Aug-Dec)

Pre-Requisites (where applicable, specify exact course names)

- First level courses in Discrete Maths, Algorithms, Software Engineering
- Foundations for Big Data Algorithms

Those opting for this course would require to have got at least a ***B*** *in the above prerequisite courses unless they can convince the instructor that they need to be treated as an exception.*

Course Description

This course is intended to be an intense, in-depth course in Statistical Learning methods. Primary Reference would be:

1. Trevor Hastie, Robert Tibshirani and Jerome Friedman. "The Elements of Statistical Learning ". Second Edition. Springer. 2008. Freely Downloadable.

Course Content

1. **Module 1 (Statistical Learning Theory)**
    - VC Theory – PAC learning, VC dimensions, Sample Complexity Bounds.
    - Rademacher Complexity
    - Overfitting Phenomenon

Template Version Number	1.6
Template update date	07 Mar 2013

Suggested Additional Reading:

a) Yaser S. Abu-Mostafa, Mailk Magdon-Ismail, and Hsuan-Tien Lin. “Learning From Data — A Short Course”. AMLbook.com, 2012.
b) Michael J. Kearns and Umesh V. Vazirani. “An Introduction to Computational Learning Theory”. The MIT Press. 1994. ISBN-13 978-0-262-11193-5.

2. Module 2 (Regularization and Model Selection)

- Bias-Variance Tradeoff; Structural Risk Minimization
- MDL
- Cross Validation
- Bayesian Approaches

Suggested Additional Reading:

a) Peter Grunwald. “A Tutorial Introduction to the Minimum Description Length Principle”. Advances in Minimum Description Length: Theory and Application. ed. P.Grunwald, I.J. Myung and M. Pitt. MIT Press 2005.
b) Volker Nannen. “A Short Introduction to Kolmogorov Complexity”. *arXiv Survey Article* 2003.
c) Volker Nannen. “A Short Introduction to Model Selection, Kolmogorov Complexity and Minimum Description Length (MDL)”. *arXiv Survey Article* 2003.

3. Module 3 (Generalized Linear Models)

- Basis Expansions
- Least Squares. Logistic Regression, LDA – Lasso, Laplace
- Classification and Regression using GLM

Suggested Additional Reading:

a) Jeff Gill. “Generalized Linear Models – A Unified Approach”. SAGE Publications. 2001. ISBN 0-7619-2055-2.
b) Annette J. Doson. “An Introduction to Generalized Linear Models”. Second Edition. Chapman & Hall/CRC. 2002. ISBN 1-58488-165-8.

4. Module 4 (Kernel Methods and SVM)

- Primer on Duality and Optimization
- SVM Classification
- SVM Regression
- Kernel Methods – Designing Kernels, Kernel Feature Extraction, Reduced Set Methods, Kernel Trick
- PAC Bounds for SVM

- Implementation Issues

Suggested Additional Reading:

a) Nello Cristianini and John Shawe-Taylor. “Support Vector Machines”. Cambridge University Press. 2000. ISBN 978-0-521-78019-3.
b) Bernhard Scholkopf and Alexander Smola. “Learning with Kernels”. The MIT Press. 2012. ISBN 0-262-17475-9.

5. Module 5 (Additive Methods and Model Averaging)

- Random Forests
- Model Averaging & Stacking
- Boosting – Generalization Bounds, Margins Explanation
- Relationship to Convex Optimization, Game Theory and Information Theory
- Extensions – Ranking, Multiclass Discrimination, Continuous Time
- Boosting Trees
- Kernel Smoothing

Suggested Additional Reading:

a) Robert E. Schapire and Yoav Freund. “Boosting”. The MIT Press. 2012. ISBN 978-0-262-01718-3.

Assessments

The evaluation will include three components:

- There will be small implementation experiments/projects for each module which the students are expected to carry out in small groups (at most 3 in each group). It is expected that students will participate in offline discussions on the observations/learnings from these experiments and other topics related to the subject matter covered on the discussion forum for the course in LMS. (**15%**)
- Mid-Semester and End-Semester exams as per schedule. (**25% + 25%**)
- A reasonably big project on something related to the modules listed above. (**35%**)

Additional References:

1. Christopher M. Bishop. “Pattern Recognition and Machine Learning”. Springer. 2006. ISBN 978-0387-31073-2.
2. Vladimir Charkassy ad Filip Mulier. “Learning from Data – Concepts, Theory and Methods”. Second Edition. Wiley Interscience and IEEE Press. 2007. ISBN 978-0-471-68182-3.
3. Kevin Murphy. “Machine Learning – A Probabilistic Perspective”. The MIT Press 2012. ISBN 978-0-262-01802-9.

Wireless Access Network

I. **Course:** Wireless Access Network (WAN)
Instructor: Dr. Debabrata Das
Credits: 4
Course Number: NC-601

III. **Texts:**

- Local Area Network, by Keiser
- High Speed Wireless ATM and LAN, by Benny Bing
- G. Bianchi, “Performance Analysis of the IEEE 802.11DistributedCoordination Function”, IEEE JSAC, V.18, No. 3, March,2000
- Qiang Ni. "Performance Analysis and Enhancements for IEEE 802.11e Wireless Networks", IEEE Network, Vol. 19, No. 4, July/August 2005.

IV. **Prerequisites:**
Back ground on Computer Networking Protocols;

IV. **Course Description:**

This course mainly teaches, how to be an innovator or tune your brain to be an innovator in your area of interest. This course will be a follow-up course to Computer Networking and Communication or if a student has a back ground on Computer networking in UG. It will mainly cover the broadband wireless access networks. In particular evolution of innovation in medium access control protocol in broadband access network. It emphasizes on Random Access Medium Access Control (MAC) and make the student feel, why one after the other innovation happened with respect to challenges and requirement in the space of wireless access network. The use case used is WiFi. Another major aim of this course to make the student think logically for innovation and the use case used to teach this course is broad areas of WAN MAC.

V. **Course Plan: Each Lecture of 3 hours**

Lecture 1: Introduction to wireless network; what is the role of medium access control (MAC) protocol.

Lecture 2: In brief MAC evolution of MAC from Pure-Aloha to Slotted-Aloha → what concept of MAC helped for the improvement of performance from Pure to Slotted?

Lecture 3: Carrier Sensing and Multiple Access Concept (CSMA); How CSMA concept helped to improve the performance of Slotted Aloha? 1-persistant, p-persistant and non-persistant CSMA.

Lecture 4: Analysis of CSMA

Lecture 5: What is the major limitation of CSMA which lead to → Carrier Sensing Multiple Access and Collision Detection (CSMA/CD); CSMA/CD MAC;

Lecture 6: Analysis of CSMA/CD

Lecture 7: What are the challenges one faces in Wireless LAN (WLAN): what is hidden terminal, why collision detection is not possible in WLAN; Types of MAC proposed in IEEE 802.11 (brief introduction to DCF, RTS/CTS, PCF); Frame structure of 802.11;

Lecture 8: Distributed coordination Function (DCF)
Lecture 9: Request of send/Clear to send (RTS/CTS) Mac; Point coordination function (PCF)

Lecture 10: Analysis of DCF

Lecture 11: Limitations of DCF, RTS/CTS and PCF to support quality of service (QoS)

Lecture 12: QoS in WLAN → 802.11e/n (EDCF)

Lecture 13: HCCF

Lecture 14: DLP, Block Acknowledgement to support better QoS

Lecture 15: AEDCF

Lecture 16: LTE Architecture

Lecture 17-40: Research Paper Studies in Class and Discussion and Innovative Idea Presentation

VI. Exam pattern: Class Tests, Midterm, Final and **Innovative Idea presentation** and Network Simulation assignments.

NC 701 Mobile Computing with IMS Architecture

Overview of Complete Course

- Introduction
- Signaling over PLMN and PSTN Network
  - SS7 and Intelligent Network
- Signaling over Internet → SIP (To start the Lab works)
- Cellular Network Architecture, Registration of Device, Mobility (Handover)
- GPRS architecture
- WiFi/WiMAX/LTE → Architecture, Device Registration and Hand over
- Heterogeneous Networks Mobility
- IMS Architecture
- IMS Protocols (Signaling and Data carrying protocols)
- Mobility from PLMN/PSTN to IMS Architecture
- Conclusion

Introduction: Broad contents will be covered on each bullet as mentioned on previous slide

Introduction (Detail in Scene2)

- What is Mobile Computing ?
- At present scenario why it is important to study the above topic?
- What are the challenges one faces due to mobility in Homogeneous and Heterogeneous Networks?
- Coexistence of GSM (Circuit switched) and IMS (Packet switched networks)
- What we know and what we will study in this course in brief →
  - We know: Internet (1st semester course);
  - We need to study: Signaling planes, Cellular networks, IMS architecture, Service planes + Broadly Convergence of Circuit Switched and Packet switched networks

Signaling over PLMN and PSTN network

- SS7 signaling architecture and major building blocks
- SS7 architecture's major building blocks functionalities
- Intelligent Network (IN),
- CAMEL

- CAP- Camel Application Part
- IN and AIN – cover ISUP, TCAP, CAP, MAP protocol, and applicability to Prepaid and SMS/MMS – Sample call flows

Signaling Over Internet

- SIP entities (Forking proxies, redirect servers)
- Message format
- The SIP request and response – Tracing Call Flows, using Ethereal and Seagull

Cellular Network Architecture

- GSM Architecture: BSC, MSC, HLR, VLR, AUC, EIR
- Frame Structure of GSM : a) Multi Frame b) Super Frame c) Hyper Frame (d) Burst Structure
- Logical channels: BCCH, FCCH, SDCCH, FACCH/F, FACCH/H,
- Location of Mobile
- Mobile Station and SIM
- Paging Procedures
- Registration Types and Security

GPRS Architecture

- Introduction to GPRS and Major elements of GPRS architecture
- Radio Requirements of GPRS
- GPRS Reference points and signaling Layers
- Access Point Name, Interconnection to other GPRS networks of other operators and roaming, Managing, the private Dynamic IP addresses for mobiles and NAT

Why IMS?

- Problems faced for multimedia from today's internet
- Proposed procedures for internet to support multimed
- Why we need IMS?
- Relationship between IMS and non-IMS services, Relationship between IMS relation standardization bodies (3GPP, 3GPP2; CSF: Converged Services Frame work by ITU-T)
- Challenges faced by research community and industry?

IMS Architecture and Protocols

- Introduction
- IMS Architecture

- P-CSCF, I-CSCF, S-CSCF
  - Application Server
- Gateways (Signaling Gateways, MGW)
- IMS Protocols
  - RTP, RTCP, RSVP, MRCP
  - Diameter

Mobile Computing

- Hand-off mechanisms due to mobility
  - Macro Mobility
  - Micro Mobility
- LTE mobility
- Inter-Working Gateways for Signaling and Media:
  - PLMN to IMS via GPRS
  - PSTN to IMS via SIP

Exams and Marks

Class Tests	20	
Midterm	25	30
Assignments/Lab/Presentation	25	30
Final Exam	25	35
Attitude	05	05

Total = 100

NC 812 - Internet of Things

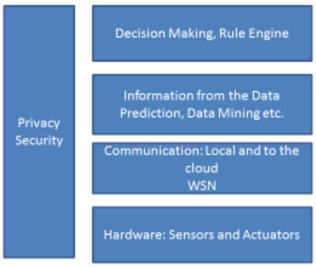
GENERAL COURSE INFORMATION

Course Name	Internet of Things
Term	Summer 2019
Instructor(s)	Profs. J Bapat and D Das
Course credits	4
Pre-requisite(s)	-

COURSE OVERVIEW

IoT is a multidisciplinary topic. Topics such as sensing/actuation, communication, networking, Data analysis, machine learning, decision engines must be considered along with concerns about privacy as well as security. A course on the other hand is a linear entity. The course will cover range of topics (as seen in diagram below); some in more detail than others. The course project and paper review will allow you investigate the areas that are of most interest to you.

Smart environment: Dimensions



COURSE CONTENTS

- What is Internet of Things (IoT) and why IoT is needed? Role of IoT in the smart environment. Case Study 1 & 2.
- Sensors: For a smart environment, we must determine the parameters to be sensed. In addition, placement of sensors, frequency of sensing play an important role. Questions what to sense, how to sense it, where to sense and when to sense will be looked into.
- Deriving information from the sensor data: Noise filtering, Signal level/Feature level/Decision level data fusion of the sensor data
- Decision making and Rule Engine
- Privacy and Security in Smart IoT based systems.
- Communication and Networking: Local communication channel requirements and options available. Role of MAC layer in making IoT a reality.
- 5G and IoT: Classification of IoT traffic based on QoS requirements and current advances for supporting IoT traffic.

GRADING

Exams (Midterm and final) : 30%, Project: 30%, Paper Review: 15%, Assignments: 15%, Class Participation: 10%

Course Proposal Template

Course Name	Advanced Computer Networks (NC861)
Course Proposer Name(s)	Dr. Samar Shailendra
Course Instructor Name(s)	Dr. Samar Shailendra
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	Elective (Special Topics)
Credits	4
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DBIS – Database and Information Systems ES – Embedded Systems ITS – IT & Society NC – Networking and Communication SE – Software Engineering	(Choose at most two areas from the list) NC
Semester	Term: Spring (Jan – Apr) Year: 2020

Pre-Requisites (where applicable, specify exact course names)

Fundamentals of Computer Networking and Communication
Basics of Probability Theory

Course Description

This course introduces the students with recent technological developments in the area of networks and their challenges. This course also embarks the understanding of how to apply the traditional mathematical tools to the newer paradigm of networking. This course has been designed to provide the understanding of current state of art of the networks along with necessary insight and methods for analyzing such future complex networks.

Course Content

- Introduction
    - Existing networking protocols and infrastructure – TCP/IP, GSM, LTE etc.
    - Challenges faced by current networking paradigm
- Fifth Generation (5G) Wireless Network
    - Requirements
    - Physical layer and spectrum challenges
    - MAC Protocols
    - Full Duplex Communication
    - Enabling Technologies for 5G – CRAN, SDN etc.
- Information Centric Networking (ICN)

- Requirements - Architecture and Protocols • Analysis of Networks - Introduction to Queues, Markov Chains
Assessments (optional for Special Topics courses)
Assessment has three primary components: ▪ Project – 50% ▪ Exams – 50%
Text Book / References
▪ Referred papers on ICN, 5G etc. ▪ Introduction to Probability Models, 10^{th} Edition, Sheldon Ross ▪ Queuing Systems, Leonard Kleinrock ▪ Algorithmic Game Theory, N. Nisan, T. Roughgarden, V. Vazirani and E. Tardos ▪ Games and Information: An Introduction to Game Theory, E. Rasmusen ▪ Graph Theory with Applications to Engineering and Computer Science, Narsingh & Deo

***Spring Term**: Jan – Apr; **Summer Term**: Jun – July; **Prep Term**: July; **Fall Term**: Aug – Nov*

<DS/NC/ESD 863: MACHINE PERCEPTION >

GENERAL COURSE INFORMATION

Course Name	Machine Perception
Term	Term I (2015-16)
Instructor(s)	Dr. Dinesh Babu J
Course credits	4
Pre-requisite(s)	Digital Image Processing or a PE with a significant component of Image Processing.

COURSE OVERVIEW AND OBJECTIVES

This course is about automating audio visual perception of humans [Audio-20% and Video 80%]. To do this, we use a Machine Learning framework, mainly supervised and sometimes unsupervised.

Topics covered (Theory - 40%, MATLAB Assignments – 20%)

COURSE CONTENTS

1. Theory - Parameter estimation and classification models
   [Maximum likelihood, Naive Bayes Classifier, Logistic Regression, Perceptron, Neural Network, SVM and Boosting]
   Applications - Music Genre / Character / Speaker Recognition
   Face detection and Human detection

2. Theory – Dimentionality Reduction
   [Principal Component Analysis, Linear Discriminant Analysis]
   Application - Face recognition

3. Theory - Latent Variable Models
   [Gaussian and generalization to Gaussian Mixture models; Maximum likelihood to Expectation Maximization procedure for parameter estimation]
   Application - Skin Detection

4. Theory - Hidden Markov Model
   [Model, training and Decoding]
   Application - Action / Phoneme Recognition

5. Theory - Continuous Latent Variable Models
   [Kalman Filtering/ Particle Filtering / Gibbs Sampling]
   Application – Head Tracking

Learn OpenCV (with couple of tutorial sessions)
OpenCV based Integration project
Group Project (2/3 members)- Demo of a real world machine perception task, integrating several simple perceptual models.

GRADING

Quizzes(10%); Assignment(30%); Mid Sem(20%); Mini Project (20%); Oral Comprehension Quiz (20%)

TEXT BOOK AND REFERENCES

1. Pattern Recognition and Machine Learning - Bishop

2. Pattern Recognition – Duda and Hart

3. Machine Learning in Action - Peter Harrington

4. Learning OpenCV - O'reilly publication

Software Defined Network and Network Function Virtualization

GENERAL COURSE INFORMATION

Course Name	Software Defined Network and Network Function Virtualization (SDN & NFV)
Term	Term I (2015-16)
Instructor(s)	Dr. Samar Shailendra and Dr. Debabrata Das
Course credits	4
Pre-requisite(s)	Computer Networking and Communication- Core course (NC-101)
Grading	A, A-, B+, B, B-, C+, C, D, F

Objective: This course is focused on building the concept of SDN and NFV, one of the fastest emerging technologies in the current era. It introduces the new paradigm of logically centralized software driven network architecture for the Internet.

Deliverable: At the completion of this course, the students are expected to learn the advantages and features of SDN, different building blocks of SDN, NFV, and hands on experience with different SDN components using mininet and other open source controllers.

Course Structure:

Topics	**Objective and Contents**	**Lecture hours**
Overview of SDN	Challenges faced in traditional networking. Centralized networking Vs Distributed networking. Is centralized networking new? Why not earlier?	1
Control and Data Plane Separation	What is control and data plane? How and why they need to be separated.	2
Virtual Networking	What is network virtualization? Advantages and challenges.	2
SDN Tools	Introduction to virtual box, mininet, and Floodlight	1

SDN Architecture:

Topics	**Objective and Contents**	**Lectures**
SDN Control Plane	What is SDN control plane, evolution of SDN control plane, SDN controllers, introduction to Floodlight and OpenDaylight, an industry grade controllers. Working with Floodlight.	4
SDN Data Plane	Network Slicing, Virtual network function, data forwarding and Policy, introduction to Flowvisor	3
OpenFlow	What is openflow? Why is openflow required? Evolution of openflow. More insight into openflow, protocol independent packet processing and examples.	4
Introduction to OpenVSwitch	What is software switch?, difference from traditional switch, advantages.	2

Network Function Virtualization:

Topics	Objective and Contents	Lectures
Overview	How NFV differs from traditional networks.	1
Design and Applications with NFV.	NFV Data and control plane, how to achieve NFV	2
What is cloud	Defining and need of cloud, how to provision cloud, Introducing concepts of IaaS, PaaS, SaaS etc., Introduction to openstack.	4
Role of SDN in cloud	Integrating SDN with cloud, discuss an openstack and ODL based use case.	2

Scalability and Security:

Topics	Objective and Contents	Lectures
Scalability Challenges	Scalability of controllers, are they able to handle load, high availability deployments, Scalability of cloud provisioning solution i.e. openstack	3
Security Challenges	Security challenges with controller, security, trust and privacy challenges in cloud environment.	3

Wireless SDN:

Topics	Objective and Contents	Lectures
Wireless SDN	Introduction to extending SDN in wireless network, its requirements and challenges.	2

Use Case:

Topics	Objective and Contents	Lectures
Enterprise Data Center	Discuss a typical data center scenario	1

No. of Lectures planned: 37 + 4 hours Lab presentation = 41 hours

Possible areas for project:

Project-1(Introduction to SDN): 2 hrs

Build a given custom topology using mininet using python scripts. Configure mininet to connect the external SDN controller (FloodLight). Configure the given QoS rules using external controller. Use wireshark/Iperf to verify the results.

Project-2 (Network Virtualization): 1hr

a) Use mininet and Floodlight controller to create VLANs over the same physical hardware where hosts in one VLAN is not able to access the hosts in another VLAN.

b) The service provider can slice the same physical hardware based upon various traffic requirements. The service provider is able to observe the underlying traffic and based upon the class of traffic, he is able to route the traffic from the given network slice based upon the class of traffic.

Project-3 (Introduction to OVS): An experiment based on OVS can be designed.: 1 hr

Exam Pattern:

Class Test: 20

Midterm Exam: 20

Final Exam: 20

Project: 30

Assignment and Class Performance: 10%

Total = 100

References:

[1] SDN: Software Defined Networks, Ken Gray, O'Reilly Publications.

[2] MOOC: Software Defined Networking, Prof. Nick Feamster, https://www.coursera.org/course/sdn1

[3] Kim Hyojoon and Nick Feamster, "Improving network management with software defined networking," IEEE Communications Magazine, February 2013.

[4] Nunes, B.A.A. and Mendonca, M. and Xuan-Nam Nguyen and Obraczka, K. and Turletti, T. "A survey of software - defined networking: Past, present, and future of programmable networks," IEEE Communications Surveys & Tutorials, February 2014.

[5] ETSI-NFV, http://www.etsi.org/technologies-clusters/technologies/nfv

[6] Learning OpenStack Networking (Neutron), James Denton, PACKT Publication

NC603/ESD608 Digital Signal Processing

GENERAL COURSE INFORMATION

Course Name	Digital Signal Processing
Term	Term II (2014-15)
Instructor(s)	P.G.Poonacha
Course credits	4
Pre-requisite(s)	Exposure to Analog Signals and Fourier Transforms

COURSE OVERVIEW AND OBJECTIVES

Processing of analog signals obtained using sensors by converting them to digital signals, process signals in the digital domain using a digital signal processor and convert back to analog signal.

At the end of the course, the student will be able to develop interesting applications using digital signal processing techniques.

COURSE CONTENTS

Fun with Fourier transform and its use in linear system analysis

Sampling Theorem and 3 equations of digital signal processing

Study of Discrete Fourier Transform and Z-transform in digital signal processing.

Study of Fast Fourier Transform and its applications in signal processing.

Design techniques for finite impulse response and infinite impulse response filters.

Effect of quantization and digital signal processing on the reconstructed analog signals.

GRADING

Assignments(2) : 20%, Class Tests(2) : 20% Mid sem exam : 30% End sem exam : 30%

TEXT BOOK AND REFERENCE

1. Digital Signal Processing, Principles, Algorithms and Applications, 4th Edition, J.G. Proakis and D.K.Manolakis, Prentice Hall Inc., 2006

Course Proposal Template

Course Name	Mathematical Analysis of Networks
Course Proposer Name(s)	Prof. Tricha Anjali, Prof. J. Bapat and Prof. Debabrata Das
Course Instructor Name(s)	Prof. T. Anjali / Prof. D. Das / Prof. J. Bapat
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	Elective (Special Topics)
Credits	4
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DBIS – Database and Information Systems ES – Embedded Systems ITS – IT & Society NC – Networking and Communication SE – Software Engineering	(Choose at most two areas from the list) NC
Semester	Term: Fall (Aug – Dec) Year: 2014

Pre-Requisites (where applicable, specify exact course names)

Fundamentals of Computer Networking and Communication (if you have done in your BTech or in IIITB or with the permission of instructor)

Course Description

Networks are typically distributed structures with complex dynamics. A thorough understanding of such a system includes modeling and analytical insights. This course has been designed to provide the necessary background tools to the students for analysis for complex networks. These tools can be applied to any network such as communication or social or biological networks among others.

Course Content

- Traffic Arrival and Service Pattern
- Stochastic Analysis, Markov chains
- Queuing Theory
- Scheduling
- Graph Theory
- Max Flow, Shortest Path

- Linear Programming
- Network Science
- Game Theory
- OFDM
- MIMO
- Network Coding

Assessments (optional for Special Topics courses)
Assessment has three primary components: ▪ Project work ▪ Exams (2 class tests, 1 midterm and 1 final)
Text Book / References
▪ Introduction to Probability Models, 10th Edition, Sheldon Ross ▪ Network Flows, Second Edition, Magnanti, Orlin, Ahuja ▪ System Simulation, Geoffrey Gordon, Prentice Hall of India ▪ Local Area Network, Gerd Keiser, McGraw Hill

***Spring Term**: Jan – Apr; **Summer Term**: Jun – July; **Prep Term**: July; **Fall Term**: Aug – Nov*

NCE 852: Network Security

GENERAL COURSE INFORMATION

Course Name	Network Security
Term	Term I (2015-16)
Instructor(s)	Prof. Tricha Anjali
Course credits	4
Pre-requisite(s)	Fundamentals of Computer Networking and Communication (if you have done in your BTech or in IIITB or with the permission of instructor)

COURSE OVERVIEW AND OBJECTIVES

Information and Network security is an area of expertise highly in demand, even more so nowadays when information is readily available and stored at unimaginable locations. Personnel with knowledge and proficiency in various aspects related to security are coveted by many organizations. To meet the national demand for network security experts, this course is being developed.

In this course, we will explore the topics related to network security. We will look at various secure protocols and their applications. It will present a comprehensive treatment of network security.

COURSE CONTENTS

1. Secret and Symmetric Key Cryptography
2. Public Key Algorithms
3. Public Key Infrastructures (PKI)
4. Hashes and Message Digests
5. Authentication Systems, AAA
6. IPsec
7. Internet Key Exchange (IKE)
8. SSL, TLS, TCP/IP security attacks
9. Virus, root kits, malware, honeypots
10. E-mail Security
11. VPN Security
12. DNSSEC
13. IDS/IPS
14. Creditcard transactional security

15. DoS Attacks, Botnet
16. Onion Routing
17. Wi-Fi security
18. Hands-on tools for security such as snort, metasploit etc.
19. LTE Security (time permits)

GRADING

Assessment has three primary components:

- Project work
- Lab work
- Exams (2 class tests, 1 midterm and 1 final)

TEXT BOOK AND REFERENCES

- Network Security Essentials: Applications and Standards, William Stallings
- Network Security: Private Communication in a Public World (2nd Edition), Charlie Kaufman, Radia Perlman, Mike Speciner

SOFT SKILL
FITNESS AND HEALTH AWARENESS

1. INDRODUCTION TO PHYSICAL TRAINING.

- Meaning, definition, objectives,principles and importance of health education.
- Need importance and scope of physical education in the modern society and its relationship with general education
- Growth and development,Difference between factors affecting growth and development.
- Age&Sex difference in relation to physical activities and sports.

2. PSYCHOLOGICAL EFFECTS OF PHYSICAL TRAINING.

- Meaning,definition,nature and scope of psychology.
- Sources of psychology.
- Need and importance of sports psychology.

3. PHYSIOLOGICAL EFFECTS AND ADDAPTATIONS OF PHYSICAL TRAINING.

- Structure and functions of body systems
- Meaning and definition of growth and development
- Factors effecting growth and development
- Adaptations to Anaerobic Training Programs.
- Adaptations to Aerobic Endurance Training programs.

SKILL DEVELOPMENT
PHYSICAL FITNESS

1. AN INDRODUCTION TO SPORTS SPECIFIC TRAINING .

- Principles of Test selection and Administration.
- Warm ups-and Flexibility Training.
- Program design and implementation.

2. MOST COMMON INJURIES AND REHABILITATION METHODS.

- Types of injuries
- Understanding the goals of each tissue healing phases.
- Reducing risks of injuries and re injuries.

3. NUTRITION.

- Role of Nutrition.
- Standard nutrition guidelines.
- Macro-nutrients.
- Micro-nutrients
- Effects of Alcohol, smoking and other substances

SE 701 Course Outline

Course Name: Design Patterns and Enterprise System Development

Instructor: Professor K V Dinesha

1. Schedule: Aug 2008 – Dec 2008
   Every week: Friday [9.00 – 10.30] + Saturday [9.00 – 10.30]
2. Course Material
   a. Text book: Head First Design Patterns in Java
   b. References: Design Patterns - Elements of Reusable OO software by GOF + material from internet [GOF stands for 4 authors – Eric Gamma, Richard Helm, Ralph Johnson, John Vlissides : affectionately called by the design pattern community as Gang Of Four (GOF)]
3. Prerequisite: Basics of Java or C++
4. Theme of the course:

   How to build flexible, reusable and maintainable OO software systems. GOF and other experienced OO developers and designers identified 23 design patterns which are used by experienced OO designers in various domains.

   The software system can be for any domain – system software (OS, compilers etc.), frameworks, platforms, IDEs, application systems (e-commerce, telecom, financial, any enterprise system).

   All the types of systems mentioned above uses the 23 design patterns to get flexibility, reusability and maintainability.

5. Course Contents
   a. Introduction: Explain flexibility, reusability, maintainability for software systems. Design principles used:
      i. separate things that change from things that do not change,
      ii. Interfaces,
      iii. program to interface,
      iv. Explain composition & inheritance - Prefer composition to inheritance to get flexibility
   b. We discuss the following patterns – Strategy, Observer, Template method, simple factory (not a design pattern still very useful), factory method, adapter, façade, singleton, MVC (compound pattern), abstract factory, iterator, composite, decorator, , Proxy (concept level), Command, State
   c. For each design pattern methodology followed – Case study approach [from Head first design patterns book]
      i. Define a problem
      ii. Design it in normal way without knowing design pattern (the design and code are written by experienced developer – they WORK)
      iii. Explain the problems in the design with respect to flexibility, reusability, maintainability (problem is NOT in correctness of code)
      iv. Explain relevant design pattern
      v. Redesign and code using the design pattern – show how it caters to flexibility, reusability, maintainability
6. Assessment: The following are components: Mid Term Exam (50%) + End Term Exam (50%)

SE 701 (new code: CS 751) Course Outline

Course Name: Design Patterns and Enterprise System Development

Instructor: Professor K V Dinesha

1. Schedule: Aug 2020 – Dec 2020 [For Samsung Participants]
   Every week: Friday [9.00 – 10.30] + Saturday [9.00 – 10.30]
2. Course Material
   a. Text book: Head First Design Patterns in Java
   b. References: Design Patterns - Elements of Reusable OO software by GOF + material from internet [GOF stands for 4 authors – Eric Gamma, Richard Helm, Ralph Johnson, John Vlissides : affectionately called by the design pattern community as Gang Of Four (GOF)]
3. Prerequisite: Basics of Java or C++
4. Theme of the course:

   How to build flexible, reusable and maintainable software systems. GOF and other experienced OO developers and designers identified 23 design patterns which are used by experienced OO designers in various domains.

   The software system can be for any domain – system software (OS, compilers etc.), frameworks, platforms, IDEs, application systems (e-commerce, telecom, financial, any enterprise system).

   All the types of systems mentioned above uses the 23 design patterns to get flexibility, reusability and maintainability.

5. Course Contents
   a. Introduction: Explain flexibility, reusability, maintainability for software systems. Design principles used:
      i. separate things that change from things that do not change,
      ii. Interfaces,
      iii. program to interface,
      iv. Explain composition & inheritance - Prefer composition to inheritance to get flexibility
   b. We discuss the following patterns – Strategy, Observer, Template method, simple factory (not a design pattern still very useful), factory method, adapter, façade, singleton, MVC (compound pattern), abstract factory, iterator, composite, decorator, , Proxy (concept level), Command, State
   c. For each design pattern methodology followed – Case study approach [from Head first design patterns book]
      i. Define a problem
      ii. Design it in normal way without knowing design pattern (the design and code are written by experienced developer – they WORK)
      iii. Explain the problems in the design with respect to flexibility, reusability, maintainability (problem is NOT in correctness of code)
      iv. Explain relevant design pattern
      v. Redesign and code using the design pattern – show how it caters to flexibility, reusability, maintainability
   d. Project:

During course of the semester the participant will identify a project (discussion with me) which illustrates use of design patterns. As I mentioned in the beginning design patterns are used in software development in every domain. Any open source (or even proprietary) software (whose source code is available) can be examined for the use of design patterns.

Choose some software which you are familiar (example say google chrome OS). Choose any module in it and search with key word as name of any pattern (like strategy, factory, observer (listener), adapter, template, command, iterator, state etc) most likely you will get a list of code line having such names as a part of class / method names. This can be one of the starting points to choose a project.

Alternately, as we progress, we understand the idea of flexibility, reusability, maintainability better. You may get some problem/idea which is interesting to you. We can discuss and choose that as well. The purpose is to

i. identify WHAT type of flexibility needed, HOW to get such flexibility in the design/code.
ii. identify WHAT type of reusability needed, HOW to get such reusability in the design/code,
iii. identify WHAT type of maintenance problems occur, HOW to create design/code which avoids such maintenance issues in the design/code.

Remember The Theme: Design patterns are about Flexibility, reusability and maintainability in software system. This theme starts from the first pattern (strategy) and it runs through every pattern.

6. Assessment: The following are components: Attendance, Assignments, Quizzes, Project.

Physics theory syllabus for iMTech 2019 batch   SM 203 Physics -1

Mechanics / Classical physics:

Unit 1: Introduction, revision of integral theorems: Gauss's divergence theorem, Green's theorem in the plane, Stokes' theorem. Curvilinear coordinates: vectros in curvilinear systems, arc length & volume element; gradient, divergence & curl in curvilinear coordinates; specific examples of spherical & cylindrical coordinate systems; transformation between coordinate systems. Jacobian; manipulation of gradient, divergence, curl, laplacian operators on vectors simlified using tensors & tensorial notation.

Unit 2: Principle of least action, Euler-Lagrange equations, generalized coordinates, generalized momenta. Lagrangian formalism. Eqns of motion for a system,cyclic/ ignorable coordinates & constants of motion, Jacobi integral, symmetries & Noether's theorem. Energy & momentum conservation as consequences of homogeneity of time & space respectively; angular velocity, angular momentum conservation & isotropy of space, pseudo-forces, rotating frames of reference. Coriolis & centrifugal forces, effects of Coriolis force. Foucault's pendulum, precession. Rigid body motion, moment of inertia tensor, perpendicular & parallel axes theorem. Euler angles & Euler equations. Central force motion, Kepler's laws.

Unit 3: Simple harmonic motion: undamped, damped, strongly damped regimes, etc Wave motion: free vibrations of a stretched string, phase velocity, group velocity, sound waves, water waves, interference & diffraction, etc. Nonlinear behaviour, phase space, chaotic behaviour.

Unit 4: Thermodynamics: Maxwell's relations and applications. Clausius theorem. Laws of thermoynamics. Clausius-Clapeyron equation. Conduction, convection and radiation. Blackbody radiation, Wien's law, Stefan Boltzmann law. The problem with a classical approach to blackbody radiation. Rayleigh-Jeans law, ultraviolet catastrophe.

Unit 5: Special theory of Relativity: inertial frames of reference, galilean transformations, Lorentz transformations; relativistic kinematics: Lorentz-Fitzgerald contraction, time dilation, velocity transformation; Doppler effect –non-relativistic and relatvistic.
Relativistic dynamics: effect on momentum and mass measurements.

ESD 503
Analysis and design of CMOS Digital IC

Instructor: Dr. Madhav Rao, IIIT-B #112, mr@iiitb.ac.in

Class Time: 9:30 - 11 AM, Monday and Thursday
Pre-requisites: MTech ESD / Digital Electronics

Text:

- **N. Weste and D. Harris, *CMOS VLSI Design A Circuits and Systems Perspective, 4th* edition, Pearson [Primary Textbook]**
- J M Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuits A Design Perspective, 2nd edition, 1999
- J. D. Plummer, M. D. Deal, and P. B. Griffin, *Silicon VLSI technology Fundamentals, Practice, and modeling,* Prentice Hall.
- Stephen Campbell*, Fabrication Engineering at the Micro- and Nanoscale*, 4th edition, Oxford Press, and

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Topics to Be Covered:

- MOSFET review, Static CMOS gates, Transmission gates.
- Non-ideal MOSFET Effects, CMOS Delay Estimation, Logical effort, Delay optimization and logical effort
- Overview of IC Processing, layout, Stick diagrams, and MOSIS design rules.
- Electric layout and schematic tool with LTspice.
- Layout of Static CMOS gates, and large circuit layouts.
- Combinational circuits, and layout of combinational circuits.
- Interconnects, if possible

Access:
The course materials will be made available to all students in LMS. Students are expected to access their LMS account frequently to obtain important information about the course. The contents include the syllabus, schedule, assignments, and lecture notes. The site contents will be updated periodically.

Homework:
Homework will be assigned and collected. Students should make their best effort in these assignments. No credit will be given for homework turned in after the due date/time. You may discuss your homework with fellow classmates, however the responsibility for the material is up to each individual student and each student will generate his or her own solution to the assignment.

In Class Activities:
Students will be given a portion of text or an article or a link to read, understand and complete an activity based on this reading. Some of the activities will require team work. Some activities will be plugging in the values to the equations. The instructor may ask to demonstrate the activities in class.

Quizzes:

Surprise quizzes will be taken in class. Being a surprise quiz, the instructor will not notify the students about the quiz. The students are encouraged to come prepared in the class for quizzes anytime in the semester.

Exams:

Two examinations: Midterm and Final exams will be given during the semester. Make-up exams will not be given.

Mini Project

Students will work in team of four to acquire experience in drawing a layout of fairly complex digital circuits. Students are encouraged to think of their own project and discuss with the instructor a month prior to the submission of project report. Each team is required to give an oral presentation in class (last week of November) and a written report, design layouts, circuit diagram and timing diagrams. The project submission date will be announced in class.

Components for grading till midterm exam

	Percentage
Assignments and activities	10 %
Mini Project	10 %
Quizzes	20 %
Midterm exam	30 %
Final exam	30 %
TOTAL	**100 %**

Class Attendance

Attendance is encouraged for all classes. It is the responsibility of the student to make up any missed work for any absences. An absence will lead to a ZERO for in-class activity and surprise quiz conducted in that class.

Academic Conduct:

All students in attendance at the IIIT-B are expected to be honorable and to observe standards of conduct appropriate to a community of scholars. Academic misconduct includes all acts of dishonesty in any academically related matter and any knowing or intentional help or attempt to help, or conspiracy to help, another student. All cases of academic misconduct including plagiarism will be passed to Director IIIT-B and Deans of IIIT-B to take further strong action.

Disruptive Behavior:

The Code of Student Conduct requires that students behave in a manner that is conducive to a teaching/learning environment. Students who engage in behavior that is disruptive or obstructive to the teaching/learning environment will be subject to disciplinary sanctions outlined by the Code of Student Conduct. Disruptive behavior is not limited to but may include the following: talking or using cell phones, reading the newspaper, physical abuse, verbal abuse, threats, stalking, intimidation, and harassment.

Course Proposal Template

Course Name	Physical Design of ASICs
Course Proposer Name(s)	Nanditha Rao
Course Instructor Name(s)	Nanditha Rao, Subir K. Roy
Course branch	**ECE**
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	**Special topics**
Credits	**4**
Grading Scheme	4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DS – Data Science ES – Embedded Systems SoC – System on Chip ITS – IT & Society NCS – Networking, Communication, and Signal Processing SE – Software Engineering	VLSI Systems
Semester	Term: Spring Year: 2020

Pre-Requisites (where applicable, specify exact course names)
Digital logic design Hardware description languages

Course Description
This course aims to provide an understanding of designing and implementing standard-cell ASIC chips using automated state-of-the-art computer-aided design (CAD) tools. This course is at the intersection of computer architecture, digital circuits, and CAD. The course provides an overview of ASIC design, CMOS circuits, full-custom design methodology and automated design methodologies. The first part provides a deeper study of CAD algorithms needed to automate the physical design or layout of ASIC chips, thereby, providing insight into academic/commercial tool usage towards optimizing ASIC chip layouts. The second part covers the CAD tools that can be used for these physical design aspects. The last part is an open-ended design project where students will design, implement and test a digital circuit using the physical design flow. Students will learn how to take the RTL designs and use automated tools to generate realistic layout. The course will enable students to implement and evaluate the power, time and area impact of the techniques they used to design the digital circuit.

Course Outline

The course describes the algorithms used for the following steps and also demonstrates the tools that are used to design/implement a digital logic circuit for each of the following steps
Introduction: VLSI design flow, challenges. Verilog/VHDL: quick summary of modeling combinational and sequential logic, writing test benches.
Physical design automation: Review of MOS/CMOS fabrication technology. VLSI design styles: full-custom, standard-cell, gate-array and FPGA.
Physical design automation algorithms:
• Partitioning
• Floor-planning, Placement and Pin Assignment
• Global Routing
• Detailed Routing
• Specialized Routing
  ✓ Clock Network Synthesis & Clock Routing
  ✓ Power & Ground Routing
• Compaction
• Timing Closure
• Design Rule Check
• Power and Delay Estimation
• Circuit & Parasitic Extraction
• Chip Level Interconnect Modeling and Signal Integrity.

Assessments (optional for Special Topics courses)

	% of Total Grade
Mid Term	25%
Assignments	20%
Presentations, Projects	25%
End Term	30%

Text Book / References

1. Neil H.E. Weste and David M. Harris, ``CMOS VLSI Design: A Circuits and Systems Perspective, 4th edition," Addison Wesley, 2011.
2. M.J.S. Smith, “Application-specific integrated circuits”, Addison-Wesley Pub. Co., 1997
3. N.A. Sherwani, “Algorithms for VLSI physical design automation”, Kluwer Academic Publishers, 1999.
4. S.M. Sait and H. Youssef, “VLSI physical design automation: theory and practice”, World Scientific Pub. Co., 1999.
5. Jayaram Bhasker & Rakesh Chadha, “Static Timing Analysis for Nanometer Designs : A Practical Approach”.
6. Sabih H. Gurez, “ Algorithms for VLSI Design Automation”, John Wiley & Sons, 2007
7. Andrew Kahng, “VLSI Physical Design from Graph Partitioning to Timing Closure”.
8. Bryan Preas, “ Physical Design Automation of VLSI Systems”
9. Thomas Lengauer, “Combinatorial Algorithms for IC Layout”, John Wiley & Sons,1999

Course Proposal Template

Course Name	Functional Verification of SoC Designs
Course Proposer Name(s)	Subir K. Roy
Course Instructor Name(s)	Subir K. Roy
Course Type *(Select one)* *All course types except "Special Topics" go through the process for Academic Senate approval*	Select one from the following: • **SOC Elective for M.Tech. ESD**
Credits	4
Grading Scheme	• 4-point scale (A,A-,B+,B,B-,C+,C,D,F)
Area of Specialization (if applicable) CS – Computer Science DBIS – Database and Information Systems ES – Embedded Systems ITS – IT & Society NC – Networking and Communication SE – Software Engineering	ES Embedded Systems
Semester	Term: Fall (August-December) Year:2013
Office hours	

Pre-Requisites (where applicable, specify exact course names)

Digital and Analog electronics

Course Description

System on Chip (SoC) designs inherit all the well known verification and validation difficulties associated with complex ASIC designs, besides adding their own set of newer problems. These arise because SoCs are primarily implemented by re-using Intellectual Property (IP) cores. It is well known that verification today constitutes about 70% to 80% of the total design effort, thereby, making it the most expensive component in terms of cost and time, in the entire design flow. It is expected to get even worse for SoC designs. In a complex SoC design flow functional verification is very important; any behavioral or functional bug escaping this phase will not be detected in the subsequent implementation phases and will surface only after the first silicon is integrated into the target system, resulting in costly design and silicon iterations. Many of the issues relate to intrinsic limitations of some of the verification approaches taken; while others have to do with the quality of the design information, by way of, design descriptions, design documentations and design specifications, from which the overall verification objectives are derived. SoCs have brought to focus the need to carry out design and verification concurrently. For the design and verification task to proceed concurrently there is a need to capture formally, design information and implementation details at various levels of abstraction. Another reason for the need to formalize is that, as designs become more complex, functional verification will have to be carried out using the divide and conquer approach. For these approaches to succeed, specifications of either, the individual modules, or individual IPs, if any are used, have to be stated formally. The proposed course will address the state of the art in the area of functional verification. It will focus on existing methodologies, tools, and practical approaches based on universal simulation, emulation, formal verification, and semi-formal verification that can be employed to overcome the SoC verification problem. A number of case studies based on real life verification projects will be presented describing the various techniques used and the effectiveness of these techniques.

Course Content

Course Outline

1. Introduction : Need for high level verification. Simulation/Emulation, Formal/Semi-formal, Design Representation.
2. High Level Design Flow and Verification Issues : System Design, Requirements, Specifications, Functional Descriptions, Implementation, Verification Problems, Verification Techniques.
3. Simulation Based Verification : Introduction, Types of Simulation, Quality of Verification and Coverage Analysis, Test Bench Automation Emulation : Systems, Flows, FPGAs as Logic Emulators, Drawbacks, Commercial Emulators
4. Formal Verification Techniques for FSM Models : Model Checking and Formal Engines, SAT Solvers, BDDs, Symbolic Model Checking with BDDs, Model Checking using SAT, Model Checking in Practice, Academic and Industrial Model Checker, Equivalence Checking.
5. Semi-Formal Verification Techniques : Symbolic Simulation, Symbolic Trajectory Evaluation, Generalized Symbolic Trajectory Evaluation, Bounded Model Checking, Guided Search, Smart Simulation.
6. Formal Verification of Analog Mixed Signal Circuits
7. Case Studies : Formal, Semi-Formal, Generalized Symbolic Trajectory Evaluation, FV of Analog Mixed Signal Circuits
8. Verification Project : To run concurrently with units 1 through 7 above.

Lab Requirements For Course Project:

1. Mentor Graphics QuestaSim (Constraint Driven Verification Tool)
2. VIS (Formal Verification Tool) from University of California, Berkeley.
3. CheckMate (AMS FV Tool) from Carnegie Mellon University.

Assessments (optional for Special Topics courses)

	% of Total Grade	Remarks
Assignments	10%	Two assignments will be given to students.
Project	25%	A verification project carried out on designs blocks using any one of the three tools will be presented by students at the end of the semester.
Midterm	25%	Midterm as per IIIT-B schedule.
Final Exam	40%	Finals as per IIIT-B schedule.

Text Book & References

Text Book

- Michael Huth & Mark Ryan, Logic in Computer Science : Modeling and Reasoning about Systems (Cambridge University Press), 2004
- Kenneth L. McMillan, Symbolic Model Checking (Kluwer Academic Publishers)
- Thomas Kropf, Introduction to Formal Hardware Verification (Springer-Verlag).

Journals

- Design and Test of Computers, IEEE.
- ACM Journal on Electronic Design Automation
- IEEE Transactions on CAD, Computers and VLSI Systems.

Conference Proceedings

- International VLSI Conference.
- Design Automation Conference (DAC).
- International Conference on Computer Aided Design (ICCAD).
- Asia South Pacific Design Automation Conference (ASPDAC).
- Formal Methods in Computer Aided Design (FMCAD).
- Computer Aided Verification (CAV).

1.

Spring Term*: Jan – Apr;* ***Summer Term****: Jun – July;* ***Prep Term****: July;* ***Fall Term****: Aug – Nov*

VL813-Real Time Operating Systems

1. Introduction to OS and real-time OS
2. Embedded HW/SW, basics of processor architecture, memory mgt and cache
3. Processes and threads, SMP, process states
4. Types of Schedulers, scheduler parameters and scheduler classifications
5. Scheduling algorithms, FCFS, SJF, RR and priority scheduling
6. Scheduling algorithms for periodic, aperiodic and sporadic tasks
7. Fixed and dynamic priority algorithms (RMS, DMS, EDF, LST), MLFQ
8. Inter-process communication (IPC) and Synchronizations
9. Semphores, mutex, Semaphores and spinlocks implementation in Linux
10. Priority inversion, Priority Inheritance
11. Message queues, pipes, shared memory, signals and events, Deadlocks
12. Introduction to Free RTOS
13. Real time communications
14. Handson with Real Microcontroller board
15. Project/exam and assignments