NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SYLLABI
FOR B.TECH. PROGRAM

From 2017-18 Batch onwards

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

SCHEME OF INSTRUCTION

B.Tech. (Computer Science and Engineering) Course Structure

I - Year

Physics Cycle							
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA101	Mathematics - I	3	0	0	03	BSC
2	HS101	English for Technical Communication	2	0	2	03	HSC
3	PH101	Physics	3	0	0	03	BSC
4	EC101	Basic Electronic Engineering	3	0	0	03	ESC
5	CE102	Environmental Science and Engineering	2	0	0	02	ESC
6	BT101	Engineering biology	2	0	0	02	ESC
7	CS101	Problem Solving & Comp Programming	3	0	0	03	ESC
8	CS102	Problem Solving & Comp Programming Lab	0	1	2	02	ESC
9	PH102	Physics Laboratory	0	1	2	02	BSC
10	EA101	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**18**	**2**	**9**	**23**	

Chemistry Cycle							
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**Cat. Code**
1	MA151	Mathematics – II	3	0	0	03	BSC
2	ME102	Engineering Graphics	1	1	4	04	ESC
3	CY101	Chemistry	3	0	0	03	BSC
4	EE101	Basic Electrical Engineering	3	0	0	03	ESC
5	ME101	Basic Mechanical Engineering	3	0	0	03	ESC
6	CE101	Engineering Mechanics	3	0	0	03	ESC
7	ME103	Workshop Practice	0	1	2	02	ESC
8	CY102	Chemistry Laboratory	0	1	2	02	BSC
9	EA151	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**16**	**3**	**11**	**23**	

II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA239	Probability Statistics and Queuing Theory	3	0	0	3	BSC
2	EE236	Network Analysis	3	0	0	3	ESC
3	EC237	Digital Logic Design	3	0	0	3	ESC
4	CS201	Discrete Mathematics	3	1	0	4	PCC
5	CS202	Data Structures and Algorithms	3	1	0	4	PCC
6	CS203	Unix Tools and Programming	1	0	2	2	PCC
7	EC238	DLD Lab	0	1	2	2	ESC
8	CS204	Data Structures and Algorithms Lab	0	0	2	1	PCC
		TOTAL	**16**	**3**	**6**	**22**	

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	EC287	IC Applications	3	0	0	3	ESC
2	CS251	Modelling and Optimization Techniques	3	0	0	3	PCC
3	CS252	Design and Analysis of Algorithms	3	0	0	3	PCC
4	CS253	Computer Architecture	3	0	0	3	PCC
5	CS254	Database Management Systems	4	0	0	4	PCC
6	CS255	Object Oriented Programming	2	0	2	3	PCC
7	EC288	IC Applications Lab	0	1	2	2	ESC
8	CS256	Database Management Systems Lab	0	0	2	1	PCC
		TOTAL	**18**	**1**	**6**	**22**	

III - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	SM317	Economic and Financial Analysis	3	0	0	3	HSC
2	CS301	Theory of Computation	3	0	0	3	PCC
3	CS302	Operating Systems	3	0	0	3	PCC
4	CS303	Data Warehousing and Data Mining	4	0	0	4	PCC
5	CS304	Software Engineering	3	0	0	3	PCC
6	CS305	CASE Tools	0	1	2	2	PCC
7	CS306	Operating Systems Lab	0	0	2	1	PCC
8	CS307	Knowledge Engineering Lab	0	0	2	1	PCC
9		Department Elective – 1	3	0	0	3	DEC
10	EP349	EPICS	0	0	0	2*	
		TOTAL	**19**	**1**	**6**	**23**	

*Credits are not considered for computation of SGPA and CGPA

III - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CS351	Language Processors	3	0	0	3	PCC
2	CS352	Computer Networks	4	0	0	4	PCC
3	CS353	Data Science	4	0	0	4	PCC
4	CS354	Language Processors Lab	0	0	2	1	PCC
5	CS355	Computer Networks Lab	0	0	2	1	PCC
6	CS356	Data Science Lab	0	0	2	1	PCC
7		Open Elective – 1	3	0	0	3	OPC
8		Department Elective – 2	3	0	0	3	DEC
9		Department Elective – 3	3	0	0	3	DEC
10		MOOCS	0	0	0	0	
11	EP399	EPICS	0	0	0	2*	
		TOTAL	**20**	**0**	**6**	**23**	

*Credits are not considered for computation of SGPA and CGPA

IV - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CS401	Machine Learning	4	0	0	4	PCC
2	CS402	Cryptography and Network Security	4	0	0	4	PCC
3	CS403	Advanced Algorithms	3	0	0	3	PCC
4	CS404	Internet of Things	2	0	2	3	PCC
5	CS405	Machine Learning Lab	0	0	2	1	PCC
6	CS406	Security Lab	0	0	2	1	PCC
7		Open Elective – II	3	0	0	3	OPC
8		Department Elective – 4	3	0	0	3	DEC
9	CS449	Project Work – Part A	0	0	4	2	PRC
		TOTAL	**19**	**0**	**10**	**24**	

IV - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CS451	Mobile Computing	3	0	0	3	PCC
2	CS452	Design of Secure Protocols	3	0	0	3	PCC
3		Department Elective – 5	3	0	0	3	DEC
4		Department Elective – 6	3	0	0	3	DEC
5		Department Elective – 7	3	0	0	3	DEC
6	CS499	Project Work – Part B	0	0	8	4	PRC
		TOTAL	**15**	**0**	**8**	**19**	

*****The result of the Mandatory Audit Course (Self Study) completed by the student either in 6th or 7th semester will be reported in this semester

List of Department Elective Courses

DAC (UG) will recommend a list of MOOCS courses and student can complete one of such MOOCS courses.

<u>III Year – I semester</u>

CS311	Web Technologies
CS312	Systems Programming
CS313	Graph Algorithms
CS314	Advanced Data Structures
CS315	Computational Number Theory
CS316	Principles of Programming Languages
CS317	File Structures
CS318	Data Networks

<u>III Year - II Semester</u>

CS361	Parallel Processing
CS362	Topics in Theoretical Computer Science
CS363	Game Theory CS364
	Distributed Systems
CS365	Distributed Computing
CS366	Cyber Laws and IPR
CS367	Statistics with R Programming
CS368	Advanced Operating Systems
CS371	Artificial Intelligence
CS372	Software Metrics and Software Project Management
CS373	Software Testing
CS374	Quantum Computing
CS375	Advanced Data Mining
CS376	Bio-Informatics
CS377	Human Computer Interaction
CS378	Intrusion Detection Systems

<u>IV Year – I semester</u>

CS411	Privacy Preserving Data Analysis
CS412	Semantic Web
CS413	Big Data Analytics
CS414	Heterogeneous Computing

CS415 Cloud Computing

CS416 Computational Geometry

CS417 Model-driven Frameworks

CS418 Software Reliability Techniques

IV Year - II Semester

CS461 Computational Neuroscience

CS462 Natural Language Processing

CS463 Pattern Recognition

CS464 Algorithmic Coding Theory

CS465 Social Media Analytics

CS466 Security and Privacy

CS467 Information Retrieval

CS471 Hardware Security

CS472 Secure Multi-party Computation

CS473 Computational Learning Theory

CS474 Distributed Object Technologies

CS475 Malware Detection and Mitigation

CS476 Algorithmic Game Theory

CS477 Formal Methods in Software Engineering

CS481 Advanced Compiler Design

CS482 Computer Vision and Image Processing

CS483 Service Oriented Architecture

CS484 Secure Software Engineering

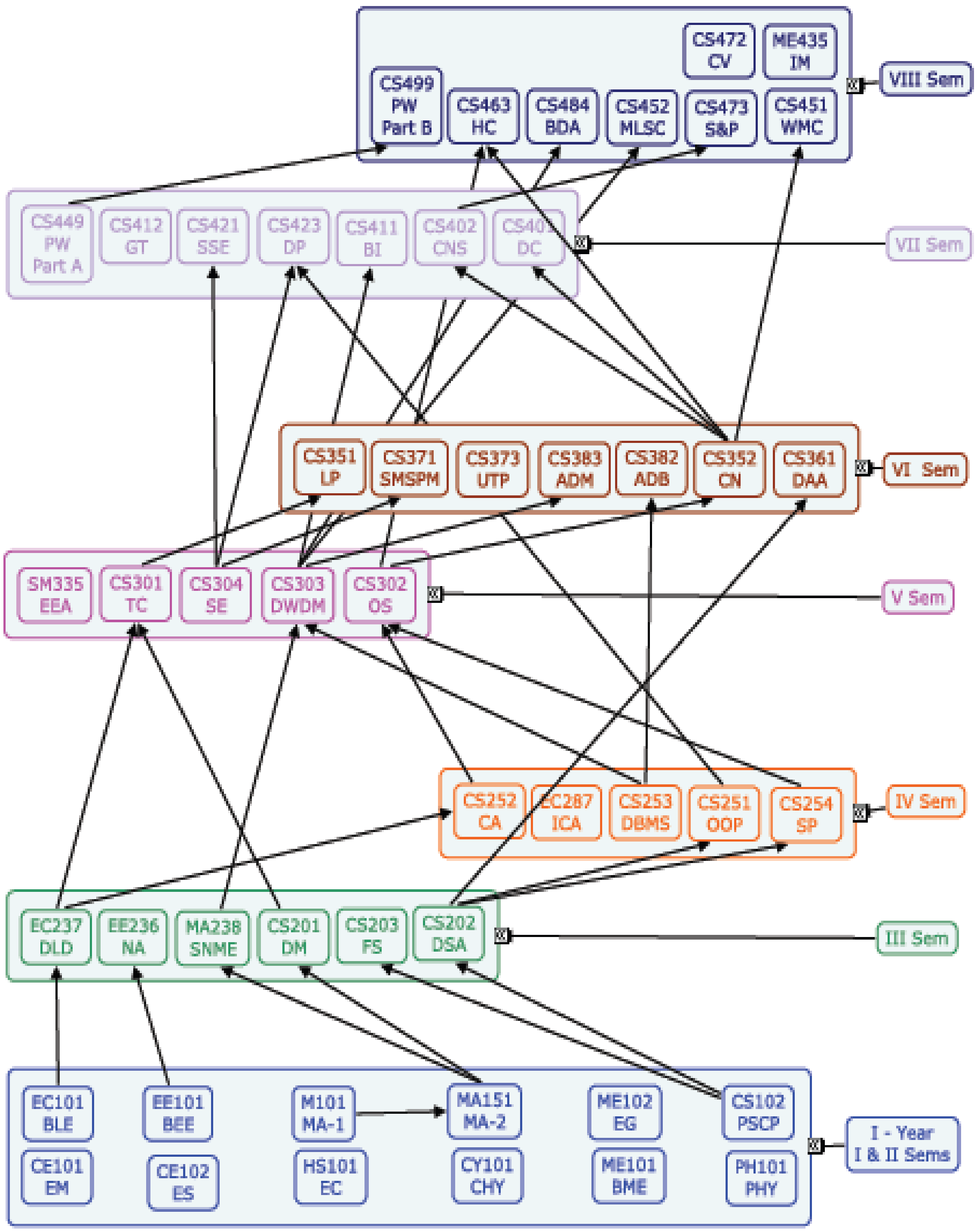
CS485 Design Patterns

CS486 GPU Programming

CS487 Program Analysis and Verification

B.TECH IN COMPUTER SCIENCE AND ENGINEERING

PRE-REQUISITE CHART



DETAILED SYLLABUS

MA 101	**MATHEMATICS – I**	**BSC**	**3-0-0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	solve the consistent system of linear equations
CO2	apply orthogonal and congruent transformations to a quadratic form
CO3	determine the power series expansion of a given function
CO4	find the maxima and minima of multivariable functions
CO5	solve arbitrary order linear differential equations with constant coefficients
CO6	apply the concepts in solving physical problems arising in engineering

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	-	-	-	-	-	-	-	1	1	1	1
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-	-	1	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	1	-	-	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	1	-	1	1
CO5	3	3	1	2	1	-	-	-	-	-	-	-		-	-	1
CO6	3	3	1	3	1	-	-	-	-	-	-	-	2	1	1	2

Detailed Syllabus

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency of the system of linear equations; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation and congruent transformation; Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices.

Differential Calculus: Taylor's theorem with remainders; Taylor's and Maclaurin's expansions; Asymptotes; Curvature; Curve tracing; Functions of several variables - partial differentiation; total differentiation; Euler's theorem and generalization; Change of variables - Jacobians; maxima and minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers.

Ordinary Differential Equations: Geometric interpretation of solutions of first order ODE �′ = ��(�,�); Exact differential equations; integrating factors; orthogonal trajectories; Higher order linear differential equations with constant coefficients - homogeneous and non-homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems - forced oscillations, electric circuits, etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 5th Edition, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2015.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

HS101	ENGLISH FOR TECHNICAL COMMUNICATION	HSC	2-0-2	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand basic principles of grammar and vocabulary
CO2	Write clear and coherent paragraphs
CO3	Write effective résumé, cover letter and letters for a variety of purposes
CO4	Prepare technical reports and interpret graphs
CO5	Develop reading comprehension skills
CO6	Comprehend English speech sounds, stress and intonation

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO5	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO6	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-

Detailed Syllabus:

1. Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts
2. Effective Sentence Construction - strategies for bringing variety and clarity in sentences- removing ambiguity - editing long sentences for brevity and clarity
3. Reported speech - contexts for use of reported speech - its impact on audiences and readers- active and passive voice- reasons for preference for passive voice in scientific English
4. Paragraph-writing: Definition of paragraph and types- features of a good paragraph - unity of theme- coherence- linking devices- direction- patterns of development.

5. Note-making - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc.
6. Letter-Writing: Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises
7. Reading techniques: Definition- Skills and sub-skills of reading- Skimming and Scanning - their uses and purposes- examples and exercises.
8. Reading Comprehension - reading silently and with understanding- process of comprehension- types of comprehension questions.
9. Features of Technical English - description of technical objects and process- Report-Writing- definition- purpose -types- structure- formal and informal reports- stages in developing report- proposal, progress and final reports-examples and exercises
10. Book Reviews- Oral and written review of a chosen novel/play/movie- focus on appropriate vocabulary and structure - language items like special vocabulary and idioms used

Language laboratory

1. English Sound System -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises
2. Stress and Intonation –word and sentence stress - their role and importance in spoken English-Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.- use of intonation in daily life–exercises
3. Introducing oneself in formal and social contexts- Role plays- their uses in developing fluency and communication in general.
4. Oral presentation - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.
5. Listening Comprehension -Challenges in listening, good listening traits, some standard listening tests- practice and exercises.
6. Debate/ Group Discussions-concepts, types, Do’s and don’ts- intensive practice.

Reading:

1. English for Engineers and Technologists (Combined Edition, Vol. 1 and 2), Orient Blackswan, 2006.
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill, 2006.

3. Meenakshi Raman and Sangeetha Sharma, Technical Communication: Principles and Practice 2nd Edition, Oxford University Press, 2011.

Software:

1. Clear Pronunciation – Part-1 *Learn to Speak English.*
2. Clear Pronunciation – Part-2 *Speak Clearly with Confidence*
3. Study Skills
4. English Pronunciation

PH101	PHYSICS	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO 1	Solve engineering problems using the concepts of wave and particle nature of radiant energy.
CO 2	Understand the use of lasers as light sources for low and high energy applications
CO 3	Understand the nature and characteristics of new Materials for engineering applications.
CO 4	Apply the concepts of light propagation in optical fibers, light wave communication systems, holography and for sensing physical parameters.
CO 5	Apply the knowledge of Solar PV cells for choice of materials in efficient alternate energy generation.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO4	3	3	1	`1	-	-	-	-	-	-	-	-	-	1	1	-
CO5	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-

Detailed Syllabus:

Quantum Mechanics: Concepts and Experiments that led to the discovery of Quantum Nature. Heisenberg uncertainty principle; Schrodinger time independent and time dependent wave equations, The free particle problem - Particle in an infinite and finite potential well, Quantum mechanical tunneling. MB, BE and FD distributions.

Wave and Quantum Optics:

Interference and Diffraction: Concept of interference and working of Fabry-perot Interferometer and its application as wavelength filter. Multiple beam diffraction and Working of diffraction Gratings, Application of Grating as wavelength splitter.

Polarization Devices: Principles, Working and applications of Wave Plates, Half Shade Polarimeter, Polariscope, Isolators and Liquid Crystal Displays.

Lasers: Basic theory of Laser, Concept of population inversion and Construction and working of He-Ne, Nd-YAG, CO_2 Lasers, LED, White light LED, Semiconductor Laser, Holography and NDT.

Optical Fibers: Structure, Types, Features, Light guiding mechanism and applications in Communications and Sensing.

Solar Cells: Solar spectrum, photovoltaic effect, materials, structure and working principle, I-V characteristics, power conversion efficiency, quantum efficiency, emerging PV technologies, applications.

Magnetic and Dielectric Materials:

Magnetic Materials and Superconductors: Introduction - Weiss Theory of Ferromagnetism – Properties – Domains – Curie Transition - Hard and soft magnetic materials – Spinel Ferrites – Structure – Classification – Applications - Meissner effect - Type-I and Type-II Superconductors – Applications.

Dielectric Materials: Introduction to Dielectrics, Dielectric constant – Polarizability - Properties and types of insulating materials - Polarization mechanisms in dielectrics(Qualitative) – Frequency and temperature dependence of polarization – Dielectric loss Clausius-Mossotti Equation(Qualitative)– dielectric Breakdown – Applications.

Functional and Nano Materials:

Functional Materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, Bio-materials, high temperature materials and smart materials - Properties and applications.

Nanomaterials: Introduction, classification, properties, different methods of preparation and applications.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, John Wiley, 9^{th} Edition, 2011.

2. Beiser A, Concepts of Modern Physics, McGraw Hill International, 5^{th} Edition, 2003.

3. Ajoy Ghatak, Optics, Tata McGraw Hill, 5^{th} Edition, 2012.

4. S.O. Pillai,Solid State Physics, New Age Publishers, 2015.

EC101	BASIC ELECTRONIC ENGINEERING	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Comprehend the characteristics of semiconductor devices, and operational amplifiers
CO2	Understand the principles of working of amplifiers
CO3	Understand and design of simple combinational and basics of sequential logic circuits
CO4	Understand the principles of electronic measuring instruments and Transducers
CO5	Understand the basic principles of electronic communication

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO5	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive Feedback, merits and demerits, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers – characteristics and linear applications

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's), Introduction to microprocessors and microcontrollers.

Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscopes (CRO's).

Electronics Instrumentation: Measurement, Sensors, principles of LVDT, strain gauge and thermocouples. Introduction to data acquisition system.

Principles of Communication: Need for Modulation, Definitions of various Modulation and Demodulation techniques, AM radio transmitter and receiver, brief understanding of FM and mobile communications.

Reading:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, Tata McGraw Hill, 2nd Edition, 2013.
2. Malvino and Brown,Digital Computer electronics, McGraw Hill, 3rd Edition,1993.
3. Keneddy and Davis, Electronic Communication Systems, McGraw Hill, 4th Edition, 1999.
4. Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall India, 2011.
5. Salivahanan, N Suresh Kumar, Electronic Devices and circuits, McGraw Hill publications,3rdEdition, 2012.
6. Neil Storey, Electronics A Systems Approach, Pearson Education Publishing Company Pvt. Ltd, 4th Edition, 2009.

CE102	ENVIRONMENTAL SCIENCE AND ENGINEERING	ESC	2-0-0	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyse material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO2	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO3	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO4	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO5	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-

Detailed Syllabus:

Introduction to Environmental Science: Environment and society, major environmental issues: Ozone layer depletion, Acid rains, global climate change etc., sustainable development, Environmental impact assessment, environmental management

Natural Resources Utilization and its Impacts: Energy, minerals, water and land resources, Resource consumption, population dynamics, urbanization.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutrofication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution: Sources, types of pollutants and their effects, water quality issues, contaminant transport, self-purification capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution: Sources, classification and their effects, Air quality standards, dispersion of pollutants, control of air pollution, automobile pollution and its control.

Solid Waste Management: Sources and characteristics of solid waste, effects, Collection and transfer system, disposal methods

Reading:

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2013.
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt. Ltd., Special Indian Edition, 2007.
3. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, 8th Edition, 2016.
4. M. Chandrasekhar, Environmental science, Hi Tech Publishers, 2009.

BT101	ENGINEERING BIOLOGY	ESC	2 – 0 – 0	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Realize the significance of biomolecules for sustaining life
CO2	Identify the difference between unicellular to multi-cellular organisms
CO3	Understand heredity, variation and central dogma of life
CO4	Analyse and understand the concepts of biology for engineering the cell

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO2	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO3	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO4	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-

Detailed Syllabus:

Molecules of life, water and carbon - chemical basis of life, protein structure and function, nucleic acids and the RNA world, carbohydrates, lipids, membranes and first cells.

Cell structure and function, inside the cell, cell–cell Interactions, cellular respiration and fermentation, photosynthesis, cell cycle, biological signal transduction.

Gene structure and expression, Mitosis, Meiosis, Mendel and the gene, DNA and the gene: synthesis and repair, how genes work, transcription, RNA processing, and translation, control of gene expression, analysing and engineering genes, genomics.

Engineering concepts in biology – genetic engineering, disease biology and biopharmaceuticals, stem cell engineering, metabolic engineering, synthetic biology, neuro transmission, biosafety and bioethics.

Reading:

1. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pearson Education India, 2016.
2. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginners, Academic Press, 2017.

CS101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object oriented features in developing programs to solve real world problems

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	-	-	-	-	-	3	3	3	3	3
CO2	2	1	2	1	2	3	-	-	-	-	-	3	3	2	2	2
CO3	1	2	2	2	2	1	-	-	-	-	-	3	3	2	2	1
CO4	2	2	2	2	2	2	-	-	-	-	-	2	3	2	1	2
CO5	2	2	3	1	2	2	-	-	-	-	-	2	3	2	2	2
CO6	2	2	3	2	2	2	-	-	-	-	-	2	3	2	2	2

Detailed Syllabus:

Fundamentals of Computers, Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Number systems and data representation, Basics of C++, Basic data types.

Numbers, Digit separation, Reverse order, Writing in words, Development of Elementary School Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of control constructs, Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions – Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion, Introduction to pointers.

Sorting and searching algorithms, Large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions

Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays

String processing, File operations.

Structures and Classes - Declaration, member variables, member functions, access modifiers, function overloading, Problems on Complex numbers, Date, Time, Large Numbers.

Reading:

1. Walter Savitch, Problem Solving with C++, Ninth Edition, Pearson, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

CS102	PROBLEM SOLVING AND COMPUTER PROGRAMMING LAB	ESC	0 – 1 – 2	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	-	-	-	-	-	-	3	3	3	3
CO2	1	1	2	1	2	2	-	-	-	-	-	-	3	3	2	2
CO3	1	2	3	2	2	1	-	-	-	-	-	-	3	3	2	2
CO4	2	2	2	2	2	3	-	-	-	-	-	-	2	3	2	1

Detailed Syllabus:

Laboratory:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.

Reading:

1. Walter Savitch, Problem Solving with C++, Ninth Edition, Pearson, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

PH102	PHYSICS LABORATORY	BSC	0 – 1 – 2	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-
CO2	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-
CO3	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-
CO4	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

MA 151	MATHEMATICS - II	BSC	3-0-0	3 Credits

Pre-requisites: MA101: Mathematics-I

Course Outcomes: At the end of the course, the students will be able to

CO 1	analyze improper integrals
CO 2	evaluate multiple integrals in various coordinate systems
CO 3	apply the concepts of gradient, divergence and curl to formulate engineering problems
CO 4	convert line integrals into surface integrals and surface integrals into volume integrals
CO 5	apply Laplace transforms to solve physical problems arising in engineering

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO5	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-

Detailed Syllabus

Integral Calculus: Convergence of improper integrals; Beta and Gamma integrals; Differentiation under integral sign; Double and Triple integrals - computation of surface areas and volumes; change of variables in double and triple integrals.

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green's theorem in a plane; Stoke's theorem; Gauss Divergence theorem.

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem; Applications of Laplace transforms - solving certain initial value problems, solving system of linear differential equations, finding responses of systems to various inputs viz. sinusoidal inputs acting over a time interval, rectangular waves, impulses etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, Narosa Publishing House, 5th Edition, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2015.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

ME102	ENGINEERING GRAPHICS	ESC	1 - 1 - 4	4 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Recall BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object and the reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined.
CO4	Analyse the internal details of an object through sectional views.
CO5	Relate 2D orthographic views to develop 3D Isometric View.
CO6	Construct 2D (orthographic) and 3D (isometric) views in CAD environment.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO2	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO3	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO4	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO5	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO6	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales

Orthographic Projection: Principles of Orthographic projection, Four Systems of Orthographic Projection.

Projection of Points: Projections of points when they are situated in different quadrants.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces.

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric Views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.

Auto-CAD Practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES

Reading:

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013.
2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, Dreamtech Press, 23rd Edition, 2016.

CY101	CHEMISTRY	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	The basic knowledge of the organic reaction mechanism and intermediates.
CO2	The basic knowledge of methods of chemical structure analysis and the instrumentation involved.
CO3	The potential energy aspects of fuel cells, rechargeable batteries and new materials for their fabrication.
CO4	About optical fibres, liquid crystals, LCD, LED, OLED, conducting polymers and their applications.
CO5	The quantum and thermodynamic aspects of various types of bonding, coordination complexes and chemical and enzymatic reactions.
CO6	The synthetic methodologies, importance and applications of nanomaterials in different fields.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO2	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO3	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO4	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO5	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO6	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-

Detailed syllabus

Quantum Chemistry and Chemical Bonding: Emergence of Quantum Theory; Postulates of Quantum Mechanics, Operators and Observables, Schrodinger Equation, Particle in a One-Dimensional Box and Colour of Conjugate Molecules, Hetero-diatomic Molecule as Harmonic Oscillator and Rigid Rotor, Hydrogen Atom, LCAO-MO Theory (MO Diagram of CO and NO Molecules).

Chemical Thermodynamics, Equilibrium and Kinetics: Enthalpy and Free Energy Changes in Chemical Reactions; Relevance of C_p and C_v in Gas Phase Reactions, Chemical Potential; Heat

Capacity of Solids, Absolute Entropy and Third Law of Thermodynamics, Rates of Enzyme-Catalysed Homogeneous and Heterogeneous Surface-Catalysed Chemical Reactions

Electrochemistry and Chemistry of Energy Systems: Electrodes and Electrochemical Cells; Potentiometric and Amperometric Sensors; Li-Ion and Ni-Cd Rechargeable Batteries; Fuel Cells (Methanol-Oxygen); Electrochemical Theory of Corrosion; Factors Affecting Rate of Corrosion; Sacrificial Anodic and Impressed Current Cathodic Protection of corrosion.

Coordination Chemistry and Organometallics: Shapes of Inorganic Compounds; Crystal Field and Molecular Orbital Theories; MO-Diagram for an Octahedral Complex; Metal Ions in Biology; Organometallic Chemistry (Metal Carbonyls).

Basics of Organic Chemistry: Classification of Organic reaction and their mechanisms. Reaction intermediates: formation, structure and properties. Named Reactions: Skraup's synthesis, Diels-Alder reaction, Click Reactions.

Engineering Materials and Application: Introduction to Optical fibres, types of optical fibres, applications of optical fibres. Liquid Crystals: LCD, LED, OLED, Conducting Polymers and applications.

Instrumental Methods of Chemical Analysis: Gas- and Liquid-Chromatographic Separation of Components of Mixtures; UV-Visible, FTIR, NMR and Mass Spectral Methods of Analysis of Structures of Organic Compounds.

Reading:

1. P. Atkins and Julio de Paula, Physical Chemistry, Freeman & Co. 8th Edition, 2017.
2. Atkins and Shriver, Inorganic Chemistry, Oxford University Press, 4th Edition, 2008.
3. Clayden, Greaves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2014.
4. Shashi Chawla, Engineering Chemistry, Dhanpat Rai & Co. 2017.
5. Paula Bruce, Organic Chemistry, Pearson, 8th Edition, 2013.

EE101	BASIC ELECTRICAL ENGINEERING	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities and requirements of illumination

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

DC Circuits: Kirchoff's Voltage and Current Laws, Superposition Theorem, Star-Delta Transformations

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of 1-ϕ Series & Parallel Circuits, Solution of 3-ϕ circuits and Measurement of Power in 3-ϕ circuits

Magnetic Circuits: Fundamentals and solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF Equation, Phasor Diagram, Equivalent Circuit of a 1-ϕ Transformer, Determination of Equivalent circuit parameters, calculation of Regulation & Efficiency of a Transformer

DC Machines: Principle of Operation, Classification, EMF and Torque Equations, Characteristics of Generators and Motors, Speed Control Methods and Applications

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-ϕ Induction Motor, Torque – Speed Characteristics of 3-ϕ Induction Motor, Applications Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters Illumination: Laws of illumination and luminance.

Reading:

1. Edward Hughes, Electrical & Electronic Technology, Pearson, 12th Edition, 2016.
2. Vincent Del Toro, Electrical Engineering Fundamentals, Pearson, 2nd Edition, 2015.
3. V N Mittle and Arvind Mittal, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2005.
4. E. Openshaw Taylor, Utilization of Electrical Energy, Orient Longman, 2010.

ME101	BASIC MECHANICAL ENGINEERING	ESC	3 - 0 - 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify Materials for Engineering Applications
CO2	Describe the functions and operations of Conventional, NC, CNC and 3D Printing methods of manufacturing.
CO3	Select a power transmission system for a given application.
CO4	Understand the concepts of thermodynamics and functions of components of a power plant.
CO5	Understand basics of heat transfer, refrigeration, internal combustion engines and Automobile Engineering.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-
CO2	3	3	3	1	3	1	1	-	-	-	-	-	-	2	-	-
CO3	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-
CO4	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-
CO5	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-

Detailed Syllabus:

Engineering Materials: Introduction to Engineering Materials, Classification and Properties

Manufacturing Processes: Castings – Patterns & Moulding, Hot Working and Cold Working, Metal Forming processes: Extrusion, Drawing, Rolling, Forging, Welding – Arc Welding & Gas Welding, Soldering, Brazing.

Machine Tools: Lathe – Types – Operations, Problems on Machining Time Calculations, Drilling M/c – Types – Operations, Milling M/c – Types – Operations – Up & Down Milling, Shaping M/c –Operations–Quick Return Mechanism, Planer M/c.– Operations–Shaper Vs Planer, Grinding M/c–Operations. Introduction to NC/CNC Machines, 3D Printing

Power Transmission: Transmission of Power, Belt Drives, Gears and Gear Trains –Simple Problems

Fasteners and Bearings: Fasteners – Types and Applications, Bearings – Types and Selection,

Thermodynamics: Energy Sources – Conventional/Renewable, Thermodynamics – System, State, Properties, Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law – Cyclic process, Change of State, C_p, C_v, Limitations of First law, Thermal Reservoirs, Heat Engine, Heat Pump/Refrigerator, Efficiency/CoP, Second law, PMM2, Carnot Cycle, Entropy – T-s and P-v diagrams.

Thermal Power Plant: Layout of Thermal Power Plant & Four circuits – Rankine cycle, T-s & P-v diagrams, Boilers – Babcock & Wilcox, Cochran Boilers, Comparison of Fire Tube &Water Tube Boilers, Steam Turbines – Impulse Vs. Reaction, Compounding – Pressure & Velocity Compounding, Condensers – Jet Condenser and Surface Condenser; Cooling Towers.

I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences

Refrigeration: Vapor Compression Refrigeration Cycle – Refrigerants, Desirable Properties of Refrigerants

Heat Transfer: Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & Cylinders, and Overall Heat Transfer Coefficient – problems

Automobile Engineering: Layout of an Automobile, Transmission, Clutch, Differential, Internal Expanding Shoe Brake

Reading:

1. M.L. Mathur, F.S. Mehta and R.P. Tiwari, R.S. Vaishwnar, Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2008.
2. Praveen Kumar, Basic Mechanical Engineering, Pearson Education, India, 2013.
3. P.N. Gupta, M.P. Poonia, Elements of Mechanical Engineering, Standard Publishers, 2004.
4. C.P. Gupta, Rajendra Prakash, Engineering Heat Transfer, NemChand Brothers, New Delhi, 1994.
5. B.S. Raghuvanshi, Workshop Technology, Vol. 1&2, Dhanpath Rai & Sons, New Delhi, 1989.

CE101	ENGINEERING MECHANICS	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Freebody diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid and M.I – Arial – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Curvilinear Motion – Normal and tangential components.

Reading:

1. J.L. Meriam, L.G. Kraige, Engineering Mechanics, John Wiley &Sons, 7th Edition, 2012.
2. Timoshenko, Young, Engineering Mechanics, McGraw Hill Publishers, 3rd Edition, 2006.
3. Gere, Timoshenko, Mechanics of Materials, CBS Publishers, 2nd Edition, 2011.

ME103	WORKSHOP PRACTICE	ESC	0 - 0 – 3	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-
CO2	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-
CO3	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-
CO4	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper. Demonstration of the working of CNC and 3D Printing Machines.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint.

CY102	CHEMISTRY LABORATORY	BSC	0- 1 - 2	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course, the student will be able to:

CO1	Select a suitable methodology and compare the strategies involved in the estimation of metal content, iodine content, active chlorine or hardness of water for various applications.
CO2	Apply a selective instrumental method in the place of tedious and complex titration processes for repeated and regulated analysis of acids, bases, redox compounds, etc.
CO3	Test and validate optical activity, corrosion inhibitor efficiency and absorption isotherm of selective compounds and processes.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO2	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO3	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-

Detailed Syllabus:

Cycle-I

1. Standardization $KMnO_4$ solution: Understanding the redox process, electron transfer, importance of qualitative and quantitative analysis.
2. Estimation of Hematite: Understanding the importance on purity of a ore, % of metal content (for Fe).
3. Hardness of Water: Understanding the of metal complexes, multi dentate ligands, importance of purity of ground water, (EDTA method; complexometry).
4. Analysis of bleaching powder for available chlorine: Understanding the importance and purity of potable water, back titration (Iodometry).
5. Preparation of nanomaterials: Understanding the importance of nanomaterials, their preparation and characterization.

Cycle II

1. pH metry: Concept of pH, Instrumentation, calibration, determination of the concentrations by instrumental methods

2. Conductometry: Concept of conductivity, importance of conductivity
3. Potentiometry: Determination of the redox potential of the reaction
4. Colorimetry: Importance of Beers and Lamberts law,
5. Photochemical experiment: Importance of visible light and its application for a redox process, importance of coloring agent
6. Preparation of bakelite / polypyrrole: Concepts of organic reactions and application for the organic material preparation.
7. Corrosion experiment: Concept of corrosion, importance of corrosion agents
8. Adsorption experiment: Understanding phenomena of adsorption and absorption
9. Analysis of a drug: Importance of the purity, concentrations of a drug molecule.
10. Preparation of bakelite / red azo dye / Aspirin / Fe(acac) / polypyrrole: Concepts of organic reactions and application for the organic material preparation

Reading:

1. Charles Corwin, Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Pearson Education, 2012.
2. David Collins, Investigating Chemistry: Laboratory Manual, Freeman & Co., 2006.

MA 239	Probability Statistics and Queuing Theory	BSC	3 - 0 - 0	3 Credits

Pre-requisites: MA101: Mathematics – I and MA151: Mathematics - II

Course Outcomes: At the end of the course, student will be able to:

CO1	find mean and variance of a given probability distribution
CO2	test the hypothesis for small and large samples
CO3	find the coefficient of correlation and lines of regression
CO4	understand the characteristics of a queuing model

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-

Detailed Syllabus

Random variables and their distributions:

Introduction to Probability, random variables (discrete and continuous), probability functions, density and distribution functions, mean and variance, special distributions (Binomial, Hyper geometric, Poisson, Uniform, exponential and normal), Chebyshev's inequality, parameter and statistic, estimation of parameters by maximum Likelihood Estimation method (16)

Testing of Hypothesis:

Testing of Hypothesis, Null and alternative hypothesis, level of significance, one-tailed and two-tailed tests, tests for large samples (tests for single mean, difference of means, single proportion, difference of proportions), tests for small samples (t-test for single mean and difference of means, F-test for comparison of variances), Chi-square test for goodness of fit, analysis of variance (one way classification with the samples of equal and unequal sizes), Karl Pearson coefficient of correlation, lines of regression. (16)

Queuing theory:

Concepts, applicability, classification, birth and death process, Poisson queues, Characteristics of queuing models - single server (with finite and infinite capacities) model, multiple server (with infinite capacity only) model. (10)

Reading:

1. R. A. Johnson: Miller and Freund's Probability and Statistics for Engineers, Pearson Publishers, 9th Edition, 2017
2. Freund: Modern elementary statistics, PHI, 2006
3. S.C.Gupta and V.K.Kapoor : Fundamentals of Mathematical Statistics, 2006
4. Kantiswarup, P.K.Gupta and Manmohan Singh : Operations Research, S.Chand & Co, 2010

EE236	NETWORK ANALYSIS	ESC	3 – 0 – 0	3 Credits

Pre-requisites: EE101-Basic Electrical Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply the knowledge of basic circuital law and simplify the network using reduction techniques.
CO2	Analyze the circuits using Kirchhoff's law and network simplification theorems.
CO3	Determine the transient response and steady state response for given network.
CO4	Obtain the maximum power transfer to the load as well as analyze the series resonant and parallel resonant circuit.
CO5	Determine the parameters of a given Two-port network.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2	1	1	1	1	-	2	–	–	-	3
CO2	3	3	3	3	3	2	1	1	1	1	-	2	–	–	-	-
CO3	3	3	3	3	3	2	1	1	1	1	-	2	–	2	-	-
CO4	3	3	3	3	3	2	1	1	1	1	-	2	–	–	-	-
CO5	3	3	3	3	3	2	1	1	1	1	-	2	–	–	1	-

Detailed syllabus:

Circuit Elements And Relations: Types of sources and source transformations – Dot convention and formation of loop and node equations.

Network Graphs And Analysis: Graph of a network – incidence matrix Formation of equilibrium equations – Dual networks.

Time Domain Analysis: Solution of network equations in time domain classical differential equations – approach – initial conditions and their evaluation – Applications to simple RLC circuits only.

Applications Of Laplace Transforms In Circuit Theory: Laplace transformers of various signals of excitation – Waveform synthesis, Laplace transformed networks – Determination and representation of initial conditions – Response for impulse function only and its relation to network admittance – convolution integral and applications.

Steady State Analysis Of Circuits For Sinusoidal Excitations: 1-phase series, Parallel, series-parallel circuits – Solution of AC networks using mesh and nodal analysis.

Resonance: Series and parallel resonance – Selectivity – Bandwidth – Q factors

Network Theorems And Applications: Superposition theorem – Thevenin's and Norton's theorems –Millman's theorem – Maximum power transfer theorem – Tellegen's theorem – Their applications in analysis of networks.

Reading:

1. M.E.Van Valken Burg, *Network Analysis*, 3/e, PHI, 2015
2. G.K.Mithal and Ravi Mittal, *Network Analysis*, Khanna Pub., 2003.
3. M.L.Soni and J.C. Gupta, *A Course in Electrical Circuit Analysis*, Dhanpat Rai & Co. (P), 2001.
4. Charles A Desoer and Ernest S Kuh, *Basic Circuit Theory*, Mc Graw Hill, 1969

EC237	DIGITAL LOGIC DESIGN	ESC	3 – 0 – 0	3 Credits

Pre-requisites: EC101-Basic Electronic Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Design digital components including - decoders, multiplexers, arithmetic circuits
CO2	Design of synchronous sequential circuits
CO3	Analyze digital systems and improve the performance by reducing complexities.
CO4	Test digital systems and analyze faults.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	1	-	-	-	-	-	-	3	3	-	-
CO2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	-	-
CO3	3	3	3	2	1	2	-	-	-	-	-	-	3	3	-	-
CO4	3	3	3	3	2	1	-	-	-	-	-	1	3	3	-	-

Detailed syllabus:

Digital Hardware, Design Process, Design of digital hardware.

Logic Circuits, Boolean Algebra, Logic Gates, Synthesis using AND, OR, NOT gates Design examples, Introduction to CAD tools and VHDL.

Implementation Technology – NMOS, CMOS gates, Standard chips, programmable logic devices. Custom chips, Standard cells and Gate Arrays.

Implementation of Logic functions, Minimization, Product-of-sums Form, Incompletely specified functions. Multiple output circuits. Cube representations – minimization

Number representations and Arithmetic circuits, Additions of unsigned and Signed number, Fast Address, Design of Arithmetic Circuits, Multiplication and other number representations.

Combinational Circuit Building blocks – Multiplexes, Decoders, encoders, Code converters, Arithmetic Comparison Circuits.

Flip-Flops, Registers and Counters – Basic Latch, SR and D latches, Master Slave edge triggered D Flip-flop, and KJ Flip Flops. Registers, Synchronous and Asynchronous Counters. Reset Synchronization

Synchronous Sequential circuits – State diagram, table and assignment choice of Flip-Flops. State Assignment problem. Moore and Mealy State models, Design of Finite State Machines

A Complete Digital System design Example (Ch. 10)

Reading:

1. Stephen Brown, Zvonko Vranesic, *Fundamentals of Digital Logic with VHDL Design*, McGrawHill, 2000. Chapters 1 to 8.
2. William I Fletcher, *An Engineering approach to Digital Design*, Eastern Economy edition, PHI Limited, 2000.

CS201	DISCRETE MATHEMATICS	PCC	3 – 1 – 0	4 Credits

Pre-requisites: MA151-Mathematics II

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply formal methods of proof to solve discrete problems
CO2	Apply Propositional logic and First order logic to solve problems
CO3	Apply techniques for counting the occurrences of discrete events including permutations, combinations with or without repetitions
CO4	Formulate and solve graph problems including searching and spanning
CO5	Formulate and solve recurrence relations

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	1	-	-	-	-	1	-	1	3	-	-	-
CO2	3	2	1	1	1	-	-	-	-	1	-	-	3	-	-	-
CO3	3	3		1	1	-	-	-	-		-	-	3	-	-	2
CO4	3	3	2	2	1	-	-	-	-	1	-	-	3	-	2	-
CO5	3	2	1	1	1	-	-	-	-	1	-	-	3	-	-	-

Detailed syllabus:

Sets and Relations: Sets, Operations on Sets, Venn Diagrams, Multi Sets, Binary Relations, Equivalence Relations, Ordering Relations, Operations on Relations, Partial Orders

Functions: Definition and Introduction, Composition of Functions, Inverse Functions, Binary and *n*-ary Operations

Mathematical Logic and Induction: Statements and Notation, Connectives, Quantified Propositions, Logical Inferences, Methods of Proof of an Implication, First Order Logic and other Methods of Proof, Rules of Inference for Quantified Propositions, Proof by Mathematical Induction

Elementary Combinatorics: Basics of Counting, Combinations and Permutations, Enumeration of Combinations and Permutations, Enumerating Combinations and Permutations with Repetitions, Enumerating Permutations with Constrained Repetitions, Binomial Coefficients, The Binomial and Multinomial Theorems, The Principle of Inclusion-Exclusion

Recurrence Relations: Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, The Method of Characteristic Roots, Solutions of Inhomogeneous Recurrence Relations

Lattices as Partially Ordered Sets: Definition and Examples, Properties of Lattices, Lattices as Algebraic Systems, Sublattices, Direct Product, Homomorphism, Some Special lattices

Graphs: Basic Definitions Undirected and Directed Graphs, Paths, Representation of Graphs, Reachability, Connected Components, Examples of Special graphs, Graph Isomorphism, Planar Graphs, Euler's Formula, Euler Circuits, Hamiltonian Graphs, Chromatic Number of a Graph, The Four-Color Problem, Graph Traversals, Applications of Graphs

Trees: Definition, Binary Tree Traversals, Spanning Trees, Minimum Spanning Tree Algorithms

Reading:

1. Joe L. Mott, Abraham Kandel, Theodore P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, Second Edition, PHI, 2001.
2. Tremblay J. P. and Manohar R., *Discrete Mathematical Structures*, MGH, 1997.
3. Kenneth H. Rosen, *Discrete Mathematics and Its Applications with Combinatorics and Graph Theory*, Seventh Edition, MGH, 2011.

CS202	DATA STRUCTURES AND ALGORITHMS	PCC	3 – 1 – 0	4 Credits

Pre-requisites: CS101-Problem Solving and Computer Programming

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the concept of ADT, identify data structures suitable to solve problems
CO2	Develop and analyze algorithms for stacks, queues
CO3	Develop algorithms for binary trees and graphs
CO4	Implement sorting and searching algorithms
CO5	Implement symbol table using hashing techniques and multi-way search trees

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	1	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	2	1		-	-	-	-	-	-	3	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	-	3	3	2	3
CO4	3	3	3	3	2	1	-	-	-	-	-	1	3	3	2	3
CO5	3	3	3	3	1	2	-	-	-	-	-	1	3	3	2	3

Detailed syllabus:

Introduction to Iterative and Recursive Algorithms

Abstract Data Types (ADTs), Implementation and Applications of Stacks, Operations and Applications of Queues, Array Implementation of Circular Queues, Implementation of Stacks using Queues, Implementation Queues using Stacks, Linked Lists, Search and Update Operations on Varieties of Linked Lists, Linked List Implementation of Stacks and Queues

Introduction to Trees, Implementation of Trees, Binary Trees, Tree Traversals with an Application, Binary Search Trees (BSTs), Query and Update Operations on BSTs, AVL Trees, Rotations, Search and Update Operations on Balanced BSTs, Splay Trees, B-trees, Trie, C-Trie

Hashing: Implementation of Dictionaries, Hash Function, Collisions in Hashing, Separate Chaining, Open Addressing, Analysis of Search Operations

Priority Queues: Priority Queue ADT, Binary Heap Implementation and Applications of Priority Queues, Disjoint Sets.

Sorting Algorithms: Stability and In Place Properties, Insertion Sort, Merge Sort, Quick Sort, Heap Sort, Lower Bound for Comparison Based Sorting Algorithms, Linear Sorting Algorithms: Counting Sort, Radix Sort, Bucket Sort

Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths, Biconnected Components.

Reading:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, Second Edition, PHI, 2009.
2. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Third Edition, Pearson Education, 2006
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *Fundamentals of Computer Algorithms*, Second Edition, Universities Press, 2011.
4. Michael T.Goodrich and Roberto Tamassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Second Edition, Wiley-India, 2006.

CS203	UNIX TOOLS AND PROGRAMMING	PCC	1 – 0 – 2	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Develop text data processing applications using Unix commands and filters
CO2	Design and develop text based user interface components
CO3	Understand user management, network management and backup utilities
CO4	Apply SCCS/RCS utilities for Software version management
CO5	Design and implement lexical analyzer, syntax analyzer using Lex/Yacc tools

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3	2	3	-	-	-	-	-	-	2	2	2	2
CO2	1	2	2	2	3	2	-	-	-	-	-	-	2	3	-	2
CO3	2	2	2	3	2	2	-	-	-	-	-	-	3	3	-	2
CO4	1	2	3	2	2	1	-	-	-	-	-	1	2	2	-	-
CO5	1	2	3	2	1	2	-	-	-	-	-	1	3	3	-	-

Detailed syllabus:

Unix Introduction : Architecture, Features, Internal and External commands, Manual pages, startup, shutdown, login, logout

Unix Commands : at, banner, batch, bc, cal, cat, cd, cmp, comm, chmod, chown, chgrp, cp, cron, cut, date, dd, diff, echo, finger, find, ftp, head, kill, lock, ln, ls, lp, lpstat, man, mesg, mkdir, more, mv, nl, nice, passwd, pr, paste, ping, ps, pwd, rcp, rlogin, rmdir, rm, rsh, split, sort, tail, talk, tar, telnet, touch, tput, tr, tty, uname, uniq, wc, who, write

Shell Programming : Different types of shells, shell environment, Pattern matching - wild cards, Escaping, quoting, File I/O, Redirection, Pipes, Command substitution, shell variables, Aliases, Command history, interactive shell scripting, if, case, for, while constructs, terminal capabilities, Text based user interface development

Filters : Regular expressions, grep, pr, head, tail, cut, paste, sort, uniq, tr, introduction to sed and awk

Backup: Backup using tar and cpio

Program development tools : make, ar, SCCS, RCS, CVS, gdb, gnu compilers, rpm, memory leakage, autoconf, automake, indent.

Lex and Yacc : (flex, bison), Recognizing words with lex, Regular expressions, Parsing command line, Start states, Example lex programs, Grammars, Shift/Reduce parsing, Definitions, rules and Actions sections, Ambiguity, precedence rules, variables, typed tokens, Symbol tables, Functions and reserved words

Reading:

1. Sumitabha Das, *Unix Concepts and Applications*, TMH, 4/e, 2008
2. John R Levine, Tony Mason, Doug Brown, *Lex and Yacc*, Orielly, 2nd Edition, 2009

CS204	DATA STRUCTURES AND ALGORITHMS LABORATORY	PCC	0 – 0 – 2	1 Credits

Pre-requisites: CS101-Problem Solving and Computer Programming

Course Outcomes: At the end of the course the student will be able to:

CO1	Develop ADT for stack and queue applications
CO2	Implement tree and graph algorithms
CO3	Implement and analyze internal and external sorting algorithms
CO4	Design and implement symbol table using hashing technique

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	1	1	1	-	-	-	-	-	-	3	3	-	3
CO2	3	3	3	2	2	2	-	-	-	-	-	-	3	3	2	3
CO3	3	3	3	3	1	1	-	-	-	-	-	1	3	3	2	3
CO4	3	3	3	2	1	1	-	-	-	-	-	1	3	3	2	3

Detailed syllabus:

1. Write a program to implement stack using arrays and evaluate a given postfix expression

2. Write a program to implement circular queue using arrays

3. Write a program to implement double ended queue (de queue) using arrays

4. Write programs for applications based on stacks and queues.

5. Write programs to implement the following data structures and their applications

(a) Single linked list (b) Double linked list

6. Write programs to implement a stack and a queue using linked lists

7. Write a program to create a binary search tree (BST) by considering the keys in given order and perform the following operations on it.

(a) Minimum key (b) Maximum key (c) Search for a given key

(d) Find predecessor of a node (e) delete a node with given key (f) applications of BST

8. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVL tree.

9. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressing methods.

10. Implement the following sorting algorithms:

(a) Insertion sort (b) Merge sort (c) Quick sort (d) Heap sort

(e) Radix sort (f) Shell sort

11. Write programs for implementation of graph traversals by applying: (a) BFS (b) DFS

12. Write programs to find out a minimum spanning tree of graph by applying:

(a) Prim's algorithm (b) Kruskal's algorithm c) any other algorithms

13. Write a program to implement Dijkstra's algorithm using priority queue.

14. Write a program to find Euler's path.

15. Write a programs to find Biconnected components and strongly Connected components.

16. Write program for creation, insertion, and printing functions of a Treap

17. Write program for creation, insertion, deletion and printing functions of a B_d-Tree.

18. Write program for creation, insertion, deletion and printing functions of B_d^+-Tree, B^*-Tree.

19. Write program for creation, insertion, deletion and printing functions of a Trie.

20. Write program for creation, insertion, deletion and printing functions of a C-Trie.

Reading:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, Second Edition, PHI, 2009.
2. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, Third Edition, Pearson Education, 2006
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *Fundamentals of Computer Algorithms*, Second Edition, Universities Press, 2011.
4. Michael T.Goodrich and Roberto Tamassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Second Edition, Wiley-India, 2006.

EC287	Linear IC Applications	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: After the completion of the course the student will be able to:

CO1	Design op-amp circuits to perform arithmetic operations.
CO2	Analyze and design linear and non-linear applications using op-amps.
CO3	Analyze and design oscillators and filters using functional ICs.
CO4	Choose appropriate A/D and D/A converters for signal processing applications.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	-	-	-	-	-	-	-	-	-	2	2	3	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-	2	2	-	1
CO3	1	2	2	-	-	-	-	-	-	-	-	-	2	2	2	-
CO4	1	2	-	-	2	-	-	-	-	-	-	2	2	2	-	3

Detailed Syllabus:

INTRODUCTION TO OP-AMPS: ideal Characteristics, Pin configuration of 741 op-amp. Bias, offsets and drift, bandwidth and slew rate. Offset and Frequency compensation. Exercise problems. Practical op amps, Basic building blocks: Current sources and active loads

LINEAR AND NON-LINEAR APPLICATIONS OF OP-AMPS: Inverting and non-inverting amplifiers and their analysis, Applications: inverting and non- inverting summers, difference amplifier, differentiator and integrator, Voltage to current converter, Exercise problems. Instrumentation amplifier, Log and antilog amplifiers. Precision rectifier, Non-linear function generator, solving differential equations using analog computing blocks. Analog IC Multipliers and applications Comparators, regenerative comparators, input - output Characteristics, Astable and Monostable multi vibrator, Triangular wave- generators, RC-phase shift oscillator, and Wein's bridge oscillator

ACTIVE FILTERS: Low pass, High pass, Band pass and Band Reject filters, Butterworth, Chebychev filters, Different first and second order filter Topologies, Frequency Transformation.

TIMERS & PHASE LOCKED LOOPS: 555 Timer functional diagram, monostable and astable operation, applications. PLL- basic block diagram and operation, capture range and lock range; applications of PLL IC 565, AM detection, FM detection and FSK demodulation. VCO IC 566.

IC VOLTAGE REGULATORS: Series op amp regulator, three terminal IC voltage regulator exercise problems. IC 723 general purpose regulator, Switching Regulator.

DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS: Weighted resistor DAC, R-2R and inverted R-2R DAC. IC DAC-08. Counter type ADC, successive approximation ADC, Flash ADC, dual slope ADC, 1-bit converters, sigma-Delta ADC. DAC and ADC Specifications, Specifications of AD 574 (12 bit ADC).

Reading:

1. G B Clayton, Operational Amplifiers, 5th Edition, Elsevier science, 2003
2. Sergio Franco, Design With Operational Amplifier And Analog Integrated Circuits, 4th Edition, TMH, 2011.
3. Roy Choudary D. and Shail B. Jain, Linear Integrated circuits, 4th Edition, New Age International Publishers, 2010
4. Ramakant A.Gayakward, Op-Amps and Linear Integrated Circuits, 4th Edition, PHI, 2010.

CS251	Modelling and Optimization Techniques	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS101: Problem Solving and Computer Programming, CS202: Data Structures and Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Prepare and solve linear programming model.
CO2	Model transportation and flow through networks and compute optimal parameters
CO3	Optimize inventory levels
CO4	Generate random numbers and random variates
CO5	Verify and validate simulation models

Course Articulation Matrix

CO \ PO|PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	-	1	-	-	-	-	1	1	1	1	2
CO2	3	3	3	2	2	-	1	-	-	-	1	1	1	2	2	2
CO3	2	2	2	1	1	-	1	-	-	-	3	-	2	1	1	2
CO4	2	2	2	1	1	-	-	-	-	-	-	1	1	1	2	-
CO5	2	2	1	-	-	-	-	-	-	-	-	-	2	2	1	2

Detailed syllabus:

Modelling with linear programming – The Simplex method, Sensitivity Analysis, Integer linear programming – Transportation Model, Network Model, Deterministic and non-deterministic inventory models, Statistical Models.

Introduction to Quadratic Programming, Constrained Optimization Problem Solving, Convex Optimization Methods.

Simulation Modelling – Random number generation, Random variate generation – Verification and Validation of simulation models, Simulation of Computer Systems and Computer Networks.

Reading:

1. Hamdy A Taha – "Operations Research-An Introduction", 9th Ed, Pearson, 2017 (Chs 1-8, 12, 14, 17)
2. Jerry Banks, Hon S Carson, Barry L Nelson, David M Nicol, "Discrete Event Simulation 5th Ed, Pearson, 2010 (Chs 8 – 12, 14, 15)

CS252	DESIGN AND ANALYSIS OF ALGORITHMS	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS101: Problem Solving and Computer Programming, CS202: Data Structures and Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze time and space complexity.
CO2	Identify algorithm design methodology to solve problems.
CO3	Design algorithms for network flows.
CO4	Distinguish between P and NP classes of problems.
CO5	Analyze amortized time complexity.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	-	1	-	-	-	-	1	3	1	1	2
CO2	3	3	3	2	2	-	1	-	-	-	1	1	3	1	2	2
CO3	2	2	2	1	1	-	1	-	-	-	3	-	3	1	1	2
CO4	2	2	2	1	1	-	-	-	-	-	-	1	3	1	2	2
CO5	2	2	1	-	-	-	-	-	-	-	-	-	3	1	1	2

Detailed syllabus:
Introduction to Algorithm Analysis, Asymptotic Notations, Divide and Conquer - Binary Search, Merge Sort, Quick Sort, Master Theorem, Expected Running Time of Randomized Quick Sort, Strassen’s Matrix Multiplication Algorithm, Karatsuba's Large Integer Multiplication, Selection in Worst Case Linear Time, Greedy Method - Activity Selection Problem, Fractional Knapsack Problem, Prim’s and Kruskal’s Algorithms for Finding Minimum Spanning Tree, Dijkstra’s Algorithm, Dynamic Programming - Matrix Chain Multiplication Problem, 0-1 Knapsack Problem, Dominating Set of a Tree, Vertex Cover of a Tree, Weighted Independent Set of a Tree, Optimal Binary Search Tree, TSP, Floyd-Warshall Algorithm, Backtracking - Enumerating Independent Sets of a Graph, Graph Coloring Problem, N-Queen’s Problem, Complexity Classes, Example NP-complete Problems, Approximation Algorithms - Vertex Cover Problem, Set Cover Problem, Randomized Min-Cut Algorithm, Introduction to Network Flows, Max-Flow Min-Cut Theorem, Boyer-Moore String Matching Algorithm, Knuth-Morris-Pratt Algorithm for Pattern Matching and Amortized Analysis.

Reading:

3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, Third Edition, PHI, 2009.
4. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *Fundamentals of Computer Algorithms*, Second Edition, Universities Press, 2011.
5. Michael T. Goodrich and Roberto Tamassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Second Edition, Wiley-India, 2006.
6. Michael R. Garey and David S. Johnson, *Computers and Intractability: A Guide the theory of NP-Incompleteness*, W.H. Freeman & Co., 1979.
7. Herbert S. Wilf, *Algorithms and Complexity*, AK Peters Ltd., 2003.

CS253	COMPUTER ARCHITECTURE	PCC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Identify functional units, bus structure and addressing modes
CO2	Design the hardwired and micro-programmed control units.
CO3	Identify memory hierarchy and performance.
CO4	Design Arithmetic Logic Unit.
CO5	Interface I/O devices

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	1	-	-	1	-	-	-	1	-	2	1	1	2
CO2	2	1	2	-	-	-	1	-	-	-	-	-	2	1	1	1
CO3	2	1	-	-	1	1	-	-	-	-	-	-	2	2	1	1
CO4	2	1	2	-	-	1	1	-	-	-	-	-	2	1	1	1
CO5	1	1	2	1	-	-	1	-	-	-	1	-	1	1	1	1

Detailed syllabus:

Basic Structures of Computers: Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Software, Performance, Multiprocessors and Multicomputers, Historical Perspective

Machine instructions and Programs: Numbers, Arithmetic Operations and Characters, Memory Locations and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Basic Input Output Operations, Stacks and Queues, Subroutines, Additional Instructions, Example Programs, Encoding of Machine Instructions

Registers and Addressing, IA-32 Instructions, IA-32 Assembly Language, Program Flow Control, Logic and Shift/Rotate Instructions, I/O Operations, Subroutines, Other Instructions, Program Examples

Input/output Organization: Accessing I/O Devices, Interrupts, Processor Examples, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces

The Memory System: Some Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed Size and Cost, Cache Memories, Performance Considerations, Virtual Memories, Memory Management Requirements, Secondary Storage

Arithmetic: Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed-Operand Multiplication, Fast Multiplication, Integer Division, Floating Point Numbers and Operations, Implementing Floating Point Operations

Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple-Bus Organization, Hardwired Control, Microprogrammed Control

Pipelining: Basic Concepts, Data Hazards, Instruction Hazards, Influence on Instruction Sets, Data Path and Control Considerations, Super Scalar Operation, UltraSPARC 2 Example, Performance Consideration

Large Computer Systems: Forms of Parallel Processing, Array Processors, the Structure of General-Purpose Multiprocessors, Interconnection Networks

Reading:

1. Carl Hamacher, *Computer Organization*, 5^{th} Edition, McGraw Hill Publishers, 2002.

2. Wiiliam Stallings, *Computer Organization and Architecture Designing for Performance*, 8th Edition, Pearson Education, 2010

CS254	DATABASE MANAGEMENT SYSTEMS	PCC	4 – 0 – 0	4 Credits

Pre-requisites: CS202- Data Structures and Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand functional components of the DBMS.
CO2	Devise queries using Relational Algebra, Relational Calculus and SQL.
CO3	Design database schema.
CO4	Develop E-R model.
CO5	Evaluate and optimize queries.
CO6	Analyze transaction processing, concurrency control and recovery techniques.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1
CO2	2	1	-	-	2	1	-	1	-	2	2	1	-	1	-	-
CO3	1	2	3	2	2	1	2	1	-	2	2	-	1	2	2	2
CO4	1	2	3	2	2	1	2	1	-	2	2	-	1	2	2	2
CO5	2	-	-	1	-	-	1	-	-	1	-	-	1	2	-	-
CO6	-	1	2	1	1	-	1	1	-	1	2	-	-	2	-	3

Detailed syllabus

Introduction to DBMS: Historical perspective, File Versus a DBMS, Advantages of DBMS, Describing and storing data in DBMS, Architecture of a DBMS, Different Data Models;

Entity Relationship(ER) model: Features of ER model, conceptual design using ER model, design for large enterprises; Relational model–structure and operations, Integrity constraints over relations;

Query languages: Relational Algebra, Relational Calculus and SQL– Queries, Constraints, Form of SQL query, UNION, INTERSECT and EXCEPT, Nested queries, Aggregate Operators, Null values, Complex Integrity constraints in SQL, triggers and Embedded SQL;

Database Design: Mapping ER model to Relational form; Functional Dependency–Closer of functional dependencies, closer of attributes, canonical cover and Properties of Decompositions; Normalization process – 1NF, 2NF, 3NF and BCNF; Multivalued dependency– Closer properties of Multivalued dependency and 4NF; Join dependency– PJNF, Decomposition Algorithms;

Transaction Management: ACID properties, transactions, schedules and concurrent execution of transactions; Concurrency control – lock based protocol, Serializability, recoverability, dealing with deadlocks and Concurrency control without locking;

Query Processing: Overview of Query Evaluation, operator evaluation; Algorithms for relational operations– Selection operation, General selection condition, Projection operation, Join operation, set operation and aggregate operation, Evaluation of relational operations; Query optimization: Alternative plans, functions of query optimizer, translating SQL queries into relational algebra, estimating the cost of a plan, relational algebra equivalences, and other approaches to query optimization;

Database Recovery: Failure classification, Recovery and atomicity, Log-based recovery shadow paging and Advanced Recovery Techniques:

Security and Authorization: Access control, direct access control and Mandatory access control, Role of DBA, Application development.

Reading:

1. Elamsri, Navathe, Somayajulu and Gupta, *Fundamentals of Database Systems*, 6th Edition, Pearson Education, 2011.
2. Raghu Ramakrishnan, Johannes Gehrke, *Database Management Systems*, 3nd Edition, McGraw Hill, 2003.
3. Silberschatz, Korth and Sudharshan, *Database System Concepts,* 6rd Edition, McGraw Hill, 2010.

CS255	OBJECT ORIENTED PROGRAMMING	PCC	2 – 0 – 2	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand object oriented paradigms: abstraction, encapsulation, inheritance, polymorphism
CO2	Learn java concepts like exception handling, interfaces, object classes and various libraries.
CO3	Design object oriented solutions for real world problems.
CO4	Implement the applications using the learnt concepts

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	-	-	1	-	3	-	-	-	2	1	-	-	3	-
CO2	1	1	2	3	3	3	-	-	-	3	-	-	-	-	-	-
CO3	2	1	1	1	1	1	-	-	3	-	3	3	1	3	2	2
CO4	1	-	1	1	1	2	2	-	3	3	2	2	1	2	2	2

Detailed syllabus:

Object Oriented Thinking – A way of Viewing the World, Computation as Simulation, Messages and Methods; - A Brief History Of Object - Oriented Programming - The History of Java, The White Paper Description; – Object - Oriented Design - Responsibility Implies Noninterference, Programming in the Small and in the Large, Why Begin with Behavior? A Case Study in RDD, CRC Cards – Recording Responsibility, Components and Behavior, Software Components, Formalizing the Interface; - A Paradigm - Program Structure, The Connection to the Java World, Types, Access Modifiers, Lifetime Modifiers; - Ball Worlds – Data Fields, Constructors, Inheritance, The Java Graphics Model, The Class Ball, Multiple Objects of the Same Class; - A Cannon Game – The Simple Cannon Game, Adding User Interaction; Pinball Game Construction Kit – First Version of Game, Adding Targets : Inheritance and Interfaces, Pinball Game Construction Kit : Mouse Events Reconsidered; - Understanding Inheritance – An Intuitive Description of Inheritance, The Base Class Object, Subclass, Subtype, and Substitutability – Forms of Inheritance, Modifiers and Inheritance, The Benefits of Inheritance, The Costs of Inheritance; - A Case Study : Solitaire – The Class Card, The Game – Card Piles-Inheritance in Action, The Application Class, Playing the Polymorphic Game, Building a More Complete Game; - Polymorphism - Varieties of Polymorphism, Polymorphic Variables, Overloading, Overriding, Abstract Methods, Pure Polymorphism; - The AWT – The AWT Class Hierarchy, The Layout Manager, User Interface Components, Panels, Dialogs, The Menu Bar; - Input And Output Streams - Streams versus Readers and Writers, Input Streams, Stream Tokenizer, Output Streams, Object Serialization, Piped Input and Output; -

Understanding Graphics - Colour, Rectangles, Fonts, Images, Graphic Contexts, A Simple Painting Program; - Applets And Web Programming – Applets and HTML, Security Issues, Applets and Applications, Obtaining Resources Using an Applet, Combining Applications and Applets.

Reading:

1. Timothy Budd, *Object Oriented Programming with JAVA*, Updated Edition, Pearson Education, 2009.
2. Herbert Schildt, *Java 2 Complete Reference*, TMH, 2010.

EC288	Integrated Circuit Applications Lab	ESC	0-1-2	2 Credits

Prerequisites: None
Course Outcomes: After the completion of the course the student will be able to:

CO1	Measure the parameters of IC 741 Op-amp.
CO2	Realize analog filters using Op-amp.
CO3	Plot the characteristics of TTL NAND Gate.
CO4	Design monostable and astable multivibrators using 555 IC.
CO5	Design modulo-N counters using TTL ICs. .

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-

List of Experiments:

1: Study and Operation of IC testers, pulse generator and digital trainer.

2: Study of logic gate ICs and their applications

3: Frequency response of inverting and non-inverting amplifier.

4: Measurement of Op.amp parameters: (i) Offset voltage (ii) Offset current (iii) CMRR and (iv) Slew rate

5: Characteristics of TTL NAND gate: (i) Sourcing (ii) Sinking (iii) Transfer

6: Verify the functionality of Mux and Decoder ICs and their application.

7: Op.amp monostable and astable multivibrators.

8: Design 2's complement adder/subtractor using IC74283 and verify experimentally.

9: Verify the functionality of Flip-Flop ICs and its application.

10: Mod-N counter using 7490 and 74190.

11: 555 timer: Monostable and astable multivibrators.

12: Mod-N counter using 7492 and 74192.

13: Shift register IC 7495.

14: Low voltage regulator IC 723.

CS256	DATABASE MANAGEMENT SYSTEMS LAB	PCC	0 – 0 – 2	1 Credits

Pre-requisites: CS202-Data Structures and Algorithms, CS254-Database Management Systems Lab

Course Outcomes: At the end of the course, student will be able to:

CO1	Design and Implement a database schema
CO2	Devise queries using DDL, DML, DCL and TCL commands.
CO3	Develop application programs using PL/SQL
CO4	Design and implement a project using embedded SQL and GUI.
CO5	Apply modified components for performance tuning in open source software.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	3	2	1	-	1	-	-	1	2	2	2	3	2	2
CO2	2	-	2	1	2	-	2	1	1	1	1	-	-	1	1	-
CO3	2	-	2	1	2	-	2	1	1	1	1	3	3	2	-	3
CO4	-	1	2	1	2	-	1	-	-	2	2	2	3	2	1	2
CO5	1	2	1	1	-	-	-	1	-	1	1	2	1	1	-	2

Detailed syllabus

Familiarization of Oracle RDBMS, SQL*Plus and Oracle developer,

SQL: query-structure; DDL-create, alter, drop, rename and Truncate; DML-select, insert, update, delete and lock; Set operations- union, intersection and except; join; Aggregate Operations- group-by and having; nested sub-queries and views; DCL-grant and revoke, TCL-Commit, save point, rollback and set transaction.

PL/SQL: Environment, block structure, variables, operators, data types, control structures; Cursors structures- Implicit and Explicit; Bulk statements- Bulk collect into and forall; Exception handling- Compilation and Run-time, user-defined; Stored procedures- creation options, pass-by-value and functions-pass-by-value; Packages-package specification, body, package creation and usage; Triggers- Data definition language triggers, Data manipulation triggers, Compound triggers and trigger restrictions; Large objects-CLOB, NCLOB, BLOB and BFILE; Implementation of applications using GUI; group project;

Reading:

1. James, Paul and Weinberg, Andy Oppel, SQL: The Complete Reference,3rd Edition, McGraw Hill, 2011.
2. Michael McLaughlin, Oracle Database 11g PL/SQL Programming, Oracle press.

SM317	ECONOMIC AND FINANCIAL ANALYSIS	HSC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand various methods of Economic Analysis and apply
CO2	Calculate Depreciation using various methods
CO3	Sensitize to Macro Economic Environment and understand the growth of IT and ITES
CO4	Analyze the financial statements with ratio's for investment decisions
CO5	Analyze costs and their role in pricing
CO6	To develop effective presentation skills

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	2	3	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-	1
CO4	-	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
CO6	1	-	-	-	-	-	-	-	-	-	-	-	2	-	3	-

Detailed syllabus

ECONOMICS

1. Introduction to Engineering Economics, Fundamental concepts, Time value of money, Cash flow and Time Diagrams, Choosing between alternative investment proposals, Methods of Economic analysis (Pay back, ARR, NPV, IRR and B/C ratio),
2. The Effect of borrowing on investment, Equity Vs Debt Financing, Concept of leverage, Income tax and leverage
3. Depreciation and methods of calculating depreciation (Straight line, Sum of the years digit method, declining Balance Method, Annuity Method, Sinking Fund method).
4. National Income Accounting, Methods of Estimation, Various Concepts of National Income, Significance of National Income Estimation and its limitations.

5. Inflation, Definition, Process and Theories of Inflation and Measures to Control,
6. Balance of payments and its impact on exchange rate.
7. New Economic Policy 1991, Growth of IT and ITES in Indian economy, Start-up culture and initiatives by Government

FINANCIAL ANALYSIS

8. Analysis of financial statements, income statements and balance sheet (simple ratios).
9. Cost Accounting, Introduction, Classification of costs, Methods of Costing, Techniques of Costing, Cost sheet and preparation cost sheet, Breakeven Analysis, Meaning and its application, Limitation.

Presentations/ Group Discussions on current topics.

Reference Books:

1. D N Dwivedi "Managerial Economics", Vikas Publishing House Private Limited

2. Agrawal AN, "Indian Economy" Wiley Eastern Ltd, New Delhi

3. R.K Sharma and Sashi K Gupta," Financial Management", Kalyani Publications

4. Arora, M.N." Cost Accounting", Vikas Publication.

Source- Internet

- Latest trends in Indian Economy.
- Capitaline Plus Database – http://www.capitaline.com/
- Ministry of Finance – http:/finmin.nic.in/
- Database of Indian Economy - http://dbie.rbi.org.in
- Statistics of India – www.indiastat.com/ or http://mospi.nic.in/

CS301	THEORY OF COMPUTATION	PCC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand formal machines, languages and computations
CO2	Design finite state machines for acceptance of strings
CO3	Design context free grammars for formal languages
CO4	Develop pushdown automata accepting strings
CO5	Design Turing machine
CO6	Distinguish between decidability and undecidability

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	2	-	-	-	-	-	-	2	2	3	-	-
CO2	3	2	2	1	2	-	-	-	-	-	-	2	2	3	-	-
CO3	3	2	2	1	2	-	-	-	-	-	-	2	2	3	-	-
CO4	3	2	2	1	2	-	-	-	-	-	-	2	2	3	-	-
CO5	3	2	2	1	2	-	-	-	-	-	-	2	2	3	-	-
CO6	2	2	2	1	2	-	-	-	-	-	-	2	2	3	-	-

Detailed syllabus:

Finite Automata - Structural Representations. Automata and Complexity, The Central Concepts of Automata Theory, Alphabets, Strings, Languages, Enabling the Automata to Ignore Actions, Deterministic, non-deterministic, Finite Automata with Epsilon-Transitions, Uses of e-Transitions.

Regular expressions - The Operators of Regular Expressions, Building Regular Expressions, Precedence of Regular-Expression Operators, Finite Automata and Regular Expressions, From DFA's to Regular Expressions, Converting DFA's to Regular Expressions by Eliminating States, Converting Regular Expressions to Automata, Applications of Regular Expressions, Regular Expressions in UNIX, Lexical Analysis, Finding Patterns in Text, Algebraic Laws for Regular Expressions, Associativity and Commutativity, Identities and Annihilators, Distributive Laws, The Idempotent Law, Laws Involving Closures, Pumping Lemma

Context Free Grammars - Derivations Using a Grammar, Leftmost and Rightmost Derivations, The Language of a Grammar, Sentential Forms, Parse Tress, Constructing Parse Trees, The

Yield of a Parse Tree, Applications of Context-Free Grammars, Parsers, The YACC Parser-Generator, Ambiguity in Grammars and Languages, Ambiguous Grammars, Removing Ambiguity From Grammars

Push Down Automata - Definition of the Pushdown Automaton, A Graphical Notation for PDA's, Instantaneous Descriptions of a PDA, The Languages of a PDA, Acceptance by Final State, Acceptance by Empty Stack, Equivalence of PDA's and CFG's, Context Free Languages - Properties, Normal Forms for Context-Free Grammars, Eliminating Useless Symbols.

Turing Machines - Introduction to Turing Machines, Problems That Computers Cannot Solve, Notation for the Turing Machine, Instantaneous Descriptions for the Turing Machines, Transition Diagrams for Turing Machines, The Language of a Turing Machine, Turing Machines and Halting, Programming Techniques for Turing Machines, Storage in the State, Multiple Tracks, Shifting Over, Subroutines, Extensions to the Basic Turing-Machines, Multiple Turing Machines, Computable Functions.

Undecidability - A Language that is Not Recursively Enumerable, Enumerating the Binary Strings, Codes for Turing Machines, The Diagonalization Language, and An Undecidable Problem That is RE, Complements of Recursive and RE Languages, The Universal Language, and Undecidability of the Universal Language

Reading:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D Ullman, *Introduction to Automata Theory, Languages and Computation*, 2nd Edition, Pearson, 2001
2. Michael Sipser, *Introduction to Theory of Computation*, 3rd Edition, Course Technology, 2012.

CS302	OPERATING SYSTEMS	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS253: Computer Architecture

Course Outcomes: At the end of the course, the student will be able to:

CO1	Distinguish functional architectures of operating systems and file systems
CO2	Develop algorithms for subsystem components
CO3	Design device drivers and multi-threading libraries for an OS
CO4	Develop application programs using UNIX system calls
CO5	Design and solve synchronization problems

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	2	-	2	-	2	2	2	2	2	3	-	2
CO2	2	2	3	3	2	-	2	-	2	2	2	2	2	3	-	2
CO3	2	2	2	3	2	-	2	-	2	2	2	2	2	3	-	2
CO4	3	2	2	3	2	-	2	-	2	2	2	2	1	3	-	-
CO5	2	2	2	3	1	-	2	-	2	2	2	2	2	3	-	-

Detailed syllabus:

Introduction: Batch, iterative, time sharing, multiprocessor, distributed, cluster and real-time systems, UNIX system introduction and commands

Operating system structures: Computer system structure, Network structure, I/O Structure, Storage Structure, Dual mode operation, System components, Operating-System Services, System Calls, System Programs, System structure, Virtual Machines, System Design and Implementation, System Generation

Processes and Threads : Process Concept, Process Scheduling, Operations on Processes, Cooperating Processes, Interprocess Communication, Communication in Client – Server Systems, Multithreading Models, Threading Issues, Pthreads Basic Concepts,

CPU Scheduling: Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Real-Time Scheduling, Algorithm Evaluation, Process Scheduling Models

Process Synchronization: Synchronization Background, the Critical-Section Problem, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Critical Regions, Monitors, OS Synchronization

Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock

Memory Management : Memory Management Background, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Segmentation with Paging, Virtual Memory, Demand Paging, Process Creation, Page Replacement, Allocation of Frames, Thrashing, Operating-System Examples, Other Considerations

File System: File Concept, Access Methods, Directory Structure, File-System Mounting, File Sharing, Protection File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery, Log-Structured File System, NFS

I/O Systems : Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O to Hardware Operations, STREAMS, Performance, Disk Structure , Disk Scheduling , Disk Management, Swap-Space Management, RAID Structure , Disk Attachment, Stable-Storage Implementation, Tertiary-Storage Structure

Protection : Goals of Protection, Domain of Protection, Access Matrix, Implementation of Access Matrix, Revocation of Access Rights, Language-Based Protection, Capability-Based Systems, The Security Problem , User Authentication , Program Threats, System Threats, Securing Systems and Facilities, Intrusion Detection, Cryptography, Computer-Security Classifications

Reading:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, *Operating System Principles*, Wiley, 8/e
2. Richard Stevens, Stephen Rago, *Advanced Programming in the UNIX Environment*, Pearson Education, 2/e

CS303	DATA WAREHOUSING AND DATA MINING	PCC	4 – 0 – 0	4 Credits

Pre-requisites: CS254: Database Management Systems.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand stages in building a Data Warehouse
CO2	Apply preprocessing techniques for data cleansing
CO3	Analyze multi-dimensional modeling techniques
CO4	Analyze and evaluate performance of algorithms for Association Rules.
CO5	Analyze Classification and Clustering algorithms

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	3	2	1	-	1	-	-	1	2	2	1	2	3	2
CO2	2	-	2	1	2	-	2	1	1	1	1		2	1	3	1
CO3	2	-	2	1	2	-	2	1	1	1	1	3	2	1	3	1
CO4	-	1	2	1	2	-	1	-	-	2	2	2	3	1	3	1
CO5	1	2	1	1	-	-	-	1	-	1	1	2	2	1	3	1

Detailed syllabus:

KDD Process, Introduction to Data Warehouse, Data Preprocessing- Data Cleaning methods, Descriptive Data Summarization, Data Reduction, Data Discretization and Concept hierarchy generation, Overview of ETL and OLAP OLTP integration – comparison of OLAP with OLTP systems, ROLAP, MOLAP and DOLAP, Data Cube Computation methods, Advanced SQL support for OLAP, multi-dimensional modeling, Attribute-oriented Induction, Data Warehouse architecture and implementation - Parallel execution, Materialized views.

Data Mining Techniques: Basic concepts of Association Rule Mining, Frequent Item set mining, Mining various kinds of association rules, Classification by decision tree induction, Bayesian Classification, Rule-based Classification, Classification Back-propagation, Associative Classification, Lazy Learners, Rough set approach, Clustering methods, Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Measuring Data Similarity and Dissimilarity Partition based Clustering, Hierarchical based clustering, Density based clustering.

Reading:

1. Jiawei Han and M Kamber, *Data Mining Concepts and techniques*, Third Edition, Elsevier Publications, 2011; chapters 1-8

Other Reference:

i) Data Warehouse Video Content

ii) NMIECT – Data Warehousing Video Content

CS304	SOFTWARE ENGINEERING	PCC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Comprehend software development life cycle
CO2	Prepare SRS document for a project
CO3	Apply software design and development techniques
CO4	Identify verification and validation methods in a software engineering project
CO5	Implement testing methods for software
CO6	Analyze and Apply project management techniques for a case study

Course Articulation Matrix

PO|PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	1	2	1	-	2	2	2	-	1	2	1	2
CO2	2	1	2	-	-	2	2	-	2	2	-	-	-	1	-	2
CO3	2	2	2	1	-	1	1	-	-	2	1	-	2	2	1	2
CO4	2	2	2	-	2	2	2	-	2	2	1	-	-	1	-	3
CO5	2	2	2	-	2	2	2	-	2	2	1	-	1	2	1	2
CO6	2	2	2	1	1	1	1	-	1	2	2	1	1	2	-	1

Detailed syllabus:

The Software Problem - Cost, Schedule, and Quality, Scale and Change ; Software Processes- Process and Project , Component Software Processes; Software Development Process Models - Waterfall Model, Prototyping , Iterative Development , Rational Unified Process , Time boxing Model , Extreme Programming and Agile Processes , Using Process Models in a Project. Project Management Process; Software Requirements Analysis and Specification - Value of a Good SRS , Requirement Process , Requirements Specification;Formal Specification- Formal Specification in the Software process, Sub-system interface specification, Behavioural Specification; Desirable Characteristics of an SRS - Components of an SRS, Structure of a Requirements Document; Functional Specification with Use Cases - Basics , Examples , Extensions, Developing Use Cases; Other Approaches for Analysis - Data Flow Diagrams , ER Diagrams , Validation; Planning a Software Project - Effort Estimation - Top-Down Estimation Approach , Bottom-Up Estimation Approach; Project Schedule and Staffing - Quality Planning, Risk Management Planning - Risk Management Concepts, Risk Assessment , Risk Control, A Practical Risk Management Planning Approach; Project Monitoring Plan - Measurements , Project Monitoring and Tracking. Detailed Scheduling; Software Architecture - Role of Software Architecture, Architecture Views - Component and Connector View - Components, Connectors, An Example. Architecture Styles for C&C View - Pipe and Filter, Shared-Data Style , Client-

Server Style, Some Other Styles, Documenting Architecture Design - Evaluating Architectures; Design - Design Concepts - Coupling , Cohesion , The Open-Closed Principle . Function-Oriented Design (from Pressman) - Structure Charts, Structured Design Methodology, An Example. Object-Oriented Design (from Jalote)- OO Concepts, Unified Modeling Language (UML) , A Design Methodology , Examples; Detailed Design - Logic/Algorithm Design, State Modeling of Classes; Verification - Metrics - Complexity Metrics for Function-Oriented Design, Complexity Metrics for OO Design; Coding and Unit Testing -Programming Principles and Guidelines - Structured Programming , Information Hiding, Some Programming Practices, Coding Standards; Incrementally Developing Code - An Incremental Coding Process ,Test-Driven Development, Pair Programming; Managing Evolving Code - Source Code Control and Build, Refactoring; Unit Testing - Testing Procedural Units, Unit Testing of Classes; Code Inspection - Planning, Self-Review, Group Review Meeting; Metrics - Size Measures, Complexity Metrics; Testing - Testing Concepts - Error, Fault, and Failure, Test Case, Test Suite, and Test Harness , Psychology of Testing , Levels of Testing; Testing Process - Test Plan, Test Case Design, Test Case Execution; Black-Box Testing - Equivalence Class Partitioning, Boundary Value Analysis , Pairwise Testing, Special Cases, State-Based Testing; White-Box Testing - Control Flow-Based Criteria, Test Case Generation and Tool Support; Metrics - Coverage Analysis, Reliability, Defect Removal Efficiency.

Reading:

1. PankajJalote, Software Engineering Precise Approach , Wiley Publishers
2. Ian Sommerville, Software Engineering. *8/e* Pearson Publishers, 2012.
3. Software Engineering, Roger Pressman, 5th edition, MCgrawHill.

CS305	CASE TOOLS LABORATORY	PCC	0 – 1 – 2	2 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Prepare Software Requirement Specification document
CO2	Prepare design document and compute effort estimates for a software project
CO3	Design UML diagram for a case study
CO4	Design and Develop test cases for a software

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	-	-	2	2	-	2	2	-	-	2	1	-	2
CO2	2	2	2	1	-	1	1	-	-	2	1	-	2	2	-	2
CO3	2	2	2	-	2	1	1	-	1	2	1	-	2	2	-	2
CO4	2	2	2	-	2	2	2	-	2	2	1	-	1	1	1	2

Detailed syllabus:

1. Develop a Software Project Plan Using Microsoft Project (Planning involves estimation – work break down structure – how much money- how much effort – how many resources – how much time it will take to a specific software –based system or product)
2. Develop a SRS Document using Rational Requisite Pro Tool. (This Lab is for mastering the software requirements in this regard the documents like Vision Document- Use Case Document – SRS Documents must be submitted for the Problem given to you)
3. Designing a Software using UML – Tool used is Rational Rose- In this lab, the student is supposed to solve the problem using OO analysis and design Methodology
4. Testing using tools Rational Robot, Rational Purify, Rational Quantify, Rational Pure Coverage etc., (Functional and Structural Testing techniques were discussed and necessary programs will be tested)
5. Writing a programs for the following : Quality Metrics and OO Metrics, Finding the coupling and cohesion intensity in java code, Reverse Engineering Problems
6. Web site Testing , Security Testing , System Testing

Reading:

1. Rational Online Documentation
2. Booch, Jackobson and Rambaugh, UML Guide , Pearson Edu, 1999
3. IEEE Standards for SRS Documents, IEEE Std. 830.
4. Fenton NE, Software Metrics: A Rigorous Approach, Chapman and Hall, 1991

CS306	OPERATING SYSTEMS LAB	PCC	0 – 0 – 2	1 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Implement elementary UNIX system commands
CO2	Develop programs to test synchronization problems
CO3	Design and develop user level thread library
CO4	Design and implement file system.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	-	2	-	2	2	2	2	-	2	-	-
CO2	2	2	2	3	3	-	2	-	2	2	2	2	2	3	-	2
CO3	2	2	2	3	3	-	2	-	2	2	2	2	2	3	-	2
CO4	2	2	2	3	3	-	2	-	2	2	2	2	2	3	-	2

Detailed syllabus:

1. Write Command Interpreter Programs which accepts some basic Unix commands and displays the appropriate result. Each student should write programs for at least six commands.
2. Study the concept of Signals and write a program for Context Switching between two processes using alarm signals.
3. Study pthreads and implement the following: Write a program which shows the performance improvement in using threads as compared with process.(Examples like Matrix Multiplication, Hyper quicksort, Merge sort, Traveling Sales Person problem)
4. Create your own thread library, which has the features of pthread library by using appropriate system calls (UContext related calls). Containing functionality for creation, termination of threads with simple round robin scheduling algorithm and synchronization features.
5. Implement all CPU Scheduling Algorithms using your thread library
6. Study the concept of Synchronization and implement the classical synchronization problems using Semaphores, Message queues and shared memory (minimum of 3 problems)
7. A complete file system implementation inside a disk image file.

Reading:

1. Richard Stevens, Stephen Rago, *Advanced Programming in the UNIX Environment*, Pearson Education, 2/e

CS307	KNOWLEDGE ENGINEERING LAB	PCC	0 – 0 – 2	1 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Build data cubes with SQL
CO2	Implement data preprocessing techniques on data.
CO3	Implement OLAP operations and multi-dimensional modeling
CO4	Implement data mining algorithms

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	1	2	1	-	2	2	2	-	3	2	3	2
CO2	2	1	2	-	-	2	2	-	2	2	-	-	2	-	3	2
CO3	2	2	2	1	-	1	1	-	-	2	1	-	2	-	3	2
CO4	2	2	2	-	2	2	2	-	2	2	1	-	3	2	3	2

Detailed syllabus:

1. Advanced SQL Analytic functions
2. Implementation of OLAP operations
3. Data preprocessing techniques
4. Cube computation methods
5. Concept hierarchy method
6. Write a program in any programming language to generate at least 10,000 transactions in a text file with at least three items.
7. Write a program to implement the *APRIORI* algorithm and also test it thoroughly.
8. Write a program for each of the following to improve *APRIORI*

   A. Hash based Technique. B. Dynamic Item set Counting Algorithm. C. Partition Based Approach.
9. Write a program for *FPGROWTH* algorithm and also test it.
10. Write a program to construct an optimized DECISION TREE for a given training data and by using any attribute selection measure.

11. Write a program for NAÏVE BAYESIAN algorithm for classifying the data.
12. Implement the K-Means Clustering algorithm for clustering the given data.

Reading:

1. Jiawei Han and M Kamber, *Data Mining Concepts and techniques*, Third Edition, Elsevier Publications, 2011

Department Electives

CS311	Web Technologies	DEC	2 – 0 – 2	3 Credits

Pre-requisites: CS254-Database Management Systems

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand, analyze and build dynamic and interactive web sites
CO2	Understand current and evolving Web languages for integrating media and user interaction in both front end and back end elements of a Web site
CO3	Analysis and reporting of web data using web analytics
CO4	Applying different testing and debugging techniques and analyzing the web site effectiveness.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	2	1	2	1	-	-	-	2	2	1	2	3	1	1
CO2	1	1	-	-	-	-	2	1	1	-	1	1	-	2	1	-
CO3	1	1	-	2	3	-	-	1	-	1	1	-	2	1	1	-
CO4	1	-	-	1	-	-	-	1	-	1	-	-	-	2	3	1

Detailed syllabus

Introduction to XHTML: Editing XHTML, First XHTML Example, W3C XHTML Validation Service, Headers, Linking, Images, Special Characters and More Line Breaks, Unordered Lists, Nested and Ordered Lists, Internet and World Wide Web Resources;

Dynamic HTML: Object Model and Collections- Introduction, Object Referencing, Collections all and children, Dynamic Styles, Dynamic Positioning, Using the frames Collection, navigator Object, Summary of the DHTML Object Model; Event Model- vent onclick, Event onload, Error Handling with onerror, Tracking the Mouse with Event onmousemove, Rollovers with onmouseover and onmouseout; Form Processing- Form Processing with onfocus and onblur, More Form Processing with onsubmit and onreset, Event Bubbling, More DHTML Events; Filters and transitions; Data binding with tabular data control, Structured graphics and active X control;

JavaScript: Functions; Program Modules in JavaScript, Programmer Defined Functions, Function Definitions, Random-Number Generation, Duration of Identifiers, Scope Rules, JavaScript Global Functions, Recursion, JavaScript arrays, JavaScript objects;

XML: Structuring Data, XML Namespaces, Document Type Definitions (DTDs) and Schemas, Document Type Definitions, W3C XML Schema Documents, XML Vocabularies, Chemical Markup Language (CML), Other Markup Languages, Document Object Model (DOM), DOM Methods, Simple API for XML (SAX), Extensible Style sheet Language (XSL), Simple Object Access Protocol (SOAP);

Web Servers: HTTP Request Types, System Architecture, Client-Side Scripting versus Server-Side Scripting, Accessing Web Servers, Microsoft Internet Information Services (IIS), Microsoft Personal Web.

Server-side Scripting: Introduction to PHP, String Processing and Regular Expressions, Form processing and Business logic, Dynamic content, Database connectivity, Applets and Servlets, JDBC connectivity, JSP and Web development Frameworks.

Reading:

1. Deitel, Deitel and Nieto, *Internet and Worldwide Web - How to Program*, 5th Edition, PHI, 2011.
2. Bai and Ekedhi, *The Web Warrior Guide to Web Programming*, 3rd Edition, Thomson, 2008.

CS312	SYSTEMS PROGRAMMING	DEC	2-0-2	3 credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Develop system level programs
CO2	Design assemblers and macro processors for a hypothetical system
CO3	Implement advanced MS DOS programs
CO4	Develop simple utilities including editor, device drivers

Course Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	1	1	1	-	-	2	-	1	2	2	-	-	2
CO2	3	3	3	2	2	1	-	-	2	-	1	3	1	1	3	-
CO3	-	2	3	-	3	-	-	-	3	-	2	3	-	2	1	2
CO4	-	3	3	2`	3	1	-	-	3	-	1	2	-	2	-	1

Detailed syllabus

Title of the unit or chapter: topic – subtopic1, subtopic2, next topic – subtopics;
Assembly language general concepts: Introduction to assembly language - virtual machine concept; data representation in computers; and Boolean operations; IA-32 processor architecture; Source and object program; Re-entrant and re-executable program;
Assembly language fundamentals: Data transfers; Addressing modes; Integer Arithmetic; Stack operation and procedures; Conditional processing; Strings and arrays; MS-DOS Programming
Input / Output: Input and Output basics – Video and Key board operations; Advanced input output – Disk Storage; Facilities for printing
Macrofacilities: Macro definition; Macro directives
Operating system-assembly language connections: System calls. Programming techniques.Loaders, linkers.Microprogramming.
One and two pass assemblers – Design of one pass assembler; two pass assembler

Reading:

1. Kip R. Irvine, Assembly Language for Intel Based Computers, 5th Edition, Prentice Hall, 2007, ISBN: 0132383101
2. Peter Abel, IBM PC Assembly Language and Programming, 5th Edition, Prentice Hall, 2001, ISBN: 013030655X
3. Ray Duncan, Advanced MS DOX Programming *the Microsoft guide for Assembly Language and C programmers,* 2nd edition, Microsoft press, 1988

CS313	GRAPH ALGORITHMS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS204-Data structures & Algorithms, CS252-Design and Analysis of Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze time and space complexities of algorithms using asymptotic analysis.
CO2	Formulate and solve graph problems.
CO3	Identify algorithm design methodology to solve problems.
CO4	Design efficient polynomial time algorithms for restricted classes of intractable problems.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	2	1	2	1	-	-	-	2	2	1	2	3	1	1
CO2	1	1	-	-	-	-	2	1	1	-	1	1	-	2	1	-
CO3	1	1	-	2	3	-	-	1	-	1	1	-	2	1	1	-
CO4	1	-	-	1	-	-	-	1	-	1	-	-	-	2	3	1

Detailed syllabus:

Analysis of algorithms, Degree sequences, Havel–Hakimi algorithm, Erdös-Gallai theorem, Cheriton-Tarjan algorithm for minimum spanning tree, Connectivity, Blocks, Algorithms for finding the blocks of a graph, Matching, Hungarian algorithm for maximum matching, Perfect matchings and 1-factorizations, Network flows, Ford-Fulkerson algorithm, Matchings and flows, Hamiltonian cycle, Euler cycle, Chinese postman problem, Strong components, Tournaments, 2-Satisfiability, Perfect graphs, Greedy graph coloring algorithm, Some special classes of graphs, Algorithms for recognition of chordal graphs, Unit disk graphs, Dominating sets, Complexity of dominating and connected dominating sets, Algorithms for dominating sets, Hardness of some graph problems, Algorithms for independent sets and cliques, Random graphs, Social network models.

Reading

1. Martin Charles Golumbic, *Algorithmic Graph Theory and Perfect Graphs*, Academic Press, 1980.
2. M.E.J. Newman*, Networks: An Introduction*, Oxford University Press, 2010.
3. Teresa W. Haynes, Stephen T. Hedetniemi and Peter J. Slater, *Fundamentals of Domination in Graphs*, Marcel Dekker, Inc., 1998.
4. William Kocay and Donald L. Kreher, *Graphs, Algorithms, and Optimization*, CRC Press, 2005.

CS314	ADVANCED DATASTRUCTURES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS101-Problem Solving and Computer Programming, CS204- Data Structures

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand implementation of symbol table using hashing techniques
CO2	Develop and analyze algorithms for red-black trees, B-trees and Splay trees
CO3	Develop algorithms for text processing applications
CO4	Identity suitable data structures and develop algorithms for computational geometry problems

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1	-	-	-	-	-	-	-	2	1	-	-
CO2	2	1	1	1		-	-	-	-	-	-	-	2	1	-	-
CO3	3	2	2	1	2	-	-	-	-	-	-	-	3	1	2	1
CO4	3	3	2	1	1	-	-	-	-	-	-	-	3	1	2	1

Detailed syllabus:

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.

Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists

Trees: Binary Search Trees (BST), AVL Trees

Red Black Trees: Height of a Red Black Tree, Red Black Trees Bottom-Up Insertion, Top-Down Red Black Trees, Top-Down Deletion in Red Black Trees, Analysis of Operations.

2-3 Trees: Advantage of 2-3 trees over Binary Search Trees, Search and Update Operations on 2-3 Trees, Analysis of Operations.

B-Trees: Advantage of B- trees over BSTs, Height of B-Tree, Search and Update Operations on 2-3 Trees, Analysis of Operations.

Splay Trees: Splaying, Search and Update Operations on Splay Trees, Amortized Analysis of Splaying.

Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.

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Reading:

1. Mark Allen Weiss, Data *Structures and Algorithm Analysis in C*++, second Edition, Pearson, 2004.
2. Michael T. Goodrich, Roberto Tamassia*, Algorithm Design*, First Edition, Wiley, 2006.

CS315	Computational Number Theory	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS252-Design and Analysis of Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyse large integer computations in $\mathbf{Z}_n$
CO2	Analyse primality testing and integer factorization algorithms
CO3	Develop algorithms for computations in groups, rings and fields
CO4	Develop algorithms for computations in polynomial rings
CO5	Develop algorithms for computations in finite fields

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	-	1	-	-	1	-	-	-	1	-	-
CO2	2	3	2	2	3	-	-	1	-	1	-	1	-	-	2	-
CO3	2	1	3	2	2	1	1	-	2	-	1	1	-	1	-	1
CO4	2	2	2	1	2	1	1	-	1	1	-	-	2	-	-	1
CO5	2	3	3	3	3	1	-	1	1	-	1	1	1	-	-	1

Detailed syllabus

Basic properties of the integers - Divisibility and primality, Ideals and greatest common divisors, unique factorization, Congruences - Basic properties, Solving linear congruences, Residue classes, Euler's phi function, Fermat's little theorem, Arithmetic functions and Mobius inversion

Computing with large integers - Asymptotic notation, Machine models and complexity theory, Basic integer arithmetic, Computing in Zn, Faster integer arithmetic; Euclid's algorithm - basic Euclidean algorithm, extended Euclidean algorithm, Computing modular inverses and Chinese remaindering, Speeding up algorithms via modular computation, Rational reconstruction and applications

The distribution of primes - Chebyshev's theorem on the density of primes, Bertrand's postulate, Mertens' theorem, sieve of Eratosthenes, prime number theorem and beyond

Probabilistic algorithms – definitions, Approximation of functions, generating a random number from a given interval, generating a random prime, generating a random non-increasing sequence, generating a random factored number, RSA cryptosystem

Algebraic Structures - Subgroups, Cosets and quotient groups, Group homomorphisms and isomorphisms, Cyclic groups, structure of finite abelian groups, Rings - Definitions, basic properties, and examples, Polynomial rings, Ideals and quotient rings, Ring homomorphisms and isomorphisms; Modules and vector spaces - Submodules and quotient modules, Module homomorphisms and isomorphisms, Linear independence and bases, Vector spaces and dimension; Matrices - linear maps, inverse of a matrix, Gaussian elimination, Applications of Gaussian elimination; Algebras - The field of fractions of an integral domain, Unique factorization of polynomials, Polynomial congruences, Polynomial quotient algebras, General properties of extension fields, Formal power series and Laurent series, Unique factorization domains.

Primality testing - Trial division, structure of Z_n, The Miller–Rabin test, Generating random primes using the Miller–Rabin test, Perfect power testing and prime power factoring, Factoring and computing Euler's phi function; Deterministic primality testing - The algorithm and its analysis

Finding generators and discrete logarithms - Finding a generator for Z_p, Computing discrete logarithms Z_p, The Diffie–Hellman key establishment protocol

Quadratic residues and quadratic reciprocity - Quadratic residues, Legendre symbol, Jacobi symbol; Computational problems related to quadratic residues - Computing the Jacobi symbol, Testing quadratic residuosity, Computing modular square roots, The quadratic residuosity assumption.

Subexponential-time discrete logarithms and factoring - Smooth numbers, algorithm for discrete logarithms, algorithm for factoring integers, Practical improvements,

Polynomial arithmetic and applications - Basic arithmetic, Computing minimal polynomials, Euclid's algorithm, Computing modular inverses and Chinese remaindering, Rational function reconstruction and applications, Faster polynomial arithmetic; Linearly generated sequences and applications - Basic definitions and properties, Computing minimal polynomials, Solving sparse linear systems, The algebra of linear transformations,

Finite fields - The existence of finite fields, The subfield structure and uniqueness of finite fields, Conjugates, norms and traces; Algorithms for finite fields - Testing and constructing irreducible polynomials, Computing minimal polynomials in F[X]/(f), Factoring polynomials: the Cantor–Zassenhaus algorithm, Factoring polynomials: Berlekamp's algorithm, Deterministic factorization algorithms, Faster square-free decomposition.

Reading:

1. Victor Shoup, *A Computational Introduction to Number Theory and Algebra*, Cambridge University Press, 2008
2. Henri Cohen, A *Course in Computational Algebraic Number Theory*, Springer-Verlag, 2000
3. Abhijit Das, Computational Number Theory, Cambridge University Press, 2013
4. Eric Bach and Jeffrey Shallit, *Algorithmic Number Theory, Volume* 1: *Efficient Algorithms*, MIT Press, 1996
5. J. P. Buhler, P. Stevenhagen, *Algorithmic Number Theory: Lattices, Number Fields, Curves and Cryptography*, Cambridge University Press, 2008

CS316	**PRINCIPLES OF PROGRAMMING LANGUAGES**	**DEC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understanding the concepts of evolution of programming languages.
CO2	Understanding the concepts of object oriented languages, functional and logical programming languages
CO3	Analyzing the methods and tools to define syntax and semantics of a languages
CO4	Analyzing the design issues involved in various constructs of programming languages
CO5	Apply the concepts and identify the issues involved in other advanced features of programming languages

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	1	1	1	1	1	1	1	2	1	3	3
CO2	1	2	2	3	2	1	1	1	1	1	1	1	2	1	3	3
CO3	3	3	2	3	1	1	1	1	2	1	1	1	2	1	3	3
CO4	2	3	1	3	3	2	1	1	1	1	1	1	2	2	2	3
CO5	2	2	1	2	2	2	1	1	1	1	1	1	2	1	3	3

Detailed syllabus:

Introduction- The Origins of Programming Languages- Abstractions in Programming Languages - Computational Paradigms -Language Definition - Language Translation

Language Design Criteria – Efficiency, regularity, security and extensibility - C++: An Object-Oriented Extension of C-Python: A General-Purpose Scripting Language –

Functional Programming - Programs as Functions - Scheme: A Dialect of Lisp - ML: Functional Programming with static typing -Delayed Evaluation- Haskell- Overloading.

Logic Programming-Logic and Logic Programs - Horn Clauses -Resolution and Unification- The Language Prolog - Problems with Logic Programming

Object-Oriented Programming- Software Reuse and Independence Smalltalk Java C++ - Design Issues in Object-Oriented Languages - Implementation Issues in Object-Oriented

Languages

Syntax-Lexical Structure of Programming Languages -Context-Free Grammars and BNFs - Parse Trees and Abstract Syntax Trees - EBNFs and Syntax Diagrams - Parsing Techniques and Tools-Lexics vs. Syntax vs. Semantics

Basic Semantics -Attributes, Binding, and Semantic Functions - Declarations, Blocks, and Scope - The Symbol Table - Name Resolution and Overloading - Allocation, Lifetimes, and the Environment Variables and Constants Aliases, Dangling References, and Garbage

Data Types-Data Types and Type Information - Simple Types - Type Constructors - Type Nomenclature in Sample Languages -Type Equivalence- Type Checking -Type Conversion-Polymorphic Type Checking- Explicit Polymorphism

Control Expressions and Statements –Expressions - Conditional Statements and Guards-Exception Handling- Procedure Definition and Activation-Procedure Semantics- Parameter-Passing Mechanisms- Procedure Environments, Activations, and Allocation-Dynamic Memory Management- Exception Handling and Environments

Abstract Data Types and Modules - The Algebraic Specification of Abstract Data Types-Abstract Data Type Mechanisms and Modules -Separate Compilation in C, C++ Namespaces, and Java Packages- Ada Packages -Modules in ML- Problems with Abstract Data Type Mechanisms

Formal Semantics- A Sample Small Language- Operational Semantics -Denotational Semantics- Axiomatic Semantics- Proofs of Program Correctness-

Parallel Programming- Introduction to Parallel Processing- Parallel Processing and Programming Languages- Threads – Semaphores- Monitors –Message Passing.

Reading:

1. Kenneth C. Louden, *Programming Language Principles and Practices*, 2nd Edition, Thomson 2003.
2. Carlo Ghezzi, Mehdi Jazayeri, *Programming Language Concepts*, 3rd Edition, John Wiley & Sons, 1997.

CS317	FILE STRUCTURES	DEC	2 – 0 – 2	3 Credits

Pre-requisites: CS101-Problem Solving and Computer Programming

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand file structures including sequential, indexed, indexed sequential, hashed file structures
CO2	Apply object-oriented concepts to design file systems
CO3	Implement file operations including read, write, update and search
CO4	Develop and analyze external sorting methods

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	1	1	-	-	-	-	-	-	3	3	2	2
CO2	1	2	3	1	1		-	-	-	-	-	-	3	3	2	2
CO3	3	3	3	2	1	1	-	-	-	-	-	-	3	3	2	2
CO4	3	3	1	3	1	1	-	-	-	-	-	-	3	3	2	2

Detailed syllabus:

Fundamental File Structure Concepts: Field and Record Organization, Using Classes to Manipulate Buffers, Using Inheritance for Record Buffer Classes, Managing Fixed Length, Fixed Field Buffers, An Object-Oriented Class for Record Files.

Managing Files and Records: Record Access, More about Record Structures, Encapsulating Record Operations in a Single Class, File Access and File Organization, Object-Oriented Approach to File Access, Portability and Standardization.

Fundamental File Processing Operations: Physical Files and Logical Files, Opening Files, Closing Files, Reading and Writing, Seeking, Special Characters in Files, The UNIX Directory Structure, Physical and Logical Files in UNIX, File-related Header Files, UNIX File System Commands. Object Oriented Support for Entry-Sequenced

Indexed Files of Data Objects- Indexing: A Simple Index for Entry-Sequenced File, Template Classes in C++, Object-Oriented support for Indexed, Entry-Sequenced Files of Data Objects, Indexes That Are Too Large to Hold in Memory, Indexing to Provide Access by Multiple Keys, Retrieval Using Combinations of Secondary Keys, Improving the Secondary Index Structure: Inverted Lists, Selective Indexes, Binding.

Multilevel Indexing and B-Trees: Introduction: The Invention of the B-Tree, Multi-level Indexing, A Better Approach to Tree Indexes, B-Tree Properties, Worst-case Search Depth, Deletion, Merging, and Redistribution, Redistribution during Insertion: A Way to Improve Storage Utilization, B* Trees, Buffering of Pages: Virtual B-Trees, Variable-length Records and Keys.

Indexed Sequential File Access and B+ Trees: Indexed Sequential Access, maintaining a Sequence Set, adding a Simple Index to the Sequence Set, The Content of the Index: Separators Instead of Keys, The Simple Prefix B+ Tree, Simple Prefix B+ Tree Maintenance, Index Set Block Size, Internal Structure of Index Set Blocks: A Variable-order B-Tree., Loading a Simple Prefix B+ Tree.

Hashing: Introduction, A Simple Hashing Algorithm, Hashing Functions and Record Distributions, How Much Extra Memory Should Be Used, Collision Resolution by Progressive Overflow, Storing More Than One Record per Address: Buckets, Making Deletions, Other Collision Resolution Techniques, Patterns of Record Access.

Extendible Hashing: Introduction, How Extendible Hashing Works, Implementation, Deletion, Extendible Hashing Performance, Alternative Approaches, Multi list and Inverted Files, Sorting of Large Files,

External sorting: Secondary storage algorithms.

.

Reading:

1. Folk, Zoellick, Riccardi; *File Structures: An Object Oriented Approach with C++*, 2/e Pearson Publishers, 1997
2. Gio Wiederhold, *Database Design*, 2/e, MGH, 2001

CS318	Data Networks	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS252-Design and Analysis of Algorithms, CS201-Discrete mathematics
Course Outcomes:

CO1	Analyze layered network architecture and passage of data over communication links
CO2	Analyze delay models in Data Networks using Queueing Systems for messaging and delay sensitive applications
CO3	Design and analyze routing algorithms for Internet and multi-hop autonomous networks
CO4	Analyze flow and rate control algorithms between a sender and receiver in wide area networks
CO5	Design and analyze software defined networking algorithms for data forwarding through Internet

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	2	-	-	-	2	2	2	3	2	2	-	2
CO2	3	3	3	3	2	-	-	-	2	2	2	3	2	2	-	3
CO3	3	3	3	3	2	-	-	-	2	2	2	3	3	3	-	3
CO4	3	3	3	3`	2	-	-	-	2	2	2	3	3	3	-	3
CO5	3	3	3	3	3	-	-	-	2	2	2	3	3	3	-	3

Detailed syllabus:

Physical Layer Channels: Frequency- and Time- Division Multiplexing; Error Detection; ARQ; Framing, *Point-to-Point Protocols at Network Layer:* Error Recovery, The X.25 Network Layer Standard, The Internet Protocol, *Transport Layer*: Transport Layer Standards, Addressing and Multiplexing TCP, Error Recovery in TCP; Flow Control in TCP/IP, *Asynchronous Transfer Mode (ATM),* Delay Models in Data Networks: The *M/M/1* Queueing System, *M/M/m, M/M/∞, M/M/m/m* and other Markov Systems, Networks of Transmission Lines, Networks of Queues – Jackson's Theorem, Multi-Access Communication: Packet Radio Networks, Splitting Algorithms, Carrier Sensing, Multi-access Reservations, Routing in Data Networks: Wide-Area Network Routing, Interconnected Network Routing, Network Algorithms and Shortest Path Routing, Broadcasting Routing Information, Flow Models, Optimal Routing and Topological Design; Characterization of Optimal Routing, Flow Control: Main Objectives of Flow Control, Window

Flow Control, Rate Control Schemes, Rate Adjustment Algorithms, Classification of TCPs, Software Defined Networks: Fundamental Characteristics of SDN, the *OpenFlow* Specification, SDN via Hypervisor-Based Overlays, SDN in the Data Center, SDN in Wide Area Networks, SDN in Mobile Networks, SDN Ecosystem and Network Virtualization.

Reading:

1. Bertsekas, Dimitri, and Robert Gallager. Data Networks (2nd Edition). Upper Saddle River, NJ, USA, Second Edition, Pearson Education/Prentice Hall, 1992
2. Walrand and Varaiya. High Performance Communication Networks. San Francisco, CA: Morgan Kaufmann Publishers, 1996
3. Stevens. TCP/IP Illustrated. Reading, MA: Addison-Wesley Pub. Co., c1994-c1996.
4. Paul Goransson, Chuck Black, Software Defined Networking: a comprehensive approach, Morgan Kaufmann (Elsevier), 2014

CS351	LANGUAGE PROCESSORS	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS301: Theory of Computation

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand phases in the design of compiler
CO2	Design top-down and bottom-up parsers
CO3	Identify synthesized and inherited attributes
CO4	Develop syntax directed translation schemes
CO5	Develop algorithms to generate code for a target machine

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-
CO2	1	-	-	3	-	-	-	-	-	-	-	-	1	-	-	-
CO3	2	2	2	-	-	2	-	-	-	-	-	-	1	-	-	-
CO4	2	1	-	-	2	-	-	-	-	-	-	-	2	-	-	-
CO5	1	-	-	1	-	-	-	-	-	-	-	-	3	-	-	-

Detailed syllabus

Phases of Compilers - Compiler Construction Tools - Bootstrapping

Lexical analyzer - The Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, A Language for Specifying Lexical Analyzers.

Parsing - The Role of the Parser, Context-Free Grammars, Top-Down Parsing, Bottom-Up Parsing, Operator-Precedence Parsing, LR Parsers, Using Ambiguous Grammars, Parser Generators.

Syntax-Directed Translation- Syntax-Directed Definitions, Construction of Syntax Trees, Bottom-Up Evaluation of S-Attributed Definitions, L-Attributed Definitions, Top Down Translation, Bottom-Up Evaluation of Inherited Attributes, Recursive Evaluators, Space for Attribute Values at Compile Time, Assigning Spaces at Compiler-Construction Time, Analysis of Syntax-Directed Definitions.

Type Checking- Type Systems, Specification of a Simple Type Checker, Equivalence of Type Expressions, Type Conversions, Overloading of Functions and Operators, Polymorphic Functions, An algorithm for Unification.

Run-Time Environments - Source Language Issues, Storage Organization, Storage-Allocation Strategies, Access to Nonlocal Names, Parameter Passing, Symbol Tables, Language Facilities for Dynamic Storage Allocation, Dynamic Storage Allocation Techniques, Storage Allocation in Fortran.

Intermediate Code Generation - Intermediate Languages, Declarations, Assignment Statements, Boolean Expressions, Case Statements, Backpatching, Procedure Calls.

Code Generation - Issues in the Design of a Code Generator, The Target Machine, Run-Time Storage Management, Basic Blocks and Flow Graphs, Next-Use Information, A Simple Code Generator, Register Allocation and Assignment, The Dag Representation of Basic Blocks, Peephole Optimization, Generating Code from DAGs, Dynamic Programming Code-Generation Algorithm, Code-Generator Generators.

Reading:

1. Alfred V. Aho, Monical S.Lam, Ravi Sethi, and Jeffrey D. Ullman *Compilers - Principles, Techniques and Tools*, 2nd Edition, Pearson, 2007.
2. Randy Allen, Ken Kennedy, *Optimizing Compilers for Modern Architectures*, Morgan Kauffmann, 2001.

CS352	COMPUTER NETWORKS	PCC	4 – 0 – 0	4 Credits

Pre-requisites: CS302: Operating Systems

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand OSI and TCP/IP models
CO2	Analyze MAC layer protocols and LAN technologies
CO3	Design applications using internet protocols
CO4	Implement routing and congestion control algorithms
CO5	Develop application layer protocols

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	-	3	-	-	-	-	-	-	2	2	2	-	2
CO4	1	2	2	1	-	-	-	-	-	-	-	-	2	2	-	-
CO5	3	3	3	-	3	-	1	1	-	-	-	2	3	3	-	-

Detailed syllabus:

Introduction – network architecture - protocol implementation issues - network design. Reference models- The OSI Reference Model- the TCP/IP Model - A Comparison of the OSI and TCP/IP Models

Datalink Layer-Ethernet, Token ring, wireless LANs-Issues with data link Protocols-Encoding framing and error detection and correction-sliding window Protocol-Medium access control

Network layer – network layer design issues - Routing algorithms - Congestion control algorithms – Internetworking - The network layer in the internet - Internet Protocol (IP) - Unicast, multicast, and inter domain routing

Transport layer - Elements of transport protocol - Congestion control – The Internet's Transmission Control Protocol (TCP) - Remote Procedure Call (RPC) – Implementation semantics of RPC – BSD sockets - client-server applications

Application layer - Domain name server – Simple Mail Transfer Protocol – File Transfer Protocol - World wide web - Hypertext transfer protocol -Presentation formatting and data compression-

Introduction to Network security - Web Services architectures for developing new application protocols.

Reading:

1. Larry L Peterson, Bruce S Davis, *Computer Networks*, 5th Edition, Elsevier, 2012.
2. Andrew S. Tanenbaum, David J Wetherall, *Computer Networks*, 5th Edition, Pearson Edu, 2010.

CS353	Data Science	PCC	4 – 0 – 0	4 Credits

Pre-requisites: CS254- Database Management Systems, CS303- Data Warehousing and Mining

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply statistical methods to data for inferences.
CO2	Analyze data using Classification, Graphical and computational methods.
CO3	Understand Data Wrangling approaches.
CO4	Perform descriptive analytics over large scale data.
CO5	Demonstrate key concepts in Data Science, including tools, approaches and application scenarios

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	1	1	-	-	-	-	1	-	-	1	1	3	1
CO2	-	-	2	-	-	-	-	-	-	2	2	-	1	1	3	1
CO3	-	-	2	1	-	-	-	1	-	2	-	-	1	2	3	2
CO4	-	-	-	`1	-	1	-	-	2	1	-	-	1	2	3	3
CO5	-	-	-	1	2	2	2	-	1	2	1	2	1	2	2	3

Detailed syllabus

Overview of Random variables and distributions, Statistical learning, Assessing Model Accuracy, Descriptive statistics, Dependent and independent events.

Data interpretation and use: visualization techniques - Histograms and frequency polygons, Box-plots, Quartiles, Scatter Plots, Heat Maps Programming for basic computational methods such as Eigen values and Eigen vectors, sparse matrices, QR and SVD, Interpolation by divided differences

Data integration - fundamentals of Linked Data, Google Refine

Data Wrangling: Data Acquisition, Data Formats, Imputation, The split-apply-combine paradigm

Data analytics: statistical modeling, basic concepts, experiment design, pitfalls, Overview of R Programming

Linear algebra for data science - Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, solution of over-determined set of equations and pseudo-inverse and Geometric view - vectors, distance, projections, eigenvalue decomposition

Statistics: descriptive statistics, notion of probability, distributions, mean, variance, covariance, and covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates. Simple Hypothesis Testing, Student's t-test, paired t and U test, correlation and covariance, tests for association

Linear Regression: Simple and multiple linear regressions, Comparison of Linear regression with K-nearest neighbors. Multivariate linear regression, model assessment, assessing importance of different variables, subset selection

Classification: Linear and Logistic Regression, LDA and comparison of classification methods.

Optimization

Reading:

1) Hastie, Trevor, Gareth James, Robert Tibshirani, and Daniela Witten. "An introduction to statistical learning with applications in R." (2013). Springer, web link: www.statlearning.com

2) Beginning R The statistical Programming Language, Mark Gardener, Wiley, 2015.

3) Data Mining Concepts and Techniques, Han, Kamber, and J Pei 3rd edition, Morgan Kaufman, 2012.

4) Data Science and Big Data Analytics, EMC Education Services, EMC^2, Wiley Publication, 2015.

Web resource: https://onlinecourses.nptel.ac.in/noc18_cs28/course

CS354	LANGUAGE PROCESSORS LAB	PCC	0 – 0 – 2	1 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Implement simple lexical analyzers
CO2	Generate predictive parsing table for a CFG
CO3	Apply Lex and Yacc tools
CO4	Design and Implement LR parser
CO5	Implement Intermediate code generation for subset C language

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	2	-	1
CO2	1	1	-	2	-	-	-	-	-	-	-	-	2	2	-	1
CO3	3	-	-	2	2	-	-	-	-	-	-	-	2	2	-	1
CO4	2	-	3	2	-	-	-	-	-	-	-	-	2	2	-	1
CO5	1	-	-	-	-	-	-	-	-	-	-	-	2	2	-	1

Detailed syllabus:

1. Lex and Yacc - Generation of Intermediate Code for Expression Grammar - Construction of Predictive Parsing Table - LR Parsing Tables - Parsing Actions.
2. Implement CYK algorithm (from Motwani's book)
3. Using lex/yacc tools generate assembly language code for a block of assignment and arithmetic statements.
4. Implement elimination of left recursion and left factoring algorithms for any given grammar and generate predictive parsing table.
5. Write a program for generating a parser program using lex and yacc for a language with integer identifiers, binary arithmetic expressions and assignments. (Input is grammar and output is parser in C language)
6. Write a program for generating SLR Parsing table and also write a parser.
7. Write a program for generating derivation sequence for a given terminal string using parsing table.

8. Using back-patching method generate three address code for while, if and Boolean expressions.
9. Major assignment: Intermediate code generation for subset C language.

Reading:

1. Alfred V. Aho, Monical S.Lam, Ravi Sethi, and Jeffrey D. Ullman *Compilers - Principles, Techniques and Tools*, 2nd Edition, Pearson, 2007.
2. John R Levine, Tony Mason, Doug Brown, *Lex and Yacc*, Orielly, 2nd Edition, 2009.

CS355	COMPUTER NETWORKS LABORATORY	PCC	0 – 0 – 2	1 Credit

Pre-requisites: CS306: Operating Systems Laboratory
Course Outcomes: At the end of the course the student will be able to:

CO1	Develop programs for client-server applications
CO2	Perform packet sniffing and analyze packets in network traffic.
CO3	Implement error detecting and correcting codes

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	-	2	-	2	-	-	-	-	2	2	2	-	-
CO2	2	3	2	2	1	1	-	2	-	-	-	1	1	2	-	2
CO3	1	1	1	2	-	-	-	-	-	-	-	-	2	-	-	-

Detailed syllabus:

Assignment-1: Programs to implement error detection and correction

Assignment-2: Client-Server applications using inter process communication mechanisms

a) FIFO b) Message queues c) Shared memory

Assignment-3: Connection-oriented Client-Server applications based on BSD sockets

Assignment-4: Connectionless Client-Server applications

Assignment-5: Implementation of Chat servers and mail Servers

Assignment-6: Implementation of routing algorithms

Assignment-7: Programs using Remote Procedure Call (RPC)

Assignment-8: Client-Server applications based on Raw Sockets, IP Spoofing

Assignment-9: Implementation of application layer protocols

Assignment-10: Datalink layer Access, Packet Sniffing

Reading:

1. W. Richard Stevens, *UNIX Network Programming, Volume 1, Second Edition: Networking APIs: Sockets and XTI*, Prentice Hall, 1998

2. W. Richard Stevens, *UNIX Network Programming, Volume 2, Second Edition: Interprocess Communications*, Prentice Hall, 1999
3. W. Richard Stevens, Stephen Rago, *Advanced Programming in the UNIX Environment*, Pearson Education, *Second Edition.*

CS356	Data Science Lab	PCC	0 – 0 – 2	1 Credit

Pre-requisites: CS254- Database Management Systems, CS303- Data Warehousing and Data Mining

Course Outcomes: At the end of the course the student will be able to:

CO1	Demonstrate skills acquired in R Programming.
CO2	Interpret models in data using statistical analysis.
CO3	Prepare environment for distributed systems applications.
CO4	Writes Programs for big data using Map Reduce.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	1	2	-	-	-	-	1	-	-	-	-	2	-
CO2	1	-	-	2	1	-	2	1	-	2	-	2	-	-	1	-
CO3	-	2	2	2	2	1	1	-	-	-	-	1	-	2	2	1
CO4	2	-	1	2	1	-	-	-	2	-	1	1	2	1	2	s

Detailed syllabus

1. **Introduction to R:** Installing R in windows, R Console (R window to edit and execute R Commands), Commands and Syntax (R commands and R syntax), Packages and Libraries (Install and load a package in R), Help In R, Workspace in R.
2. **Familiarity of Data Structures in R**: Introduction to Data Types (Why Data Structures?, Types of Data Structures in R), Vectors, Matrices, Arrays, Lists, Factors, Data Frames, Importing and Exporting Data.
3. **Graphical Analysis:** Creating a simple graph (Using plot() command), Modifying the points and lines of a graph (Using type, pch, font, cex, lty, lwd, col arguments in plot() command), Modifying Title and Subtitle of graph (Using main, sub, col.main, col.sub, cex.main, cex.sub,

font.main, font.sub arguments in plot() command), Modifying Axes of a Graph (Using xlab, ylab, col.lab, cex.lab, font.lab, xlim, ylim, col.axis, cex.axis, font.axis arguments and axis() command), Adding Additional Elements to a Graph (Using points(), text(), abline(), curve() commands), Adding Legend on a Graph (Using legend() command), Special Graphs (Using pie(), barplot(), hist() commands), Multiple Plots (Using mfrow or mfcol arguments in par() command and layout command).

4. **Descriptive Statistics:** Measure of Central Tendency (Mean, Median and Mode), Measure of Positions (Quartiles, Deciles, Percentiles and Quantiles), Measure of Dispersion (Range, Median, Absolute deviation about median, Variance and Standard deviation), Measure of Distribution (Skewness and Kurtosis), Box and Whisker Plot (Box Plot and its parts, Using Box Plots to compare distribution).
5. **Comparing Population:** Test of Hypothesis (Concept of Hypothesis testing, Null Hypothesis and Alternative Hypothesis), Cross Tabulations (Contigency table and their use, Chi-Square test, Fisher's exact test), One Sample t test (Concept, Assumptions, Hypothesis, Verification of assumptions, Performing the test and interpretation of results), Independent Samples t test (Concept, Type, Assumptions, Hypothesis, Verification of assumptions, Performing the test and interpretation of results), Paired Samples t test (Concept, Assumptions, Hypothesis, Verification of assumptions, Performing the test and interpretation of results), One way ANOVA (Concept, Assumptions, Hypothesis, Verification of assumptions, Model fit, Hypothesis testing, Post hoc tests: Fisher's LSD, Tukey's HSD).
6. Use cases based on Linear Regression and Multiple Regression Methods, classification, optimization
7. Set up and practice examples on Hadoop 2.0;
8. Map Reduce implementation for Relational algebra operations
9. Map reduce implementation for matrix multiplications.

Reading:

1) An Introduction to Statistical Learning with Applications in R, Gareth James Daniela Witten Trevor Hastie, Robert Tibshirani, February 11, 2013, web link: www.statlearning.com

2) Beginning R The statistical Programming Language, Mark Gardener, Wiley, 2015.

CS361	PARALLEL PROCESSING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Design and analyze the parallel algorithms for real world problems and implement them on available parallel computer systems.
CO2	Optimize the performance of a parallel program to suit a particular platform.
CO3	Design algorithms suited for Multicore processor systems using OpenCL, OpenMP, Threading techniques.
CO4	Analyze the communication overhead of interconnection networks and modify the algorithms to meet the requirements.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	2	2	-	-	-	-	-	-	3	2	2	2
CO2	3	2	3	3	2	2	-	-	-	-	-	-	2	2	-	3
CO3	3	3	3	2	2	2	-	-	-	-	-	-	3	3	-	2
CO4	2	3	3	2	2	2	-	-	-	-	-	-	3	3	-	3

Detailed syllabus:

Introduction: Implicit parallelism, Limitations of memory system performance, control structure, communication model, physical organization, and communication costs of parallel platforms, Routing mechanisms for interconnection networks, mapping techniques.

Parallel algorithm design: Preliminaries, decomposition techniques, tasks and interactions, mapping techniques for load balancing, methods for reducing interaction overheads, parallel algorithm models.

Basic communication operations: Meaning of all-to-all, all-reduce, scatter, and gather, circular shift and splitting routing messages in parts. Analytical modeling of parallel programs: sources of overhead, performance metrics, the effect of granularity on performance, scalability of parallel systems, minimum execution time, minimum cost-optimal execution time, asymptotic analysis of parallel programs.

Programming using message passing paradigm: Principles, building blocks, MPI, Topologies and embedding, Overlapping communication and computation, collective communication operations, Groups and communicators

Programming shared address space platforms: Threads, POSIX threads, Synchronization primitives, attributes of threads, mutex and condition variables, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, An overview of Intel Threading building blocks.

Dense Matrix Algorithms: matrix vector multiplication, matrix-matrix multiplication, solving system of linear equations, Sorting: Sorting networks, Bubble sort, Quick sort, Bucket sort and other sorting algorithms Graph algorithms: Minimum spanning tree, single source shortest paths, all-pairs shortest paths, Transitive closure, connected components, algorithms for sparse graphs.

Reading:

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar : Introduction to Parallel Computing, Second Edition Pearson Education – 2007
2. Michael J. Quinn (2004), Parallel Programming in C with MPI and OpenMP McGraw-Hill International Editions, Computer Science Series,

CS362	Topics in Theoretical Computer Science	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS403-Advanced Algorithms, CS401-Machine Learning

Course Outcomes: At the end of the course, student will be able to:

CO1	Identify and explain fundamental mathematical constraints for developing algorithms to solve problems in high dimensional space
CO2	Develop methods to study how to draw good samples efficiently and how to estimate statistical and linear algebra quantities, with such Samples.
CO3	Apply learning models and algorithms with provable guarantees on learning error and time.
CO4	Build models to understand and to capture essential properties of large structures, like the web and social networks
CO5	Build applications for ranking and social choice as well as problems of sparse representations such as compressed sensing

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	-	1	-	-	1	-	-	3	1	2	-
CO2	2	3	2	1	3	-	-	1	-	1	-	1	3	1	3	-
CO3	2	2	3	2	2	1	1	-	2	-	1	1	3	2	2	1
CO4	2	2	2	2	3	1	1	-	1	1	-	-	3	`3	2	1
CO5	2	3	3	3	3	1	-	1	1	-	-	1	3	3	2	2

Detailed syllabus

High-Dimensional Space - The Law of Large Numbers, The Geometry of High Dimensions, Properties of the Unit Ball, Volume of the Unit Ball, Volume Near the Equator, Generating Points Uniformly at Random from a Ball, Gaussians in High Dimension, Random Projection and Johnson-Lindenstrauss Lemma, Separating Gaussians, Fitting a Spherical Gaussian to Data

Best-Fit Subspaces and Singular Value Decomposition (SVD) - Singular Vectors, Best Rank-k Approximations, Left Singular Vectors, Power Method for Singular Value Decomposition, A Faster Method, Singular Vectors and Eigenvectors, Applications of Singular Value Decomposition, Centering Data, Principal Component Analysis, Clustering a Mixture of Spherical Gaussians, Ranking Documents and Web Pages, Application of SVD to a Discrete Optimization Problem

Random Walks and Markov Chains - Stationary Distribution, Markov Chain Monte, Metropolis-Hasting Algorithm, Gibbs Sampling, Areas and Volumes, Convergence of Random

Walks on Undirected Graphs, Using Normalized Conductance to Prove Convergence, Electrical Networks and Random Walks, Random Walks on Undirected Graphs with Unit Edge Weights, Random Walks in Euclidean Space, The Web as a Markov Chain,

Machine Learning - The Perceptron algorithm, Kernel Functions, Generalizing to New Data, Overfitting and Uniform, llustrative Examples and Occam's Razor, Learning Disjunctions, Occam's, Application: Learning Decision Trees, Regularization: Penalizing Complexity, Online, Online to Batch Conversion, Support-Vector Machines, VC-Dimension, Strong and Weak Learning – Boosting, Stochastic Gradient Descent, Combining (Sleeping) Expert Advice, Deep Learning, Further Current Directions.

Algorithms for Massive Data Problems: Streaming, Sketching, and Sampling - Frequency Moments of Data Streams, Matrix Algorithms using, Sketches of Documents

Clustering - Two General Assumptions on the Form of Clusters, k-Center, Spectral Clustering, Approximation Stability, High-Density Clusters, Kernel Methods, Recursive Clustering based on Sparse Cuts, Dense Submatrices and Communities, Community Finding and Graph Partitioning, Spectral clustering applied to social

Random Graphs - The G (n; p) Model, Phase Transitions, Giant, Cycles, Phase Transitions for Increasing, Branching Processes, CNF-SAT, Nonuniform Models of Random Growth Models, Small World Graphs

Topic Models, Nonnegative Matrix Factorization, Hidden Markov Models, and Graphical Models - Topic Models, An Idealized Model, Nonnegative Matrix Factorization – NMF, NMF with Anchor Terms, Hard and Soft Clustering, The Latent Dirichlet Allocation Model for Topic, The Dominant Admixture, Finding the Term-Topic Matrix, Hidden Markov, Graphical Models and Belief, Bayesian or Belief, Markov Random, Factor, Tree Algorithms, Message Passing in General, Graphs with a Single Cycle, Belief Update in Networks with a Single, Maximum Weight Matching, Warning

Other Topics - Ranking and Social Choice, Compressed Sensing and Sparse, Applications, Uncertainty Principle

Reading:

1. Brian Steele, John Chandler, Swarna Reddy, *Algorithms for Data Science*, Springer, 2016
2. Noga Alon and Joel H Spenser, *Probabilistic Method*, Third Edition,. John Wiley & Sons, 2008.
3. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press, 1995

CS363	Game Theory	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS252-Design and Analysis of Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze games based on complete and incomplete information about the players
CO2	Analyze games where players cooperate
CO3	Compute Nash equilibrium
CO4	Apply game theory to model network traffic
CO5	Analyze auctions using game theory

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	-	1	-	-	1	-	-	3	1	1	-
CO2	2	3	2	2	3	-	-	1	-	1	-	1	2	2	1	-
CO3	2	1	3	2	2	1	1	-	2	-	1	1	2	2	2	1
CO4	2	2	2	1	2	1	1	-	1	1	-	-	2	1	2	1
CO5	2	3	2	3	3	1	-	1	1	-	-	1	2	2	1	-

Detailed syllabus

Noncooperative Game Theory: Games in Normal Form - Preferences and utility, examples of normal-form, Analyzing games: Pareto optimality, Nash equilibrium, Maxmin and minmax strategies, dominated strategies, Rationalizability, Correlated equilibrium

Computing Solution Concepts of Normal-Form Games: Computing Nash equilibria of two-player, zero-sum games, Computing Nash equilibria of two-player, general-sum games, Complexity of computing Nash equilibrium, Lemke–Howson algorithm, Searching the space of supports, Computing Nash equilibria of n-player, general-sum games, Computing maxmin and minmax strategies for two-player, general-sum games, Computing correlated equilibria

Games with the Extensive Form: Perfect-information extensive-form games, Subgame-perfect equilibrium, Computing equilibria, Imperfect-information extensive-form games, Sequential equilibrium

Other Representations: Repeated games: Finitely repeated games, Infinitely repeated games, automata, Stochastic games Bayesian games: Computing equilibria

CoalitionalGameTheory: Transferable Utility, Analyzing Coalitional Games, Shapley Value, the Core

Mechanism Design: Strategic voting, unrestricted preferences, Implementation, quasilinear setting, efficient mechanisms, and Computational applications of mechanism design, Task scheduling, Bandwidth allocation in computer networks

Auctions: Single-good auctions, Canonical auction families, Bayesian mechanisms, Multiunit auctions, combinatorial auctions,

Reading:

1. Shoham, Y. and Leyton–Brown, K. *Multiagent Systems: Algorithmic, Game Theoretic, and Logical Foundations*. Cambridge University Press, 2008.
2. Osborne, M. J., and Rubinstein, A. *A Course in Game Theory. Cambridge*, MA: MIT Press, 1994.
3. D. Fudenberg and J. Tirole, Game Theory, The MIT Press, 2005

CS365	DISTRIBUTED COMPUTING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS302: Operating Systems, CS352: Computer Networks

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand models of distributed computing
CO2	Analyze algorithms for coordination, communication and synchronization in distributed systems
CO3	Analyze distributed shared memory models
CO4	Design and Implement distributed file systems
CO5	Design distributed algorithms for handling deadlocks

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	2	2	-	-	-	-	-	-	3	2	-	-
CO2	2	3	2	1	2	3	-	-	-	-	-	-	3	3	-	3
CO3	3	3	3	2	2	2	-	-	-	-	-	-	2	2	-	3
CO4	1	2	3	3	3	2	-	-	-	-	-	-	3	3	-	3
CO5	3	3	2	2	2	3	-	-	-	-	-	-	3	3	-	2

Detailed syllabus:

Distributed Computing Introduction : Definition, Relation to parallel systems, synchronous vs asynchronous execution, design issues and challenges

A Model of Distributed Computatioms : A Model of distributed executions, Models of communication networks, Global state of distributed system, Models of process communication.

Logical Time : Logical clocks, scalar time, vector time, Matrix time, vrtual time, Physicla clock synchronization - NTP

Global state and snapshot recording algorithms: System model, Snapshot algorithms for FIFO channels, Variations of Chandy-Lamport algorithm, Snapshot algorithms for non-FIFO channels, Snapshots in a causal delivery system, Monitoring global state, Nececssary and sufficient conditions for consistent global snapshots, Finding consistent global snapshots in a distributed computation.

Message ordering and group communication : Mesage ordering paradigms, Group communication, Causal order (CO), Total order, Multicast, Propagation trees for multicast, Application-level multicast algorithms, Fault-tolerant group communication, Multicast algorithms at the network layer.

Termination detection: System model of a distributed computation, Termination detection using distributed snapshots, weight throwing and spanning-tree-based algorithms, Message-optimal termination detection, and Termination detection in a general distributed computing model, Termination detection in the atomic computation model, Termination detection in a faulty distributed system

Distributed mutual exclusion algorithms: Lamport's algorithm, Ricart–Agrawala algorithm, Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual exclusion algorithm, Quorum-based mutual exclusion algorithms, Maekawa's algorithm, Agarwal–El Abbadi quorum-based algorithm, Token-based algorithms, Suzuki–Kasami's broadcast algorithm, Raymond's tree-based algorithm,.

Deadlock detection in distributed systems : System model, Models of deadlocks, Knapp's classification of distributed deadlock detection algorithms, Mitchell and Merritt's algorithm for the single resource model, Chandy–Misra–Haas algorithm for the AND model, Chandy–Misra–Haas algorithm for the OR model, Kshemkalyani–Singhal algorithm for the P-out-of-Q model

Distribued shared memory : Abstraction and advantages, Memory con sistency models, Shared memory mutual exclusion, Wait-freedom, Register hierarchy and wait-free simulations, Wait-free atomic snapshots of shared objects

Check pointing and rollback recovery : Introduction, Background and definitions, Issues in failure recovery, Checkpoint-based recovery, Log-based rollback recovery, Koo–Toueg coordinated check pointing algorithm, Juang–Venkatesan algorithm for asynchronous check pointing and recovery, Manivannan–Singhal quasi-synchronous check pointing algorithm, Peterson–Kearns algorithm based on vector time, Helary–Mostefaoui–Netzer–Raynal communication-induced protocol

Consensus and agreement algorithms : Problem definition, Overview of results, Agreement in a failure-free system (synchronous or asynchronous), Agreement in (message-passing) synchronous systems with failures, Agreement in asynchronous message-passing systems with failures, Wait-free shared memory consensus in asynchronous systems

Failure detectors : Unreliable failure detectors, The consensus problem, Atomic broadcast, A solution to atomic broadcast, The weakest failure detectors to solve fundamental agreement problems, An implementation of a failure detector, An adaptive failure detection protocol

Reading:

1. Ajay D. Kshemakalyani, Mukesh Singhal, *Distributed Computing,*Cambridge University Press, 2008
2. Andrew S. Tanenbaum, Maarten Van Steen, *Distributed Systems - Principles and Paradigms,* PHI, 2004

CS366	Cyber Laws and Intellectual Property Rights	DEC	3 - 0 - 0	3 Credits

Pre-requisites: CS201**-** Discrete Mathematics, CS252- Design and Analysis of Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand Cyber laws in general and Indian IT Act in particular.
CO2	Analyze cyber crimes and their culpability under various sections of the act.
CO3	Understand Cyber case law and an ability to recall various cases for developing solutions
CO4	Understand Intellectual property rights in Indian context
CO5	Extract illegal knowledge related to computer based activities and diffuse such knowledge.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	1	-	-	-	-	1	-	-	-	1	-	-	1	1	-
CO2	-	1	-	-	2	-	2	-	-	-	1	-	-	-	2	-
CO3	-	-	2	-	1	-	-	-	1	1	1	1	1	-	2	1
CO4	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	1
CO5	1	-	-	1	1	1	-	-	-	1	-	2	-	-	2	1

Detailed syllabus

Cyber Space- Fundamental definitions -Interface of Technology and Law

Jurisprudence and-Jurisdiction in Cyber Space - Indian Context of Jurisdiction -Enforcement agencies – Need for IT act - UNCITRAL – E-Commerce basics

Information Technology Act, 2000 - Aims and Objects — Overview of the Act – Jurisdiction - Electronic Governance – Legal Recognition of Electronic Records and Electronic Evidence - Digital Signature Certificates - Securing Electronic records and secure digital signatures - Duties of Subscribers - Role of Certifying Authorities -

Regulators under the Act -The Cyber Regulations Appellate Tribunal - Internet Service Providers and their Liability – Powers of Police under the Act – Impact of the Act on other Laws.

Cyber Crimes -Meaning of Cyber Crimes –Different Kinds of Cyber crimes – Cyber crimes under IPC, Cr.P.C and Indian Evidence Law - Cyber crimes under the Information Technology Act, 2000 - Cyber crimes under

International Law - Hacking Child Pornography, Cyber Stalking, and Denial of service Attack, Virus Dissemination,

Software Piracy, Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing etc - Cyber Terrorism - Violation of Privacy on Internet - Data Protection and Privacy – Indian Court cases

Intellectual Property Rights –

Copyrights- Software – Copyrights vs Patents debate - Authorship and Assignment Issues - Copyright in Internet - Multimedia and Copyright issues - Software Piracy - **Trademarks -** Trademarks in Internet – Copyright and Trademark cases

Patents - Understanding Patents - European Position on Computer related Patents - Legal position on Computer related Patents - Indian Position on Patents – Case Law

Domain names -registration - Domain Name Disputes-Cyber Squatting-IPR cases

Reading:

1. Justice Yatindra Singh: Cyber Laws, Universal Law Publishing Co., New Delhi
2. Farouq Ahmed, *Cyber Law in India,* New Era publications, New Delhi
3. S.R.Myneni: *Information Technolgy Law (Cyber Laws),* Asia Law House, Hyderabad
4. Chris Reed, *Internet Law-Text and Materials*, Cambride University Press
5. Pawan Duggal: *Cyber Law- the Indian perspective* Universal Law Publishing Co., New Delhi

CS367	Statistics with R Programming	DEC	3 – 0 – 0	3 Credits

Pre-requisites: MA101-Mathematics I, MA151- Mathematics II

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply statistical methods to data for inferences.
CO2	Access online resources for R and import new function packages into the R workspace
CO3	Import, review, manipulate and summarize data-sets in R
CO4	Perform descriptive analytics over large scale data and apply appropriate statistical tests using R
CO5	Explore data-sets to create testable hypotheses and identify appropriate statistical tests

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	1	1	-	-	-	1	1	1	-	1	1	-	1
CO2	2	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-
CO3	-	-	-	2	2	-	1	-	-	-	2	1	-	-	-	-
CO4	2	-	1	`1	1	1	-	-	2	1	-	1	1	2	-	1
CO5	-	1	2	1	2	2	2	-	1	2	1	2	1	-	2	-

Detailed Syllabus:

Introduction, How to run R, R Sessions and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes**.**

R Programming Structures, Control Statements, Loops, - Looping Over Nonvector Sets,- If-Else, Arithmetic and Boolean Operators and values, Default Values for Argument, Return Values, Deciding Whether to explicitly call return- Returning Complex Objects, Functions are Objective, No Pointers in R, Recursion, A Quicksort Implementation-Extended Extended Example: A Binary Search Tree.

Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability- Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Extended Example: Vector cross Product- Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /out put, Accessing the Keyboard and Monitor, Reading and writer Files,

Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot () Function – Customizing Graphs, Saving Graphs to Files.
Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests,-ANOVA.
Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, - Poisson Regression- other Generalized Linear Models-Survival Analysis, Nonlinear Models, Splines- Decision- Random Forests,

TEXT BOOKS:

1. The Art of R Programming, Norman Matloff, Cengage Learning
2. R for Everyone, Lander, Pearson
3. R Cookbook, PaulTeetor, Oreilly.
4. R in Action, Rob Kabacoff, Manning

CS368	ADVANCED OPERATING SYSTEMS	DEC	3 – 0 – 0	3

Pre-requisites: CS302: Operating Systems

Course Outcomes: At the end of the course, student will be able to:

CO1	Design and implement Unix kernel data structures and algorithms
CO2	Analyze synchronization problems in uniprocessor and multiprocessor systems
CO3	Evaluate the scheduling requirements of different types of processes and find their solutions
CO4	Implement user level thread library and mimic the behavior of Unix kernel for scheduling, synchronization and signals

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	-	-	-	-	-	1	-	3	3	-	2
CO2	1	2	3	3	3	2	-	-	-	-	1	-	3	3	-	2
CO3	2	2	3	3	1	1	-	-	-	-	1	-	3	2	-	3
CO4	1	2	3	3	2	2	-	-	-	-	1	-	3	3	-	2`

Detailed syllabus

Introduction to UNIX: The process and the kernel, Mode, space and context, Process abstraction, kernel mode, synchronization by blocking interrupts, process scheduling.

Introduction to Threads: Fundamental abstractions, Lightweight process design, Issues to consider, User level thread libraries, scheduler activations

Signals: Signal generation and handling, Unreliable signals, Reliable signals, Signals in SVR4, Signals implementation, Exceptions, Process Groups

Process Scheduling: Clock interrupt handling, Scheduler Goals, Traditional UNIX scheduling, scheduling case studies

Synchronization and Multiprocessing: Introduction, Synchronization in Traditional UNIX Kernels, Multiprocessor Systems, Multiprocessor synchronization issues, Semaphores, spin locks, condition variables, Read-write locks, Reference counts

Introduction to Intel X86 Protected Mode: Privilege Levels, Flat memory model, Descriptors - Segment, Task, Interrupt; GDT, LDT and IDT, Initializing to switch to protected mode operation, Processor Exceptions.

Kernel Memory Allocators: Resource map allocator, Simple power-of-two allocator, McKusick-Karels Allocator, Buddy system, SVR4 Lazy Buddy allocator, OSF/1 Zone Allocator, Hierarchical Allocator, Solaris Slab Allocator

File system interface and framework : The user interface to files, File systems, Special files, File system framework, The Vnode/Vfs architecture, Implementation Overview, File System dependent objects, Mounting a file system, Operations on files.

File System Implementations : System V file system (s5fs) implementation, Berkeley FFS, FFS functionality enhancements and analysis, Temporary file systems, Buffer cache and other special-purpose file systems
Distributed File Systems: Network File System (NFS), Remote File Sharing (RFS)
Advanced File Systems : Limitations of traditional file systems, Sun-FFS, Journaling approach 4.4 BSD, Log-Structured file system, Meta logging Episode FS, Watchdogs, 4.4 BSD portal FS, Stackable FS layers, 4.4 BSD FS interface.

Reading:

1. Uresh Vahalia, *UNIX Internals*, Pearson Education, 2005.
2. Richard Stevens, Stephen A. Rago, *Advanced Programming in the UNIX Environment*, Pearson Education, 2/e, 2005.

CS 371	Artificial Intelligence	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Solve searching problems using A*, Mini-Max algorithms.
CO2	Create logical agents to do inference using first order logic.
CO3	Understand Bayesian Networks to do probabilistic reasoning.
CO4	Perform Statistical learning using EM algorithm.

Mapping of course outcomes with program outcomes/ program specific outcomes

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	1	1	-	1	-	1	1	1	-	2	1	2	-
CO2	2	2	1	1	1	-	-	-	-	1	1	-	2	1	2	-
CO3	2	2	2	2	1	1	1	-	-	1	1	1	2	1	3	-
CO4	2	2	2	2	1	1	1	-	-	1	1	1	2	1	3	-

Detailed Syllabus:

INTRODUCTION – Agents and Objects – Evaluation of Agents – Agent Design Philosophies - Multi-agent System – Mobile Agents – Agent Communication – Knowledge query and Manipulation Language – Case Study. What is AI? , The Foundations of Artificial Intelligence; - INTELLIGENT AGENTS – Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents; - SOLVING PROBLEMS BY SEARCH – Problem-Solving Agents, Formulating problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Depth-first search, Searching with Partial Information, Informed (Heuristic) Search Strategies, Greedy best-first search, A* Search: Minimizing the total estimated solution cost, Heuristic Functions, Local Search Algorithms and Optimization Problems, Online Search Agents and Unknown Environments; –ADVERSARIAL SEARCH – Games, The minimax algorithm, Optimal decisions in multiplayer games, Alpha-Beta Pruning, Evaluation functions, Cutting off search, Games that Include an Element of Chance; - LOGICAL AGENTS – Knowledge-Based agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Reasoning Patterns in Propositional Logic, Resolution, Forward and Backward chaining; - FIRST ORDER LOGIC – Syntax and Semantics of First-Order Logic, Using First-Order Logic , Knowledge Engineering in First-Order Logic; - INFERENCE IN FIRST ORDER LOGIC – Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution ; - UNCERTAINTY – Acting under Uncertainty, Basic Probability Notation, The Axioms of Probability, Inference Using Full Joint Distributions, Independence, Bayes' Rule and its Use, The Wumpus World Revisited; - PROBABILISTIC REASONING – Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distribution, Exact

Inference in Bayesian Networks, Approximate Inference in Bayesian Networks; STATISTICAL LEARNING METHODS – Statistical Learning, Learning with Complete Data, Learning with Hidden Variables: EM Algorithm.

Reading:

1. Stuart Russell, Peter Norvig, *Artificial Intelligence -A Modern Approach*, 3/e, Pearson, 2003.
2. Nils J Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann Publications, 2000.

CS372	SOFTWARE METRICS AND SOFTWARE PROJECT MANAGEMENT	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the software measurement attributes and metrics
CO2	Plan and evaluate software projects
CO3	Analyze factors involved in implementation of software projects.
CO4	Understand project monitoring and control techniques

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	1	1	1	1	1	1	1	1	2	1	3	3
CO2	1	2	2	3	2	1	1	1	1	1	1	1	2	1	3	3
CO3	1	1	2	3	1	1	1	1	2	1	1	1	2	1	3	3
CO4	1	1	1	3	3	1	1	1	1	1	1	1	2	2	2	3

Detailed syllabus:

The Basics of Measurement: Measurement in software engineering, The scope of software metrics, the representational theory of measurement, Measurement and models, Measurement scales and scale types, Meaningfulness' in measurement

Goal-based framework for software measurement: Classifying software measures, determining what to measure, applying the framework, Software measurement validation

Empirical investigation: Principles of investigation, planning formal experiments, planning case studies

Measuring internal product attributes: Aspects of software size, Length, reuse

Measuring internal product attributes; Types of structure measures, Control-flow structure, and Modularity and information flow attributes, Object-oriented metrics

Measuring external product attributes: Modeling software quality, measuring aspects of quality

Making process predictions: Good estimates, Cost estimation - problems and approaches, Models of effort and cost, Problems with existing modeling methods, Dealing with problems of current estimation methods, Implications for process prediction

Software Project Management: General management, introduction to software project management, Conventional software management, project initiation, feasibility study, project planning, project evaluation, resource allocation, project monitoring, project control, case studies

Reading:

1. Norman E. Fenton, Shari Lawrence Pfleeger, *Software Metrics - A Rigorous and Practical Approach*, 2nd Edition, PWS Pub, 1996.
2. Walker Royce, *Software Project Management*, Addison Wesley, 1998.
3. Pankaj Jalote, *Software Project Management in Practice*, Pearson Education Inc. Delhi, 2002.

CS373	SOFTWARE TESTING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze Various test processes and continuous quality improvement
CO2	Analyze Types of errors and fault models
CO3	Modeling the behavior using FSM
CO4	Application of software testing techniques in commercial environments
CO5	Analyze various test tools

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	1	1	2	2	2	2	1	2	1	3	3
CO2	2	2	2	3	2	1	1	1	1	1	2	1	2	1	3	3
CO3	3	1	2	3	2	1	1	1	2	1	2	1	3	3	3	3
CO4	2	2	1	3	3	2	2	2	2	1	2	1	3	2	2	3
CO5	2	2	1	2	1	1	1	1	1	2	1	1	2	1	3	3

Detailed syllabus:

Introduction, Purpose of testing, Dichotomies, model for testing, consequences of bugs, taxonomy of bugs Flow graphs and Path testing: -Basics concepts of path testing, predicates, path predicates and achievable paths, path sensitizing, path instrumentation, application of path testing.

Transaction Flow Testing:-transaction flows, transaction flow testing techniques. Dataflow testing:- Basics of dataflow testing, strategies in dataflow testing, application of dataflow testing.

Domain Testing:-domains and paths, Nice & ugly domains, domain testing, domains and interfaces testing, domain and interface testing, domains and testability.

Paths, Path products and Regular expressions: - path products & path expression, reduction procedure, applications, regular expressions & flow anomaly detection.

Logic Based Testing:-overview, decision tables, path expressions, kV charts, specifications.

State, State Graphs and Transition testing:-state graphs, good & bad state graphs, state testing, Testability tips.

Graph Matrices and Application:--Motivational overview, matrix of graph, relations, power of a matrix, node reduction algorithm, building tools.

Reading:

1. Software Testing techniques, Baris Beizer, Dreamtech, second edition.
2. The craft of software testing, Brian Marick, Pearson Education.

CS374	Quantum Computing	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS201-Discrete Mathematics

Course Outcomes: At the end of the course, student will be able to:

CO1	Demonstrate fundamental concepts of quantum computing
CO2	Explain the basic architecture of Quantum computing using qubit
CO3	Analyze the applications of Quantum Computing Algorithms
CO4	Develop applications using Quantum Programming

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	2	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3	-

Detailed Syllabus:

Mathematics: Complex Numbers; Complex Vector Spaces

Leap from Classical to Quantum: Classical Deterministic Systems; Probabilistic Systems, Quantum Systems, Assembling Systems

Basic Quantum Theory: Quantum States, Observables; Measuring; Dynamics; Assembling Quantum Systems

Architecture: Bits and Qubits; Classical Gates; Reversible Gates; Quantum Gates

Algorithms: Deutsch's Algorithm; Deutsch–Jozsa Algorithm; Simon's Periodicity Algorithm; Grover's Search Algorithm; Shor's Factoring Algorithm

Programming Languages: Programming in a Quantum World; Quantum Assembly Programming; Toward Higher-Level Quantum Programming; Quantum Computation Before Quantum Computers

Reading:

1. Noson S. Yanofsky, Mirco A. Mannucci, *Quantum Computing for Computer Scientists*, Cambridge University Press, 1st Edition, 2008
2. Eleanor G. Rieffel, Wolfgang H. Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011

CS375	**ADVANCED DATA MINING**	**DEC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze Algorithms for sequential patterns
CO2	Determine patterns from time series data
CO3	Develop algorithms for Temporal Patterns
CO4	Distinguish computing frameworks for Big Data analytics.
CO5	Apply Graph mining algorithms to Web Mining.

Course Articulation Matrix

CO \ PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	1	1	-	1	-	-	1	-	-	3	-	3	2
CO2	2	3	2	2	3	-	-	1	-	1	-	1	3	-	3	2
CO3	2	1	3	2	2	1	1	-	2	-	1	1	3	-	3	1
CO4	2	2	2	1	2	1	1	-	1	1	-	-	2	2	3	1
CO5	2	3	2	3	3	1	-	1	1	-	-	1	3	2	3	1

Detailed syllabus:

Sequential Pattern Mining concepts, primitives, scalable methods; Transactional Patterns and other temporal based frequent patterns, Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis; Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams, Class Imbalance Problem; Graph Mining, Mining frequent subgraphs, finding clusters, hub and outliers in large graphs, Graph Partitioning; Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining, Distribute data mining framework, Distributed data source, Distributed data mining techniques, Distributed classifier learning, distributed clustering, distributed association rule mining and Challenges of distributed data mining; Social Network Analysis, characteristics of social Networks.

Reading:

1. J Han and M Kamber, *Data Mining Concepts and Techniques*, 2nd Edition, Elsevier, 2011

2. Pang Ning Tan, M Steinbach, Vipin Kumar, *Introduction to Data Mining*, Addision Wesley, 2006
3. G Dong and J Pei, *Sequence Data Mining*, Springer, 2007.

CS376	**BIO-INFORMATICS**	**DEC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the theoretical basis behind bioinformatics.
CO2	Compute homologues, analyse sequences, construct and interpret evolutionary trees.
CO3	Analyse protein sequences, identify proteins, and retrieve protein structures from databases.
CO4	Understand homology modelling and computational drug design.
CO5	Determine and model biological information and apply this to the solution of biological problems in any arena involving molecular data.

Course Articulation Matrix

PO/PSO / **CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	-	2	-	3	-	-	1	-	-	-	-	1	1	2	-
CO2	-	2	3	-	-	1	2	3	-	2	-	-	1	1	3	1
CO3	3	-	2	-	3	-	-	-	3	-	-	3		2	3	1
CO4	2	3	2	3	2	-	-	3	-	1	2	-	1	1	3	1
CO5	-	1	3	-	1	-	3	-	2	2	3	3	1	2	2	-

Detailed syllabus:

Introduction to Bioinformatics: What is a Data Base, Types of Databases, Biological Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases, Pair wise Sequence Alignment: Evolutionary Basics, Sequence homology versus similarity, Sequence similarity versus Identity, Scoring Matrices, Statistical Significance of Sequence alignment, Database similarity searching: Unique requirement of Database searching, Heuristic Database searching, Basic alignment search tool: Comparison of FASTA and BLAST, Multiple Sequence Alignment, Scoring Function, Exhaustive Algorithms, Heuristic Algorithms, Gene Prediction, Categories of gene prediction programs, Gene prediction in prokaryotes and Eukaryotes, Phylogenetics Basics Molecular phylogenetics and molecular basics Gene phylogeny versus species phylogeny, Forms of tree representation, Why finding a true tree is difficult, Phylogenetic tree construction methods and programs Protein structure basics: Amino acid, peptide formation, Dihedral Angles, Hierarchy, Secondary structures, Tertiary structure, Determination of protein 3-D structure, Protein structure data base, Genome mapping, assembly and comparison, Genome mapping, Genome sequencing, Genome sequence assembly, Genome Annotation, Comparative genomics, Functional Genomics, Sequence based approaches, Microarray based approaches, Comparisons of SAGE and DNA microarray.

Reading:

1. Jin Xiong, *Essential Bioinformatics*, 1th Edition, Cambridge University Press, 2011.
2. Arthur M Lesk, *Introduction to Bioinformatics*, 2nd Edition, Oxford University Press, 2007.

CS377	HUMAN COMPUTER INTERACTION	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Describe the capabilities of both humans and computers from the viewpoint of Human information processing.
CO2	Describe what interaction design is and how it relates to human computer Interaction and other fields.
CO3	Describe typical HCI models, styles, and various historic HCI paradigms.
CO4	Discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.
CO5	Create, justify, and critique interface designs using appropriate theoretical and Methodological HCI frameworks.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	1	1	-	-	-	1	1	1	-	1	1	-	1
CO2	2	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-
CO3	-	-	-	2	2	-	1	-	-	-	2	1	-	-	-	-
CO4	2	-	1	`1	1	1	-	-	2	1	-	1	1	2	-	1
CO5	-	1	2	1	2	2	2	-	1	2	1	2	1	-	2	-

Detailed syllabus:

Introduction: Usability of Interactive Systems- Usability goals and measures, usability motivations, universal usability, goals for Professional Managing design processes: Introduction, Organizational design to support usability, Four pillars of design, Development methodologies, Ethnographic observation, Participatory design, Scenario Development, Social impact statement for early design review, legal issues, Usability Testing and Laboratories.

Design: Introduction, Task- Related Menu Organization, Single menus, Combinations of Multiple Menus, Content Organization, Fast Movement Through Menus, Data entry with Menus: Form Fill-in, dialog Boxes, and alternatives, Audio Menus and menus for Small Displays.

Command and Natural Languages: Command organization Functionality, Strategies and Structure, Naming and Abbreviations, Natural Language in Computing Interaction Devices: Introduction, Keyboards and Keypads, Pointing Devices, Speech and Auditory Interfaces, Displays- Small and large.

Quality of Service: Models of Response-Time impacts, Expectations and attitudes, User Productivity, Variability in Response Time, Frustrating Experiences Balancing Function and Fashion: Introduction, Error Messages, Nonanthropomorphic Design, Display Design, Web Page Design, and Window Design.

Documentation and Information Search: Online Vs Paper Documentation, Reading from paper Vs from Displays, Shaping the content of the Documentation, Accessing the Documentation, Online tutorials and animated documentation, online communities for User Assistance, The Development Process, Searching in Textual Documents and Database Querying, Multimedia Document Searches.

Reading:

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven M Jacobs, Designing the User Interface, Strategies for Effective Human Computer Interaction, 5ed, Pearson
2. Wilbert O Galitz, The Essential guide to user interface design,2/e, Wiley DreamaTech.

CS378	Intrusion Detection Systems	DEC	3-0-0	3 Credits

Pre-requisites: CS02-Operating systems, CS352- Computer Networks

Course Outcomes: At the end of the course, student will be able to:

CO1	Explore the concepts of Network Protocol Analysis, and analyze information systems and networked systems
CO2	Identify system vulnerabilities and attacks, and troubleshoot system problems
CO3	Design and Develop intrusion detection systems& intrusion prevention systems and identify their signatures
CO4	Select technologies and tools for intrusion detection and intrusion prevention
CO5	Exercises and use cases for testing and evaluating various IDS techniques.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	1	-	-	-	1	-	2	-	-	-	2	-	2	1	-
CO2	2	1	-	1	-	1	-	1	-	-	-	2	-	1	1	2
CO3	1	1	1	1	2	-	1	-	1	2	-	-	1	1	-	2
CO4	-	2	-	-	1	-	-	-	1	2	-	1	-	1	-	1
CO5	2	-	1	2	2	-	1	-	-	-	1	-	2	-	1	1

Detailed syllabus

Firewall Planning and Design, Developing a Security Policy, System Configuration Strategies, Working with Proxy Servers and Application-Level Firewalls, Authenticating Users, Encryption and Firewalls.

Intrusion detection, Audit, Internaland external threats to data, attacks, Informationsources - Host based information sources, and Network based informationsources; Types and classification of IDS.

Intrusion Prevention Systems, NetworkSystems, Network IDs protocol based IDs ,HybridIDs, Analysis schemes,models for intrusion analysis, techniques, mappingresponses to policy vulnerability analysis, credential analysis noncredential analysis

IDS using SNORT, NIDS, NNID and HIDS;

Discovery and Detection: Identify IDS signatures such as anomaly detection, pattern matching andstatistical analysis; Machine Learning models for IDS, Distributed IDS models; Architecture models of Intrusion Detection and intrusion prevention.

Reading:

1. RafeeqRehman: “Intrusion Detection with SNORT, Apache, MySQL, PHP and ACID,” Prentice Hall, 2003.
2. Christopher Kruegel, FredrikValeur, Giovanni Vigna: “IntrusionDetection and Correlation Challenges and Solutions”, Springer, 2005.
3. Carl Endorf, Eugene Schultz and Jim Mellander“IntrusionDetection & Prevention”, Tata McGraw-Hill, 2004.
4. Stephen Northcutt, Judy Novak: “Network IntrusionDetection”, New Riders Publishing, 2002.

CS401	MACHINE LEARNING	PCC	4 – 0 – 0	4 Credits

Pre-requisites: CS204- Data Structures and Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand instance based learning algorithms
CO2	Design neural network to solve classification and function approximation problems
CO3	Build optimal classifiers using genetic algorithms
CO4	Design convolutional networks to solve classification problems

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	-	1	-	-	1	-	-	2	1	2	2
CO2	2	1	2	2	2	-	1	-	-	1	-	-	2	2	2	2
CO3	2	1	1	2	2	-	1	-	-	1	-	-	2	2	2	2
CO4	2	2	2	2	2	1	2	-	-	1	1	-	2	2	3	3

Detailed syllabus:

Introduction – Well defined learning problems, Designing a Learning System, Issues in Machine Learning; - The Concept Learning Task - General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias - Decision Tree Learning - Decision tree learning algorithm-

Inductive bias- Issues in Decision tree learning; - Artificial Neural Networks – Perceptrons,Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of backpropagation rule-Backpropagation Algorithm- Convergence, Generalization; – Evaluating Hypotheses – Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms; - Bayesian Learning – Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm; - Computational Learning Theory – Sample Complexity for Finite Hypothesis spaces, Sample Complexity for Infinite Hypothesis spaces, The Mistake Bound Model of Learning; - Instance-Based Learning – *k*-Nearest Neighbor Learning, Locally Weighted Regression, Radial basis function networks, Case-based learning - Genetic Algorithms – an illustrative example, Hypothesis space search, Genetic Programming, Models of Evolution and Learning; Reinforcement Learning - The Learning Task, *Q* Learning, Support vector Machines, Deep learning networks – Deep Feedforward Networks – Regularization for Deep Learning – Optimization for Training Deep Models – Convolutional Networks.

Reading:

1. Tom.M.Mitchell, *Machine Learning*, McGraw Hill International Edition, 1997.

2. C Bishop – Pattern Recognition and Machine Learning – Springer, 2006.
3. Ian Goodfellow, Yoshua Bengio, AaronCourville – Deep Learning, The MIT Press Cambridge, Massachusetts, London, England, 2016

CS402	CRYPTOGRAPHY AND NETWORK SECURITY	PCC	4 – 0 – 0	4 Credits

Pre-requisites: CS352- Computer Networks

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze encryption algorithms.
CO2	Apply cryptographic algorithms to build secure protocols
CO3	Identify system vulnerabilities of communication protocols
CO4	Design of secure protocols to solve real world scenario

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	1	-	-	-	-	1	-	1	2	2	-	-	2
CO2	2	3	3	3	3	1	-	-	2	-	2	3	2	1	-	3
CO3	-	2	-	2	3	1	1	-	3	2	3	3	-	-	1	2
CO4	2	1	3	3	3	2	1	2	3	2	3	3	2	2	3	3

Detailed syllabus

Security Goals and Services: Definitions – Threat; Vulnearbilitis; Attacks – Classifications of attacks; Security services; Security mechanisms

Number theory: Introduction to number theory – Modular Arithmetic; Finite fields; Number theory properties – Primality testing; Fetmat's and Euler's theorem; Chinese remainder theorem; Integer factorization; discrete logarithm

Cryptographic algorithms : Private key algorithms – Classical Encryption techniques;Stream ciphers ;Block cipher modes; DES;AES; Random number generators; Public key algorithms-Principles of Public key Cryptography; RSA; Deffie-Hellman;ElGamal;Elliptic Curve Cryptography

Security mechanisms: Key management and Distribution-Certificate authorities; PKI; MAC; Hashing; Digital Signatures-Authentication protocols; Digital Signature Standard;

Introduction to network security: Network security threats; Vulnerabilities - Denial-of-service/Distributed denial-of-service attacks; Spoofing, Man-in-the-middle, Replay, TCP/Hijacking, Fragmentation attacks, Weak keys, Mathematical attacks, Social engineering, Port scanning, Dumpster diving, Birthday attacks, Password guessing, Software exploitation, Inappropriate system use, Eavesdropping, War driving, TCP sequence number attacks, War dialing/demon dialing attacks.

Internet Protocols: TCS; DNS and routing

Network Defense Tools: Firewalls- Firewall Properties; Design of firewalls; VPN’s; Filtering; Intrusion detection
Security protocols – Network and transport layer security- SSL/TLS, IPsec IKE; IPsec AH, ESP; Application security- Kerberos; S/MIME; PGP; PKI;

Reading:

1. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: Private Communication in a Public World, Prentice Hall, 2002
2. William Stallings, Cryptography and Network Security, 6th edition Pearson Education, 2014
3. A. Menezes, P. Van Oorschot, S. Vanstone, Handbook of Applied Cryptography, CRCPress, 2004

CS403	ADVANCED ALGORITHMS	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS204-Data structures and Algorithms, CS252-Design and Analysis of Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze time and space complexities of algorithms using asymptotic analysis.
CO2	Analyze amortized time complexity.
CO3	Classify problems into different complexity classes.
CO4	Analyze approximation algorithms and determine approximation factor.
CO5	Design FPT algorithms for some intractable problems.
CO6	Design and analyze efficient randomized algorithms.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	-	1	-	-	-	-	1	3	1	1	2
CO2	2	2	1	-	-	-	-	-	-	-	-	-	3	1	1	2
CO3	2	2	2	1	1	-	1	-	-	-	-	-	3	1	2	2
CO4	3	2	2	2	-	-	1	-	-	-	-	-	2	-	1	-
CO5	3	2	2	2	-	-	-	-	-	-	-	-	2	-	1	-
CO6	3	2	2	2	-	-	1	-	-	-	-	-	2	-	1	-

Detailed syllabus:

Algorithm design techniques: Overview, Tree related dynamic programming, The Cheriton-Tarjan algorithm for minimum spanning tree, Backtracking algorithm for finding a maximum independent set/clique, Enumerating cliques

Amortized Analysis: Three approaches to amortized analysis, Disjoint-sets, Fibonacci heap

NP-completeness: Polynomial-time solvability, Polynomial-time verification, NP-completeness and reducibility

Approximation Algorithms: One way of coping with NP-Hardness, The vertex cover problem, The set cover problem, The connected dominating set problem, The graph coloring problem, The traveling-sales person problem, The bin packing problem.

Fixed-Parameter Algorithms-: Another Way of Coping with NP-Hardness, Parameterized Complexity, Bounded search tree, Kernelization, The vertex cover problem, the dominating set problem.

Randomized Algorithms: Las Vegas and Monte Carlo algorithms, Karger's min cut algorithm and improvements to it by Karger and Stein, Randomized selection, The stable marriage problem, The coupon collector`s problem.

Reading:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, *Introduction to Algorithms*, Third Edition, PHI, 2009.
2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, *Fundamentals of Computer Algorithms*, Second Edition, Universities Press, 2011.
3. Michael T. Goodrich and Roberto Tamassia, *Algorithm Design: Foundations, Analysis and Internet Examples*, Second Edition, Wiley-India, 2006.
4. Herbert S. Wilf, *Algorithms and Complexity*, AK Peters Ltd., 2003.
5. Michael R. Garey and David S. Johnson, *Computers and Intractability: A Guide the theory of NP-Incompleteness*, W.H. Freeman & Co., 1979.
6. Rodney G. Downey and M. R. Fellows, *Parameterized Complexity*, Springer, 2012.
7. Vijay V. Vajirani, *Approximation Algorithms*, Springer, 2001.
8. Rajeev Motwani and Prabhakar Raghavan, *Randomized Algorithms,* Cambridge University Press, 1995.

CS404	Internet of Things	PCC	2 – 0 – 2	3 Credits

Pre-requisites: CS252-Design and Analysis of Algorithms, CS204-Data Structures and Algorithms, CS352- Computer Networks

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the protocol Stack for Internet of Things to address the heterogeneity in devices and networks
CO2	Develop smart IoT Applications using smart sensor devices and cloud systems
CO3	Development of smart mobile apps for societal applications
CO4	Design secure protocols for IoT systems

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	-	-	-	-	-	-	2	2	2	2	2	2
CO2	3	3	3	3	3	2	2	-	2	2	2	2	2	2	3	3
CO3	3	3	3	3	3	2	2	-	2	2	2	2	2	3	2	3
CO4	2	2	2	`2	2	-	-	-	-	-	2	2	2	3	-	3

Detailed syllabus:

Introduction to IoT architectures, Communication Standards, M2M and Smart IoT Technology, Sensor based Solutions and RFIDs in IoT, Data Link Layer Protocols, Network Layer Protocols, Application oriented communication protocols, Data Acquiring and Storage, Cloud Service models for IoT, Business Models in IoT, Prototyping Embedded Device Software, Web APIs, Hardware platforms, Smart Applications, Mobile app developments for IoT, Machine leaning algorithms for IoT Systems, Vulnerabilities, Security Requirements and Threat Analysis, IoT Security Tomography and Layered Attacker model, Access control methods, Privacy Issues in IoT Architectures, Programming with Raspberry Pi, Data acquisition with a Cloud platform, Implementing smart IoT applications through web APIs.

Reading:

1. Arshdeeep Bahga, Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2015
2. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education private limited, 2017
3. Kai Hwang, Min Chen, Big Data Analytics for Cloud, IoT and Cognitive Computing, Wiley, 2018

CS405	MACHINE LEARNING LABORATORY	PCC	0 – 0 – 2	1 Credits

Pre-requisites: CS204- Data Structures and Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Design and implement algorithm using least means square learning rule to play checkers game
CO2	Design a classifier using Genetic Algorithm..
CO3	Apply supervised learning using perceptron
CO4	Design and implement Convolutional Networks to solve classification problem.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	-	1	-	-	1	-	-	2	1	2	1
CO2	2	1	2	2	2	-	1	-	-	1	-	-	2	1	2	2
CO3	2	1	1	2	2	-	1	-	-	1	-	-	1	1	1	1
CO4	2	2	2	2	2	1	2	-	-	1	1	-	2	2	2	2

Detailed Syllabus

1. Design and implement machine learning algorithm using least means square learning rule to play checkers game. The training experience should be generated by the system playing game with itself.
2. Implement a genetic algorithm program to successfully classify examples in the restaurant domain problem.
   Data for RESTAURANT domain given in this table.

Example	Friday	Patrons	Price	Rain	Res	Est	Type	Will Wait
X1	No	Some	High	No	Yes	0-10	French	Yes
X2	No	Full	Low	No	No	30-60	Thai	No
X3	No	Some	Low	No	No	0-10	Burger	Yes
X4	Yes	Full	Low	Yes	No	10-30	Thai	Yes
X5	Yes	Full	High	No	Yes	>60	French	No
X6	No	Some	Med	Yes	Yes	0-10	Italian	Yes
X7	No	None	Low	Yes	No	0-10	Burger	No

X8	No	Some	Med	Yes	Yes	0-10	Thai	Yes
X9	Yes	Full	Low	Yes	No	>60	Burger	No
X10	Yes	Full	High	No	Yes	10-30	Italian	No
X11	No	None	Low	No	No	0-10	Thai	No
X12	Yes	Full	Low	No	No	30-60	Burger	Yes

Res indicates reservation made and Est means estimated waiting time to get table, WillWait target attribute indicates whether to wait for table in that restaurant.

3. Design a feed forward neural network using back propagation algorithm to to solve and written character recognition problem for A to Z and 0 to 9 letters.
4. Implement perceptron learning algorithm and attempt to solve two input i) AND gate ii) Or Gate iii) EXOR gate problems.
5. Implement Adaline learning algorithm and attempt to solve two input i) AND gate ii) Or Gate iii) EXOR gate problems.
6. Implement a Genetic algorithm to generate solutions for 8-Queens problem.
7. Implement a machine learning program to play 5× 5 Tic tac toe game. The program should use least means square learning rule.
8. Design a Convolutional network for handwritten character recognition problem for A to Z and 0 to 9 digits.

Reading:

1. Tom.M.Mitchell, *Machine Learning*, McGraw Hill International Edition
2. C Bishop – Pattern Recognition and Machine Learning – Springer, 2006.
3. Ian Goodfellow, Yoshua Bengio, AaronCourville – Deep Learning, The MIT Press Cambridge, Massachusetts, London, England.

CS406	Security Laboratory	PCC	0-0-2	1 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Implement Cryptographic algorithms
CO2	Analyze the network traffic and simulate the attacks
CO3	Design and implement security protocols
CO4	Analyse the protocol using security tools

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	-	2	-	-	-	1	-	1	2	1	2	-	2
CO2	-	3	3	2	3	1	-	-	1	-	1	2	-	-	3	3
CO3	3	2	3	3	3	1	1	1	3	2	3	3	3	2	3	3
CO4	-	3	2	1	3	2	1	1	2	2	3	3	-	-	1	3

Detailed syllabus

Cycle 1: Number theory and Cryptographic experiments -

1) Installation of GMP library
2) Euclidean algorithm for computing the GCD of two integers
3) Extended Euclidean algorithm
4) Modular Arithmetic over Zn
5) Polynomial Arithmetic over GF(2^n)
6) Substitution Technique
7) DES
8) AES
9) Chinese Remainder Theorem
10) RSA
11) Diffie-Hellman Key Exchange
12) Elgamal Cryptographic System
13) Elliptic curve cryptography
14) Elgamal and DSS Digital signature scheme

Cycle 2: Network Security experiments

1. Design and Implement a protocol with the details as given below

a. User A likes to allow to read his encrypted messages by User B without revealing his private key
b. User A generates a new key pair which is shared between User B and Proxy
c. User A delegates a proxy to reencrypt /partial decrypt the encrypted message of User A using new key in the key pair
d. Proxy sends the modified encrypted message to UserB
e. User B decrypts the encrypted message using new key in the key pair

Use key exchange algorithm between User A and Proxy, User A and User B

Encryption and decryption can be using any PKC

2 A network in which the nodes are logically connected using tree structure, a layered encryption and decryption is followed in the protocol. Design and code the protocol with the following details

1. The nodes are divided into left sub tree and right sub tree
2. Among the nodes in the same level one is elected as leader on both left and right subtree separately.
3. There is only one key is allotted at each level
4. The key is shared among all nodes in the same level
5. When the document is to be encrypted the leader collects the shares from other nodes and encryption is done by the leader
6. The encrypted document travels from lower level to upper level through leader in left sub tree and encrypted at each level
7. When the document reaches root it travels from higher level to lower level
8. Each level the key for decryption is collected by leader from the nodes in the same level
9. Decryption is done at each level and reaches a destination.

3. A network in which each node can act as a client or server for the other computers in the network, allowing shared access to various resources such as files, peripherals, etc without the need for a central server.

- Design and code security association/agreement between server and client b.
- Procedure for key management c.
- Design and code for authentication between server and client vice versa

4. Design and implement a communication system with the following details

- The users are divided logically into groups.
- Each user can have many public and private key pairs.
- Each users maintains a table in which public key is stored.
- Each user maintains private keys in another table along with the id of the public key which is in encrypted form.
- The encryption and decryption is based on the public key id sent along with the cipher text. Use any public key cryptography for encryption and decryption

5. Design and implement secure communication between two groups A and B:

- A server is connected to n number of registered users.
- The users are divided into two groups such as A and B.

- Members can be added and removed dynamically.
- The communication is between two group leaders (Assume the leaders are already elected).
- Each group leader authenticates his members by using any authentication technique before any communication happens.
- The server generates a common (public key, private key) for each group and divides the private key into shares and dispatches to the users of respective groups.
- A user from group A can communicate to group B user through the leader and vice versa.
- The encryption and decryption is using key par (public key, private key), which is the common practice.

6. Implement PGP email security - The design is available in the text book

7. Implement Kerberos version 4 authentication protocol between server and the client - The design is available in the text book

Cycle 3: Security tools

1. Introduction to Packet sniffing tools
2. Penetration testing tools
3. Internet security protocols validation tool – AVISPA
4. Network intrusion detection and prevention system - Snort

Reading:

1. GNU-MP Manual
2. A. Menezes, P. Van Oorschot, S. Vanstone, Handbook of Applied Cryptography, CRC Press, 2004
3. Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: Private Communication in a Public World, Prentice Hall, 2002

CS411	Privacy Preserving Data Analysis	DEC	3-0-0	3 Credits

Pre-requisites: CS302-Operating systems, CS352-Computer Networks

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply anonymization methods for sensitive data protection.
CO2	Apply state-of art techniques for data privacy protection
CO3	Design privacy preserving algorithms for real-world applications.
CO4	Identify security and privacy issues in OLAP systems
CO5	Apply information metrics for Maximizing the preservation of information in the anonymization process.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	2	-	1	2	-	-	-	-	1	2	-	2	1
CO2	-	1	-	-	2	-	-	-	-	1	-	1	1	-	2	-
CO3	1	-	1	1	1	-	-	-	2	1	1	-	1	1	1	-
CO4	-	2	-	2	-	1	1	2	2	-	2	-	-	1	-	2
CO5	1	-	2	1	-	2	-	-	-	-	1	-	-	2	1	1

Detailed syllabus

1. privacy issues and privacy models
2. Anonymization: Operations on Anonymization, Information metrics, Anonymization methods for the transaction data, trajectory data, social networks data, and textual data. Collaborative Anonymization
3. Access control methods for outsourced data
4. Use of Fragmentation and Encryption to Protect Data Privacy;
5. Security and Privacy in OLAP systems.
6. Extended Data publishing Scenarios
7. Anonymization for Data Mining and social media data

Reading:

1. Benjamin C.M. Fung, Ke Wang, Ada Wai-Chee Fu and Philip S. Yu, **Introduction to Privacy-Preserving Data Publishing: Concepts and Techniques,** 1st Edition, Chapman & Hall/CRC, 2010.
2. Charu C. Aggarwal, **Privacy-Preserving Data Mining: Models and Algorithms**, 1st Edition, Springer, 2008.

CS412	Semantic Web	DEC	3-0-0	3 Credits

Pre-requisites: CS311-Web Technologies, CS204-Data Structures and Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the standards and data formats used in the Semantic Web
CO2	Comprehend technologies including XML and XSLT
CO3	Design semantic web meta data and RDF schema
CO4	Develop ontology programming with Jena API

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	-	1	-	-	2	-	2	-	-	-	-	1	1
CO2	-	1	2	-	2	1	2	-	-	-	-	2	-	1	2	1
CO3	2	1	1	1	2	1	-	1	2	1	2	1	1	1	2	1
CO4	-	-	1	1	1	2	1	-	1	-	-	1	2	1	1	1

Detailed syllabus

The Semantic Web Vision, overview of techniques and standards, Semantic Web Architecture, XML with Document Type Definitions and Schemas, Transformation/Inference rules in XSLT, RuleML and RIF, metadata with RDF (Resource Description Framework); metadata taxonomies with RDF Schema; Ontology languages, Ontology Development using Protege editor, Ontology Querying, Ontology Reasoning and Description Logic (DL), Semantic Web Application Areas, Ontology programming with Jena API, Ontology Engineering.

Reading:

1. Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, 1st Edition, MIT Press, 2004.
2. John Hebeler, Matthew Fisher, Ryan Blace and Andrew Perez-Lopez, Semantic Web Programming, 1st Edition, Wiley, 2009.

CS413	Big Data Analytics	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS254-Database Management Systems, CS303- Data Warehousing and Data Mining

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand big data challenges in different domains including social media, transportation, finance and medicine
CO2	Analyze scalability and performance of relational model, SQL and emergent systems.
CO3	Comprehend machine learning and algorithms for data analytics.
CO4	Understand the capability of No-SQL systems
CO5	Analyze Map-Reduce programming model for better optimization

Course Articulation Matrix

CO \ PO|PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	-	-	1	1	-	-	-	1	-	-	-	1	-
CO2	2	1	2	2	-	-	-	2	2	-	-	1	-	2	2	2
CO3	2	-	-	2	-	2	-	-	-	2	2	1	2	-	2	-
CO4	-	1	-	1	-	-	2	2	2	2	-	-	-	2	1	2
CO5	1	-	2	-	2	-	-	-	1	-	2	2	1	2	1	-

Detailed syllabus:

Big Data – An Introduction: Big Data - Definition, overview of Big Data; HPC & Big Data, Big Data Characteristics, Issues and challenges of Big Data, Stages of analytical evolution, State of the Practice in Analytics, Big Data Architecture – space of Big Data: Transactions, Interactions, Observations; Big data Technological approaches and Potential use cases for Big Data.

Big Data Analytics – Big Data Mining, Big Data Analytics in Industry Verticals, Data Analytics Lifecycle. Unstructured Data Analytics - Text Analytics; Big Data Visualization Techniques; Advanced system Approaches for Analytics – In-Database Analytics and In-memory Databases. **The Hadoop Ecosystem** - Advantages of Hadoop, Query languages for Hadoop, Hadoop Distributed File System, HDFS, Overview of HBase, Hive and PIG,

Big Data Processing Algorithms: Distributed Algorithms, MapReduce Framework and MapReduce Programming – The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners; Advanced MapReduce Techniques, Scalable Algorithms – Algorithms using Map Reduce.

Technologies and Tools for Big Data Analytics: Data Analytic Methods Using R, Spreadsheet-like analytics, Mining Data Streams, Machine learning with Mahout, SPARK.

NoSQL Databases – Review of traditional Databases, Need for NoSQL Databases, Columnar Databases, Failover and reliability principles, working mechanisms of NoSQL Databases – HBase, Cassandra, Couch DB, Mango DB.

Challenges for Big Data & Analytics: Data models for managing big data, Real-time streaming data analytics, Scalable analytics on large data sets, Systems architecture for big data management, Main memory data management techniques, energy-efficient data processing, Benchmarking big data systems, Security and Privacy of Big Data, Failover and reliability for big data systems, Social Network Analytics, Applications of Big Data.

Reading:

1. Big Data – A Primer, H. Mohanty, P. Bhuyan, D. Chenthati (Eds.), Springer , Studies in Big Data, vol. 11, 2015.
2. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, Cambridge Universities Press, 2012.
3. Big Data Analytics with R and Hadoop, Vignesh Prajapati, PACKT Publishing
4. Bill Franks, Taming *The Big Data Tidal Wave*, 1st Edition, Wiley, 2012.
5. Frank J. Ohlhorst, *Big Data Analytics*, 1st Edition, Wiley, 2012.

CS414	HETEROGENEOUS COMPUTING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand different models of parallel programming and the usage of MPI and OpenMP libraries
CO2	Analyze for the performance of GPU memory hierarchy
CO3	Develop parallel programs using OpenCL library
CO4	Generate parallel programs for matrix, graph and sorting problems using Cuda library
CO5	Develop mixed mode programs for Multicore and GPGPU systems

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	2	-	-	-	-	-	-	2	2	-	-
CO2	3	2	2	2	2	2	-	-	-	-	-	-	2	2	-	3
CO3	3	3	3	3	2	2	-	-	-	-	-	-	3	3	2	2
CO4	3	3	3	3	3	3	-	-	-	-	-	-	3	3	-	2
CO5	2	3	3	3	3	2	-	-	-	-	-	-	3	3	-	2

Detailed syllabus:

Programming using message passing paradigm: Principles, building blocks, MPI, Topologies and embedding, Overlapping communication and computation, collective communication operations, Groups and communicators

Programming shared address space platforms: Threads, POSIX threads, Synchronization primitives, attributes of threads, mutex and condition variables, Composite synchronization constructs, OpenMP Threading Building blocks; An Overview of Memory Allocators, An overview of Intel Threading building blocks.

GPU Computing - Introduction : Introduction to General Purpose Computing on Graphic Processing Units (GPGPU); GPU as parallel computers – CUDA enabled NVIDIA GPUs; AMD-ATI-OpenCL, GPGPU Architecture of a Modern GPU – Threaded Streaming Multi-processors; communication bandwidth; Unified Graphics and Computing Processors; GPGPU- GPU computing – Scalable GPUs; Speed-up & Parallelism; CPU/GPU programing; SPMD programming model

CUDA APIs & CUDA Threads - GPUs-Data Parallelism; GPU-CUDA Program Structure; GPU device memories & Data transfer; Kernel functions and threading; CUDA Runtime API; CUDA Thread Execution; CUDA Thread organization; Synchronization; Thread Scheduling;

OpenCL (Open Computing Language) : Heterogeneous Computing – Programming; Data Parallelism Model – OpenCL; OpenCL, Device Architecture; OpenCL Kernel Functions; OpenCL APIs – Matrix-Matrix, Computations using different partitioning techniques– OpenCL; OpenCL – Device Management and Kernel launch; Compilation Model and programming features of OpenCL – Device query; Object Query, and task parallelism model

Mixed Programming - Multi-Core Processors & GPUs : Heterogeneous computing – mixed programming (Message Passing-MPI and Shared Memory Programming (Pthreads, OpenMP); Heterogeneous computing - mixed programming – CPU (Pthreads, OpenMP) & GPU (CUDA, OpenCL); MPI-OpenCL & MPI-CUDA ; Programming for Dense Matrix Computations

Reading:

1. Benedict R Gaster, Lee Howes, David R Kaeli Perhaad Mistry Dana Schaa, *Heterogeneous Computing with OpenCL,* MGH, 2011
2. Jason Sanders, Edward Kandrot, *CUDA By Example – An Introduction to General-Purpose GPU Programming,* Addison Wesley, 2011
3. Michael J Quinn, Parallel Programming in C with MPI and OpenMP, TMH, 2004

CS415	**Cloud Computing**	**DEC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: CS352-Computer Networks, CS302-Operating Systems
Course Outcomes**:**

CO1	Determine Cloud Computing Architectures and Services for various societal applications
CO2	Analyze Cloud infrastructure including Google Cloud and Amazon Cloud.
CO3	Develop private and hybrid cloud for organizations to execute customized applications
CO4	Analyze authentication, confidentiality and privacy issues in Cloud computing environment.
CO5	Determine financial and technological implications for selecting cloud computing platforms

Course Articulation Matrix

CO \ PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	-	2	-	2	-	-	-	-	2	2	-	-	2
CO2	3	3	2	2	2	1	2	-	2	2	-	2	3	3	2	2
CO3	3	3	2	3	2	2	2	-	2	2	2	2	3	3	2	2
CO4	3	3	2	`2	2	1	2	-	2	2	-	2	3	2	-	3
CO5	-	-	3	-	3	2	2	-	-	2	2	2	2	-	1	2

Detailed syllabus:

Introduction - Cloud Computing Architecture, Cloud Delivery Models, The SPI Framework, SPI Evolution, The SPI Framework vs. the Traditional IT Model, Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS) Google Cloud Infrastructure - Google File System – Search engine – MapReduce - Amazon Web Services - REST APIs - SOAP API - Defining Service Oriented Architecture, Combining the cloud and SOA, Characterizing SOA, Loosening Up on Coupling, Making SOA Happen, Catching the Enterprise Service Bus, Telling your registry from your repository, Cataloging services, Understanding Services in the Cloud. Serving the Business with SOA and Cloud Computing, Query API - User Authentication- Connecting to the Cloud - OpenSSH Keys - Tunneling / Port Forwarding - Simple Storage Service - S3, EC2 - EC2 Compute Units, Platforms and storage, EC2 pricing, EC2 customers Amazon Elastic Block Storage - EBS - Ubuntu in the Cloud - Apache Instances in EC2 – Amazon Cloud Services- Amazon Elastic Compute Cloud (Amazon EC2), Amazon SimpleDB, Amazon Simple Storage Service (Amazon S3), Amazon CloudFront, Amazon Simple Queue Service (Amazon SQS), Amazon Elastic

MapReduce, Amazon Relational Database Service (Amazon RDS) , EC2 Applications - Web application design - AWS EC2 Capacity Planning – Apache Servers - Mysql Servers - Amazon Cloud Watch - Monitoring Tools.

Reading:

1. Anothony T Velte, Toby J Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, MGH, 2010.
2. Arshdeep Bahga, Vijay Madisetti, Cloud Computing: A Hands-on Approach, Universities Press (India) Private Limited, 2014
3. Gautam Shroff, *Enterprise Cloud Computing*, Cambridge, 2010.
4. Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing Principles and Paradigms, Wiley, 2011
5. Ronald Krutz and Russell Dean Vines, *Cloud Security*, 1st Edition, Wiley, 2010.

CS416	Computational Geometry	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS252- Design and Analysis of Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Summarize combinatorial geometry.
CO2	Analyse algorithms for efficiently solving geometric problems involving 2D polygons and 3D polyhedrons
CO3	Choose and apply data structures for geometric combinatorial problems.
CO4	Build algorithms for applications to such areas as computer graphics, big data analytics and pattern recognition, geometric databases, numerical taxonomy, and robotics

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	-	1	-	-	1	-	-	2	1	-	1
CO2	2	3	2	2	3	-	-	1	-	1	1	1	3	2	3	1
CO3	2	1	3	2	2	1	1	-	1	-	1	1	2	2	2	1
CO4	3	3	2	3	3	1	1	-	1	1	1	-	3	`3	2	2

Detailed syllabus

Combinatorial geometry: Polygons, polytopes, triangulations and simplicial complexes, planar and spatial subdivisions. Constructions: triangulations of polygons and point sets, convex hulls, intersections of halfspaces, Voronoi diagrams, Delaunay triangulations, restricted Delaunay triangulations, arrangements of lines and hyperplanes, Minkowski sums, Reeb graphs and contour trees; relationships among them. Geometric duality and polarity. Upper Bound Theorem, Zone Theorem.

Algorithms and analyses: Sweep algorithms, incremental construction, divide-and-conquer algorithms, randomized algorithms, backward analysis. Numerical predicates and constructors, geometric robustness. Construction of triangulations, convex hulls, halfspace intersections, Voronoi diagrams, Delaunay triangulations, arrangements, Minkowski sums, and Reeb graphs.

Geometric data structures: Doubly-connected edge lists, quad-edges, face lattices, trapezoidal maps, conflict graphs, history DAGs, spatial search trees (a.k.a. range search), segment trees, binary space partitions, quadtrees and octrees, visibility graphs.

Applications: Line segment intersection and overlay of subdivisions for cartography and solid modeling. Triangulation for graphics, interpolation, and terrain modeling. Nearest neighbor search, small-dimensional linear programming, database queries, point location queries, windowing queries, discrepancy and sampling in ray tracing, curve reconstruction and surface reconstruction, robot motion planning.

Reading:

1. Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars, *Computational Geometry: Algorithms and Applications*, Third edition, Springer-Verlag, 2008
2. F. P. Preparata and M. I. Shamos, *Computational Geometry: An Introduction,* Springer-Verlag, 1985
3. Ketan Mulmuley, *Computational Geometry: An Introduction through Randomized Algorithms*, Prentice Hall, 1994.
4. H. Edelsbrunner, *Algorithms in Combinatorial Geometry*, Springer-Verlag, 1987.

CS417	MODEL-DRIVEN FRAMEWORKS	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Construct domain specific languages
CO2	Construct model transformations
CO3	Synthesize model metrics
CO4	Understand contemporary approaches to model driven engineering
CO5	Apply domain specific modeling approach to authentic cases

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	3	1	2	-	2	-	-	3	1	3	-	2
CO2	3	3	3	-	3	-	1	-	2	-	-	1	1	3	-	2
CO3	3	3	3	2	3	1	1	-	1	-	-	1	1	3	-	2
CO4	3	3	3	-	3	-	1	-	2	-	-	2	1	3	-	2
CO5	3	3	3	-	3	-	1	-	2	-	-	2	1	3	-	2

Detailed syllabus:

Traditional software engineering approach: Drawbacks, Software processes, modular-based software design

Model Driven Software Engineering (MDSE) Principles: MDSE basis, Overview of MDSE Technology, Criticism of MDSE, MDSE use cases

Model driven Architecture (MDA): MDA Definitions and Assumptions, the modeling levels-CIM, PIM, PSM, mapping, general purpose and domain specific language in MDA, architecture Driven modernization

Integration of MDSE in a development process: introducing MDSE in a software development process, traditional development process and MDSE, Domain driven design and MDSE, Test driven Development and MDSE

Modeling Language at a glance: Anatomy of modeling language, general purpose vs. domain specific modeling language, General purpose modeling- the case of UML, UML profile platforms, software artifacts using UML standard modeling language, defining modeling constraints, automated GUI generation

Transformations: Model to model transformations, model to text transformations

MDA Practice, Usage of QVT, Kermeta, etc., MDA Transformation Languages, model editors, model valuators, model metrics, modeling framework, middleware to support transformations, MDA applications

Reading:

1. Thomas Stahl, Markus Voelter, *Model-Driven Software Development: Technology, Engineering, Management*, Wiley, 2006.
2. Anne Kleppe, Jos Warmer, and Wim Bast, *MDA Explained - The Model Driven Architecture: Practice and Promise*, Pearson Education, Boston, USA, 2003.

CS418	SOFTWARE RELIABILITY TECHNIQUES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS304- Software Engineering, MA239- Probability and Statistics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand Software Reliability during different phases of Software Development Life Cycle
CO2	Analyze Software Reliability parameters using Markovian Modelling
CO3	Estimate Software Reliability parameters using Maximum Likelihood and Least Square Method
CO4	Evaluate performance of Binomial-Type, Poison-Type and Markovian Models
CO5	Predict Software Reliability using Intelligent Techniques

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	-	-	-	2	2	2	2	-	3	-	2
CO2	3	2	3	2	2	-	-	-	2	2	2	2	-	3	-	3
CO3	3	2	3	2	2	-	-	-	2	2	2	2	-	3	-	3
CO4	3	2	3	2	2	-	-	-	2	2	2	2	-	3	-	2
CO5	3	2	3	2	2	-	-	-	2	2	2	2	-	3	-	2

Detailed syllabus:

Introduction to Software Reliability: The need for Software Reliability, Some Basic Concepts, Software Reliability and Hardware Reliability, Availability, Modelling and General Model Characteristics.

Software Reliability Modeling: Halstead's Software Metric, McCabe's Cyclomatic Complexity Metric, Error Seeding Models, Failure Rate Models, Curve Fitting Models, Reliability Growth Models, Markov Structure Models, Time Series Models, Non-homogeneous Poison Process Models.

Markovian Models: General Concepts, General Poison-Type Models, Binomial -Type Models, Poison-Type Models, Comparison of Binomial-Type and Poison-Type Models, Fault Reduction Factor for Poison-Type Models.

Descriptions of Specific Models: Finite Failure Category Models, Infinite Failure Category Models.

Parameter Estimation: Maximum Likelihood Estimation, Least Squares Estimation, Bayesian Inference.

Comparison of Software Reliability Models: Comparison Criteria, Comparison of Predictive Validity of Model Groups, Evaluation of other Criteria.

Software Reliability Prediction: Problems associated with different Software Reliability Models, Software Reliability prediction parameters, Intelligent Techniques for Software Reliability Prediction.

Reading:

1. M. Xie, *Software Reliability Modelling*, *World Scientific*; 1991.
2. John D. Musa, Anthony Iannino, Kazuhira Okumoto, *Software Reliability Measurement, Prediction, Application.McGraw-Hill Book Company*; 1987.
3. Hoang Pham, *System Software Reliability*, *Springer*; 2005

CS451	MOBILE COMPUTING	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS352-Computer Networks

Course Outcomes: At the end of the course, student will be able to:

CO1	Identify mobile computing societal applications and communication constraints in wireless environment
CO2	Analyze mobile IPv4 and IPv6 architectures with agents and proxies.
CO3	Design MAC protocols for wireless networks.
CO4	Evaluate the performance of TCP protocols in Wireless Networks with mobile nodes.
CO5	Design and analyze the existing routing protocols for multi-hop wireless networks.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	2	2	2	-	-	-	1	1	2	2	1	1	-	2
CO2	1	2	2	2	2	-	-	-	1	1	2	2	1	2	-	2
CO3	2	2	3	2	3	-	2	-	1	1	2	2	2	3	-	3
CO4	2	2	3	2	3	-	2	-	1	1	2	2	1	3	-	3
CO5	2	2	3	2	3	-	2	-	1	1	2	2	2	3	-	3

Detailed syllabus:

Basic communication Technologies, Introduction to Mobile Networks, Introduction to different categories of Wireless networks (MANET: Mobile ad-hoc networks- Communication Architectures of a typical MANET, Applications of MANET, WSN: Wireless Sensor Networks- topologies in WSN-Linear, Grid and Cluster based topologies, communication architectures in a WSN, applications of WSNs, VANET: Vehicular Ad-hoc Networks- communication architectures in VANET, Applications of VANET, PAN: Personal Area Networks- the Bluetooth technology, the blue tooth specifications, DTN: Delay Tolerant Network-delay tolerant network architecture, applications of DTN), Wireless Communication Fundamentals, Cellular Wireless Networks.

Medium Access Control Layer- Hidden terminal problem, Exposed terminal problem, Collision avoidance, Congestion Avoidance, Congestion control, Energy Efficiency, MACA and MACAW protocols, Wireless LAN and IEEE 802.11- Network architecture, the physical layer, the MAC layer, security.

Detailed network layer functionalities in multi-hop wireless networks- Mobile Ad-hoc Networks- broadcasting in a MANET, flooding generated broadcast storm problem, rebroadcasting schemes, Issues in providing multicasting in MANET, Multicast routing protocols, Geocasting- Geocast routing protocols. Mobile Network Layer (Mobile IP), DHCP (Dynamic host configuration protocol), Routing in Mobile Ad hoc Networks (MANET)- Topology-based versus position based approaches, Proactive routing protocols, Reactive routing protocols, Hybrid routing protocols, position based routing issues and forwarding strategies, AODV (Ad-hoc On-Demand Distance Vector Routing Protocol)- Analysis of AODV under mobility and Faults in a network, DSR (Dynamic Source Routing)-Analysis of DSR under mobility and Faults in a network, Secure routing protocols in MANET, Wireless Sensor Networks: (Routing protocols, Localization methods, Sensor Deployment Strategies), traffic flow pattern in WSN- one to many, many to one and many to many, Routing protocols for Delay Tolerant Networks, Routing protocols for Vehicular Ad-hoc Networks, Wireless Access Protocol, GPS (Global positioning system) and applications, RFID and its applications.

Reading:

1. Jochen Schiller, *Mobile Communications*, Second Edition, Pearson Education, 2003.
2. C D M Cordeiro, D. P. Agarwal, *Adhoc and Sensor Networks: Theory and applications*, World Scientific, 2006.
3. Asoke K Talukder and Roopa R. Yavagal, *Mobile Computing – Technology, Applications and Service Creation*; TMH Pub., New Delhi, 2006

CS452	Design of Secure Protocols	PCC	3 – 0 – 0	3 Credits

Pre-requisites: CS252-Design and Analysis of Algorithms, CS402-Cryptography and Network Security, CS352-Computer Networks, CS302-Operating Syatem

Course Outcomes: At the end of the course, student will be able to:

CO1	Identify security goals and risks,
CO2	Analysis of risks and threat modeling
CO3	Integrate different technologies to achieve security goals
CO4	Develop security protocols and policies
CO5	Implement security protocols and secure coding

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	-	1	-	-	1	-	-	1	1	3	3
CO2	2	3	2	2	3	-	-	1	-	1	-	1	2	2	1	2
CO3	2	1	3	2	2	1	1	-	2	-	1	1	3	3	1	3
CO4	2	2	2	1	2	1	1	-	1	1	-	-	3	`2	1	3
CO5	2	3	3	3	3	1	-	1	1	-	1	1	3	3	2	3

Detailed syllabus

Needham-Schroeder public-key protocol. Introduction to finite-state checking, SSL/TLS case study, IP security. Internet Key Exchange (IKE) protocol, Introduction to process algebra, Just Fast Keying (JFK) protocol, Security as observational equivalence. JFK protocol in applied pi calculus, Protocols for anonymity, Probabilistic model checking, Probabilistic contract signing protocols, Floyd-Hoare logic. Compositional protocol logic,

Paulson's inductive method, Analyzing SET with the inductive method, Symbolic constraint solving, Formal definitions of security for symmetric ciphers, Formal model for secure key exchange, Simulatability-based proofs of protocol security, Probabilistic polynomial-time process calculus, Formal analysis of denial of service,

Formal verification of routing protocols, Computational soundness of formal models, Multicast security, Spoofing and identity theft, Fair exchange and contract signing protocols, Trusted computing, Privacy preserving data mining, Automatic proofs of strong secrecy, Game-based verification of contract signing protocols, Wireless security, Game-based analysis of denial-of-service protection, Analysis of Internet voting protocols, Privacy-preserving graph algorithms, Universal composability framework, Analysis of Group Diffie-Hellman protocols

Reading:

1. Oded Goldreich, *Foundations of Cryptography*, Vol. I and II, Cambridge University Press, 2007.
2. Jonathan Katz and Yahuda Lindell, *Introduction to Modern Cryptography*, CRC press, 2008.
3. Van Oorschot, Paul Scott, A Vanstone, A J Menezes, *Handbook of Applied Cryptography*, CRC Press, 2004.

CS461	COMPUTATIONAL NEUROSCIENCE	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Simulate simple models of neurons, and their populations using computing languages.
CO2	Understand the working of neural networks to store and process information
CO3	Construct computational models for hypothesis testing
CO4	Perform literature surveys and evaluate evidence for the impact of neuroscience on specific computational and cognitive neuroscience theories.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2	-	-	-	-	2	2	3	3	-	1
CO2	2	2	1	3	3	3	3	3	1	1	-	-	3	3	3	2
CO3	1	1	3	3	3	3	2	1	-	-	2	2	3	3	3	3
CO4	-	-	2	2	-	2	-	2	1	3	3	3	1	1	1	2

Detailed syllabus:

Analyzing And Modeling Neural Responses: Introduction-Properties of Neurons, Recording Neuronal Responses, From Stimulus to Response Spike Trains and Firing Rates-Measuring Firing Rates, Tuning Curves, Spike-Count Variability What Makes a Neuron Fire?-Describing the Stimulus, The Spike-Triggered Average, White-Noise Stimuli, Multiple-Spike-Triggered Averages and Spike-Triggered correlations, Spike Train Statistics-The Homogeneous Poisson Process, The Spike-Train Autocorrelation Function, The Inhomogeneous Poisson Process, The Poisson Spike Generator, Comparison with Data, The Neural Code-Independent-Spike, Independent Neuron and Correlation Codes, Temporal Codes

Information Theory : Entropy and Mutual Information, Entropy, Mutual Information, Entropy and Mutual Information for Continuous Variables Information and Entropy Maximization-Entropy Maximization for a Single Neuron, Populations of Neurons, The Whitening Filter, Filtering Input Noise, Temporal Processing in the LGN, Cortical Coding Entropy and Information for Spike Trains

Modeling Neurons And Networks : Levels of Neuron Modeling-Levels of Neuron Modeling, Single-Compartment Models-Integrate-and-Fire Models, Spike-Rate Adaptation and Refractoriness, Hodgkin-Huxley model, Firing-rate Models- Feed forward Networks-Neural Coordinate Transformations, Recurrent Networks, Network Stability, Associative Memory, Excitatory-Inhibitory Networks-Homogeneous Excitatory and Inhibitory Populations, Phase-Plane Methods and Stability Analysis, The Olfactory Bulb, Oscillatory Amplification, Stochastic Networks

Plasticity and Learning: Synaptic Plasticity Rules-The Basic Hebb Rule, the Covariance Rule, the BCM Rule, Synaptic Normalization, Subtractive Normalization, Multiplicative Normalization and the Oja Rule, Timing-Based Rules, Unsupervised Learning, Supervised Learning-Supervised Hebbian Learning, Classification and the Perceptron, Function Approximation-Supervised Error-Correcting Rules, the Perceptron Learning Rule, the Delta Rule-Contrastive Hebbian Learning

Reading:

1. Peter Dayan and L F Abbott, *Theoretical Neuroscience*, MIT Press, 2001.
2. Christopher Koeli, *Electrophysics of Neuron*, 1st Edition, MIT Press, 2004.

CS462	NATURAL LANGUAGE PROCESSING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS204**-** Data Structures and Algorithms

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand language modeling with N-Grams.
CO2	Apply syntactic parsing to produce parse trees.
CO3	Analyze semantics with dense vectors.
CO4	Apply lexical semantics with word senses.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	-	2	2	2	1	1	-	1	2	-	-	2	1	2	1
CO2	1	-	1	1	2	1	1	-	1	1	-	-	2	1	2	2
CO3	1	-	1	1	2	1	1	-	1	1	-	-	1	1	1	2
CO4	1	-	2	2	2	1	1	-	1	2	-	-	2	2	1	2

Detailed Syllabus:
Introduction, Regular Expressions, Text Normalization and Edit Distance. Finite State Transducers, Language Modeling with N-Grams, Spelling Correction and the Noisy Channel, Naive Bayes Classification and Sentiment, Part-of-Speech Tagging, Syntactic Parsing, Statistical Parsing, Dependency Parsing, Vector Semantics, Lexicons for Sentiment and Affect Extraction, Information Extraction, Semantic Role Labeling and Argument Structure, Seq2seq Models and Machine Translation, Dialog Systems and Chatbots, Speech Recognition and Synthesis

Text Books:

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing (3rd ed.)
2. Allen, James, Natural Language Understanding, Second Edition, Benjamin/ Cumming, 1995.
3. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

CS463	PATTERN RECOGNITION	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Determine classifiers for pattern recognition
CO2	Analyze feature selection and dimensionality reduction techniques
CO3	Apply MC and HMM models
CO4	Classify the data objects and develop template matching module to recognize the patterns.
CO5	Apply unsupervised learning algorithms to data objects.
CO6	Analyze clustering algorithms.

Mapping of course outcomes with program outcomes

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	2	-	-	-	-	-	2	1	3	1
CO2	2	2	3	1	2	2	1	-	-	-	-	1	1	1	3	2
CO3	2	2	-	-	3	1	1	-	-	-	-	1	2		3	1
CO4	2	1	-	1	3	1	1	-	-	-	-	1	2	1	3	1
CO5	3	2	1	1	2	1	1	-	-	-	1-	1	2	1	3	1
CO6	2	3	2	1	2	2	2	-	-	-	-	1	2	1	3	2

Brief syllabus

Classifiers Based on Bayes Decision Theory: Introduction, Bayes Decision Theory, Discriminant Functions and Decision Surfaces, Bayesian Classification for Normal Distributions, Estimation of Unknown Probability Density Functions: Maximum Likelihood Parameter Estimation, Maximum a Posteriori Probability Estimation, Bayesian Inference, Maximum Entropy Estimation, Mixture Models, Nonparametric Estimation, The Naive-Bayes Classifier, The Nearest Neighbor Rule, Bayesian Networks

Linear Classifiers: Linear Discriminant Functions and Decision Hyperplanes, The Perceptron Algorithm, Least Squares Methods, Mean Square Estimation Revisited :, Logistic Discrimination, Support Vector Machines

Non Linear Classifiers: The XOR Problem , TheTwo-Layer Perceptron , Three Layer Perceptrons, Algorithms Based on Exact Classification of the Training Set , The Backpropagation Algorithm , Variations on the Backpropagation Theme, The Cost Function Choice, Choice of the Network Size, A Simulation Example, Networks with Weight Sharing, Generalized Linear Classifiers, Capacity of the *l*-Dimensional Space in Linear

Dichotomies, Polynomial Classifiers, Radial Basis Function Networks, Universal Approximators, Support Vector Machines: The nonlinear Case, Decision Trees, Combining Classifiers , The Boosting Approach to Combine Classifiers

Feature Selection: Preprocessing, Feature Selection Based on Statistical Hypothesis Testing, The Receiver Operating Characteristics (ROC) Curve, Class Separability Measures, Feature Subset selection, Optimal Feature Generation, Neural Networks and Feature Generation / Selection, The Bayesian Information Criterion

Feature Generation: Linear Transforms, Regional Features, Features for Shape and Size Characterization, Typical Features for Speech and Audio Classification **Template Matching:** Introduction, Similarity Measures Based on Optimal Path Searching Techniques, Measures Based on Correlations, Deformable Template Models

Context Dependent Classification: Markov Chain Models, Hidden Markov Models

Clustering Algorithms: Clustering Algorithms Based on Graph Theory, Competitive Learning Algorithms: Supervised Learning Vector Quantization

Reading:

1. S Theodoridis and K Koutroumbas – Pattern Recognition, 4^{th} Edition, Academic Press, 2009.
2. C Bishop – Pattern Recognition and Machine Learning – Springer, 2006.

CS464	Algorithmic Coding Theory	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course outcomes:

CO1	Apply shannon's noisy coding theorem, shannon capacity and entropy
CO2	Design of error correcting codes and decoding algorithms
CO3	Design and Analyze of light weight and code based cryptosystems
CO4	Design of network coding algorithms for communication networks

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	1	-	-	-	1	-	2	2	2	2	-	2
CO2	2	3	2	2	1	-	-	-	1	-	2	2	2	3	-	2
CO3	2	3	2	2	2	-	-	-	1	-	2	2	2	3	-	2
CO4	2	3	2	2	1	-	-	-	1	-	2	2	2	3	-	2

Detailed syllabus:

Shannon Theorem, Shannon capacity, Hamming's Theory, Error correcting codes, Linear codes, Impossibility results for codes, Mac Williams Identities, Linear programming bound, The asymptotic perspective, Encoding, Decoding from erasures, Decoding RS codes, List decoding, linear time decoding, LDPC codes, Sipser-Spielman codes, Linear time encoding and decoding, Linear time and near optimal error decoding, Expander based constructions of efficiently, decodable codes, Some NP hard coding theoretic problems, Applications in complexity theory, Cryptography with error correcting codes, Lossless Multicast Network Coding, Network coding in Lossy Networks, Security against adversarial errors, Error correction bounds for centralized network coding.

Reading:

1. Tom Richardson, Rudiger Urbanke, *Modern Coding Theory, Cambridge University Press, 2008*
2. John b. Anderson and Seshadri Mohan, *Source and Channel Coding: An Algorithm Approach*, Springer, 1991.
3. G. Kabatiansky, E. Krouk and S. Semenov, *Error Correcting Coding and Security for Data Networks,* John Wiley & Sons Ltd., 2005.
4. Jiri Adamek, *Foundations of Coding, Wiley Interscience Publication,* John Wiley & Sons*, 1991*

CS465	Social Media Analytics	DEC	3-0-0	3 Credits

Pre-requisites: CS303- Data Warehousing and Data Mining, CS204- Data Structures and Algorithms, CS353- Data Science

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the importance of social media and networks
CO2	Enhance analytical skills for analyzing social media and networking data
CO3	Develop skills to leverage extended enterprise data
CO4	Create real-life case studies using social media data

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	1	-	1	-	-	1	-	-	1	-	1	-	-	1
CO2	1	-	-	2	2	2	2	-	-	1	1	-	-	-	2	-
CO3	1	2	2	-	1	-	2	-	-	2	-	2	-	2	-	2
CO4	-	1	1	2	-	2	-	1	2	-	-	1	-	2	-	-

Detailed syllabus

Introduction to social network analysis: Vertex or node, edge, neighbors, degree, shortest path, cycle, tree, complete graph, bipartite graphs, directed graphs, weighted graphs, adjacency matrix;

Social networks examples (facebook, movie collaboration, and paper collaboration), information networks (web), biological networks (neural networks, ecological networks), random graphs with general degree distributions, models of network formation, Properties of Large-Scale Networks: Six-degree separation, scale-free distributions, small-world effect, and strong community structure;

Networks and Centrality Measures: Degree, closeness, betweenness, edge betweenness, eccentricity, clustering coefficient, eigenvector; Spread of influence through a network, influence maximization in networks, spread of disease on networks, Information networks;

Community Detection and graph based clustering: communities in social media, node-centric community detection, group-centric community detection, network-centric community detection, hierarchy-centric community detection, Topology discovery. Community Evaluation;

Link Prediction: Challenges in link prediction, link prediction methods and algorithms, clustering approaches for link prediction;

Sentiment Analysis: Sentiments and Opinions, lexicon based methods, machine learning based methods, feature-based sentiment analysis, slang sentiment analysis;

Social Listening and Social Recommendation Systems: Social Recommendation Using collaborative filtering, community detection and probabilistic matrix factorization

Reading:

1. Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Social Media Mining – An Introduction, Cambridge University Press, 2014.
2. Charu C Aggarwal (Ed.), Socail Network Data Analytics, Springer, 2011.
3. Hansen, Derek, Ben Sheiderman, Marc Smith., Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.

CS466	Security and Privacy	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS252- Design and Analysis of Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Evaluate the risks and vulnerabilities in protocols/Standards.
CO2	Design and security analysis of cryptographic algorithms.
CO3	Design and security analysis of authentication, message integrity and authenticated encryption protocols
CO4	Develop techniques for Privacy preserving Data analysis
CO5	Compute lower bounds for differential privacy

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	-	1	-	-	1	-	-	2	2	1	3
CO2	2	3	2	2	3	-	-	1	-	1	-	1	2	2	1	3
CO3	3	1	3	2	2	1	1	-	2	-	1	1	2	2	1	3
CO4	2	2	2	1	2	1	1	-	1	1	-	-	2	2	1	3
CO5	3	3	3	2	3	1	-	1	1	-	-	1	2	2	1	3

Detailed syllabus

Introduction to Security – risks, threats and vulnerabilities, Cryptography.
Symmetric key Cryptography – Encryption, Block ciphers, Chosen plaintext attacks, Stream Ciphers – One-time Pad (OTP), Perfect secrecy, Pesudo-random generators (PRG), Attacks on stream ciphers and OTP, Real world stream ciphers, Semantic security, Case Study- RC4, Salsa 20, CSS in DVD encryption, A5 in GSM, Block ciphers- DES, attacks, AES, Block ciphers from PRG, Modes of operation – one-time key and many-time keys, CBC, CTR modes,
Message Integrity – MAC, MAC based on PRF, NMAC, PMAC, Collision resistance – Birthday attack, Merkle-Damgard construction, HMC, Case study:SHA-256, Authenticated encryption, Key exchange algorithms,
Public key cryptosystems – Public key tools, Public key encryption, Chosen ciphertext secure public-key encryption, Digital signature, Fast hash based signatures, RSA, ElGamal, Elliptic curve cryptosystems – PKC, key exchange, IBE, Analysis of number theoretic assumptions, Case studies – HTTPS – SSL/TLS, SSH, IPSec, 802.11i WPA.
Protocols - Protocols for identification and login, Identification and signatures from sigma protocols, Proving properties in zero-knowledge, Authenticated key exchange, Key establishment with online trusted third parties, Two-party and multi-party secure computation
Privacy preserving Data analysis - Basis Techniques - Randomized response, the Laplace mechanism, the exponential mechanism, Composition theorems, and sparse vector technique.

Releasing Linear Queries with Correlated Error**,** Mechanisms via α-nets, Iterative construction mechanism, Boosting for queries algorithm, Stability and privacy, Lower bounds for differential privacy.
System design and analysis – Survivable distributed storage system, Electronic voting system, Digital Cash, Bit coin.

Reading:

1. J. Katz and Y. Lindell, *Introduction to Modern Cryptography*, CRC press, 2008.
2. C. Dwork and A. Roth, *The Algorithmic Foundations of Differential Privacy*, now Publishers, 2014.
3. Van Oorschot, Paul Scott, A Vanstone, A J Menezes, Handbook *of Applied Cryptography*, CRC Press, 2004.

CS467	Information Retrieval	DEC	3-0-0	3 Credits

Pre-requisites: CS303- Data Warehousing and Data Mining, CS204- Data Structures and Algorithms

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the concepts of information retrieval and their application to locate relevant information in large corpus of documents
CO2	Design and develop information retrieval systems for retrieval from web and other resources
CO3	Develop skills to analyze the performance of retrieval systems
CO4	Explore real-life case studies in different domains

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	1	-	1	-	2	1	-	2	-	1	-	2	1	-
CO2	1	1	1	1	1	-	-	-	1	2	1	-	1	1	1	2
CO3	-	2	-	1	-	1	2	-	-	1	-	-	-	1	1	1
CO4	-	1	2	-	1	1	1	-	2	1	1	1	1	-	1	-

Detailed syllabus

Information Retrieval (IR) problem, Search and Browse, Efficient text indexing, inverted index, Metrics – relevance, effectiveness, precision, recall;

Linguistic Processing - Term vocabulary and postings lists, document frequency, term frequency, tf-idf

Retrieval models: Probabilistic IR - the binary independence model; Boolean and vector-space retrieval models; Evaluation and interface issues

IR techniques for the web, including crawling, link-based algorithms, and metadata usage

Document clustering and Document classification -, Text classification (Naive Bayes, kNN, decision boundaries, Support Vector Machine)

Traditional and machine learning-based ranking approaches; personalization, link analysis, information visualization.

Parallel and distributed IR, Multimedia IR – Search and Indexing.

Reading:

1. C. Manning, P. Raghavan, and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2. D. Grossman and O. Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2004.
3. R. Baeza-Yates and B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, ACM Press, 1999.

CS471	HARDWARE SECURITY	DEC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	understand the vulnerabilities in current digital system design flow and the physical attacks to these systems
CO2	Understand that security starts from hardware design and be familiar with the tools and skills to build secure and trusted hardware
CO3	Address different security threats on modern hardware design, manufacturing, installation, and operating practices.
CO4	Differentiate between the threats ranging from a single user to an entire nation's public infrastructure

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	1	3	-	-	-	-	-	-	-	-	-	1	-
CO2	1	2	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	1	2	1	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	2	2	3	-	-	-	-	-	-	-	3	2	2	-

Detailed syllabus

Preliminaries: Algebra of Finite Fields, Basics of the Mathematical Theory of Public Key Cryptography, Basics of Digital Design on Field-programmable Gate Array (FPGA), Classification using Support Vector Machines (SVMs)

Useful Hardware Security Primitives: Cryptographic Hardware and their Implementation, Optimization of Cryptographic Hardware on FPGA, Physically Unclonable Functions (PUFs), PUF Implementations, PUF Quality Evaluation, Design Techniques to Increase PUF Response Quality

Side-channel Attacks on Cryptographic Hardware: Basic Idea, Current-measurement based Side-channel Attacks (Case Study: Kocher′s Attack on DES), Design Techniques to Prevent Side-channel Attacks, Improved Side-channel Attack Algorithms (Template Attack, etc.), Cache Attacks

Testability and Verification of Cryptographic Hardware: Fault-tolerance of Cryptographic Hardware, Fault Attacks, Verification of Finite-field Arithmetic Circuits

Modern IC Design and Manufacturing Practices and Their Implications: Hardware Intellectual Property (IP) Piracy and IC Piracy, Design Techniques to Prevent IP and IC Piracy, Using PUFs to prevent Hardware Piracy, Model Building Attacks on PUFs (Case Study: SVM Modeling of Arbiter PUFs, Genetic Programming based Modeling of Ring Oscillator PUF)

Hardware Trojans: Hardware Trojan Nomenclature and Operating Modes, Countermeasures Such as Design and Manufacturing Techniques to Prevent/Detect Hardware Trojans, Logic Testing and Side-channel Analysis based Techniques for Trojan Detection, Techniques to Increase Testing Sensitivity Infrastructure Security: Impact of Hardware Security Compromise on Public Infrastructure, Defense Techniques (Case Study: Smart-Grid Security)

Reading:

1. DebdeepMukhopadhyay and RajatSubhra Chakraborty, "Hardware Security: Design, Threats, and Safeguards", CRC Press

2. Ahmad-Reza Sadeghi and David Naccache (eds.): Towards Hardware-intrinsic Security: Theory and Practice, Springer.

3. TedHuffmire et al: Handbook of FPGA Design Security, Springer.

4. StefanMangard, Elisabeth Oswald, Thomas Popp: Power analysis attacks - revealing the secrets of smart cards. Springer 2007.

5. Doug Stinson, Cryptography Theory and Practice, CRC Press.

CS472	Secure Multi-party Computation	DEC	3-0-0	3 Credits

Pre-requisites: None
Course Outcomes: At the end of the course, student will be able to:

CO1	Understanding real world notions related to secure multi party computation
CO2	Distinguishing various models with respect to secure computation
CO3	Applying semi honest and active security secure computation protocols on solving real world problems
CO4	Apply zero knowledge proofs

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	-	2	-	-	2	2	2	3	1	-	1	1
CO2	2	2	3	1	-	-	-	-	-	1	1	2	1	2	1	2
CO3	3	3	3	3	1	1	2	1	2	1	-	3	3	1	2	2
CO4	3	2		3`	1	-	-	-	-	2	-	-	2	-	1	2

Detailed syllabus

Introduction to secure computing: Definition-Secure Computation-Computational/statistical Indistinguishability; Real-Ideal World or Simulationbased Security notions, secret sharing;
Models of Secure Computation: Honest vs. Dishonest majority settings; semi-honest vs active (malicious) adversary; static vs. adaptive computation; computational vs. information theoretic security; synchronous vs. asynchronous network
Oblivious Transfer and its extension: Oblivious transfer protocols - Definitions, constructions, and applications
Secure computation with semi-honest security: Honest-majority Setting- Secret Sharing, BenOr-Goldwasser-Wigderson (BGW) Construction, Optimizations (MPC in preprocessing mode and circuit randomization), Cramer-Damgaard-Neilsen (CDN) Construction; Dishonest majority Setting- Oblivious Transfers (OT), two-party Goldreich-Micali-Wigderson (GMW) construction, Optimizations of GMW (Random input OT and OT extension), Yao construction, BMR construction and multi-party GMW construction.
Secure computation with Active security: Honest Majority Setting.-Verifiable Secret Sharing, BGW Construction with active security, Hyper-invertible Matrices and Beerliova-Hirt (BH) Construction, Information Checking Protocol; Dishonest majority Setting-Commitment Schemes, Zero-knowledge, GMW Compiler for active corruption, Cut-and-Choose OT and Lindell-Pinkas Construction.

Zero-knowledge proof systems: zero-knowledge proofs of knowledge; non-interactive zero-knowledge

Broadcast & Byzantine Agreement : Dolev-Strong Broadcast; Exponential Information Gathering (EIG) construction for BA; Berman-Garay-Perry (BGP) construction for BA; Multi-valued Broadcast and BA.
Practical Secure Computation: Secure Set Intersection; Privacy Preserving Biometrics & Genomics; Secure Cloud Computing

Reading:

1. Manoj M. Prabhakaran, Amit Sahai, Secure Multi-Party Computation,Cryptography and Information security series Vol 10, IOS Press, 2013
2. Ronald Cramer, Ivan Damgaard and JesperBuus Nielsen, Secure Multiparty Computation and Secret Sharing - An Information Theoretic Approach, Cambridge Press. (Book Draft)

CS473	Computational Learning Theory	DEC	3 – 0 – 0	3 Credits

Pre-requisites:CS252- Design and Analysis of Algorithms, CS401- Machine Learning

Course Outcomes: At the end of the course, student will be able to:

CO1	Develop algorithms and methods to analyse learning algorithms
CO2	Design algorithms that are compuationally efficient with limited amount of data to understand statistical and computational trade-offs in learning algorithms
CO3	Design models to address relevant practical questions of the day, such as learning with limited memory, communication, and labelled and unlabelled data
CO4	Develop algorithms to address privacy in learning algorithms.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	-	1	-	-	1	-	-	3	2	1	-
CO2	2	3	3	2	3	-	-	1	-	1	1	1	3	2	1	-
CO3	2	1	3	3	2	1	1	-	1	-	1	1	3	1	1	-
CO4	3	3	2	3	3	1	1	-	1	1	1	-	2	`1	-	3

Detailed syllabus

The Probably Approximately Correct Learning Model - General Mode, Learning Boolean Conjunctions Intractability of Learning 3-Term DNF Formulae, Using 3-CNF, Formulae to Avoid Intractability

Occam's razor - Occam Learning and Succinctness, Improving the Sample Size for Learning Conjunctions, Learning Conjunctions with Few Relevant Variables, Learning Decision Lists

Vapnik-Chervonenkis Dimension - Learning with a Finite Sample, Examples of the VC Dimension, Polynomial Bound - A Polynomial Bound on the Sample Size for PAC Learning - Importance of f-Nets, A Small f-Net from Random Sampling, Sample Size Lower Bounds, Application to Neural Networks

Weak and Strong Learning - Relaxed Definition of Learning, Boosting the Confidence, Boosting the Accuracy - A Modest Accuracy Boosting Procedure, Error Analysis for the Modest Procedure, A Recursive Accuracy Boosting Algorithm, Bounding the Depth of the Recursion, Analysis of Filtering Efficiency

Learning in the Presence of Noise - Classification Noise Model, Algorithm for Learning Conjunctions from Statistics, Statistical Query Learning Model, Simulating Statistical Queries in the Presence of Noise - Nice Decomposition of Px, Solving for an Estimate of Px. Guessing and Verifying the Noise Rate, Description of the Simulation Algorithm

Inherent Unpredictability - Representation Dependent and Independent Hardness, Discrete Cube Root Problem, Difficulty of Discrete Cube Roots, Discrete Cube Roots as a Learning Problem, Small Boolean Circuits Are Inherently Unpredictable, Reducing the Depth of Inherently Unpredictable Circuits- Expanding the Input, General Method and Its Application to Neural Networks

Reducibility in PAC Learning - Reducing DNF to Monotone DNF, General Method for Reducibility, Reducing

Boolean Formulae to Finite Automata - Learning Finite Automata by Experimentation, Active and Passive Learning, Exact Learning Using Queries, Exact Learning of Finite Automata - Access Strings and Distinguishing Strings, Efficiently Computable State Partition, Tentative Hypothesis, Using a Counterexample, Algorithm for Learning Finite Automata, Running Time Analysis; Learning without a Reset - Using a Homing Sequence to Learn, Building a Homing Sequence Using Oversized Generalized, Classification Trees, No-Reset Algorithm, Making Sure L_sigma Builds Generalized Classification Trees.

.**Reading:**

1. Michael Kearns and Umesh Vazirani, *An Introduction to Computational Learning Theory,* MIT Press, 1994.
2. David Mackay, *Information Theory, Inference and Learning Algorithms*. Cambridge University Press, 2003.
3. Shai Shalev-Shwartz and Shai Ben-David. *Understanding Machine Learning: From Theory to Algorithms*. Cambridge University Press, 2014.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, *The Elements of Statistical Learning,* Second edition, Springer, 2008

CS474	DISTRIBUTED OBJECT TECHNOLOGIES	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic concepts of distributed systems and objects.
CO2	Design distributed systems using .Net and CORBA-based platforms, Java RMI and Web services.
CO3	Understand the principles of object oriented middleware and common design problems
CO4	Implement distributed multi-tier application using distributed objects
CO5	Evaluate management methods for distributed systems

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	3	2	1	1	-	-	-	-	-	-	-	2	-	2
CO2	1	2	3	2	2	2	-	-	-	-	-	-	3	3	-	2
CO3	1	2	3	2	2	2	-	-	-	-	-	-	3	3	-	2
CO4	2	2	3	3	3	3	-	-	-	-	-	-	3	3	-	2
CO5	3	2	3	3	3	2	-	-	-	-	-	-	1	2	-	3

Detailed syllabus:

Introduction: Evolution of corporate computing models from centralized to distribute computing, client server models. Benefits of client server computing, pitfalls of client server programming, Benefits of Java Programming with CORBA

CORBA with Java: Review of Java concept like RMI, RMI API, JDBC, applets. CORBA overview Client/Server. Overview of Java ORB

DCOM: DCOM and Java, DCOM Java counting example.

Introducing C# and the .NET Platform: Understanding .NET Assemblies; Object –Oriented Programming with C#; Callback Interfaces, Delegates, and Events.

Building C# applications: Type Reflection, Late Binding, and Attribute-Based Programming; Object Serialization and the .NET Remoting Layer; Data Access with ADO.NET; XML Web Services.

Core CORBA / Java: Two types of Client/Server invocations-static, dynamic. The static CORBA, first CORBA program, ORBlets with Applets, Dynamic CORBA- portable count, the dynamic count, multi count.

Existential CORBA: CORBA initialization protocol, CORBA activation services, CORBA IDL mapping to Java, CORBA Java-to-IDL mapping, the introspective CORBA/Java object. Java Bean Component Model: Events, properties, persistency, Introspection of beans, CORBA Beans.
EJBs and CORBA: Object transaction monitors CORBA OTM's, EJB and CORBA OTM's, EJB container frame work, Session and Entity Beans, The EJB client/server development Process The EJB container protocol, support for transaction EJB packaging EJB design Guidelines.

Reading:

1. Robert Orfali and Dan Harkey, *Client/Server Programming with Java and CORBA*, 2nd Edition, John Wiley & Sons, 1998.
2. Robert J. Oberg, *Introduction to C# Using .NET*, Prentice Hall, 2002
3. G. Brose, A Vogel, K Duddy, *Java Programming with CORBA*, 3rd Edition, Wiley, 1998.

CS475	MALWARE DETECTION AND MITIGATION	DEC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Possess the skills necessary to carry out independent analysis of modern malware samples using both static and dynamic analysis techniques.
CO2	Have an intimate understanding of executable formats, Windows internals and API, and analysis techniques.
CO3	Extract investigative leads from host and networkbased indicators associated with a malicious program
CO4	Apply techniques and concepts to unpack, extract, decrypt, or bypass new antianalysis techniques in future malware samples.

Mapping of course outcomes with program outcomes

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	-	-	-	-	-	-	-		-	1	-
CO2	3	2	2	2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	3	3	-	-	-	-	-	-		3	3	3	-

Detailed syllabus

Introduction

Introduction to malware, OS security concepts, malware threats, evolution of malware, malware types- viruses, worms, rootkits, Trojans, bots, spyware, adware, logic bombs, malware analysis, static malware analysis, dynamic malware analysis.

Advanced Static Analysis

X86 Architecture- Main Memory, Instructions, Opcodes and Endianness, Operands, Registers, Simple Instructions, The Stack, Conditionals, Branching, Rep Instructions, C Main Method and Offsets. Analyzing Windows programs, Portable executable file format, disassembling malicious executable programs. Anti-static analysis techniques- obfuscation, packing, metamorphism, polymorphism.

Advanced Dynamic Analysis

Debugging malware- ollydbg, windbg, setting virtual environments- sandboxes, emulators, Hypervisors, virtual machines, live malware analysis, dead malware analysis, analyzing traces of malware- system-calls, api-calls, registries, network activities. Anti-dynamic analysis techniques-anti-vm, runtime-evasion techniques.

Malware Functionality
Downloaders, Backdoors, Credential Stealers, Persistence Mechanisms, Privilege Escalation, Covert malware launching- Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC injection.

Malware Detection Techniques
Signature-based techniques: malware signatures, packed malware signature, metamorphic and polymorphic malware signature. Non-signature based techniques: similarity-based techniques, machine-learning methods, invariant-inferences.

Reading:

1. Sikorski, Michael, and Andrew Honig. *Practical malware analysis: the hands-on guide to dissecting malicious software*. no starch press, 2012.
2. Filiol, Eric. Computer viruses: from theory to applications. Springer Science & Business Media, 2006.
3. Ligh, Michael, Steven Adair, Blake Hartstein, and Matthew Richard. *Malware analyst's cookbook and DVD: tools and techniques for fighting malicious code*. Wiley Publishing, 2010.

CS476	Algorithmic Game Theory	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS252- Design and Analysis of Algorithms, CS363- Game Theory

Course Outcomes: At the end of the course, student will be able to:

CO1	Computation of equilibrium besed on complete and incomplete information about the players
CO2	Develop Combinatorial Algorithms for Market Equilibria
CO3	Analyse mechanism design
CO4	Design and analyse combinatorial auctions
CO5	Design of Scalable Resource Allocation Mechanisms

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	-	1	-	2	1	-	-	3	1	1	1
CO2	2	3	2	2	3	-	-	1	-	1	1	1	2	2	1	
CO3	2	1	3	2	2	1	1	-	2	-	1	1	2	2	2	1
CO4	2	2	2	1	2	1	1	-	1	1	1	-	2	1	2	1
CO5	2	3	3	3	3	1	-	1	1	-	1	1	2	2	1	-

Detailed syllabus

Basic Solution Concepts and Computational Issues - Games, Strategies, Costs, and Payoffs, Basic Solution Concepts, Finding Equilibria and Learning in Games, Refinement of Nash: Games with Turns and Subgame Perfect Equilibrium, Nash Equilibrium without Full Information: Bayesian Games, **Cooperative** Games, Markets and Their Algorithmic Issues

The Complexity of Finding Nash Equilibria - NP-Completeness, the Lemke–Howson Algorithm, the Class PPAD, Succinct Representations of Games, Reduction, Correlated Equilibria

Equilibrium Computation for Two-Player Games in Strategic and Extensive Form - Bimatrix Games and the Best Response Condition, Equilibria via Labeled Polytope, Lemke–Howson Algorithm, Integer Pivoting, Degenerate Games, Extensive Games and Their Strategic Form, Subgame Perfect Equilibria, Reduced Strategic Form, Sequence Form, Computing Equilibria with the Sequence Form

Learning, Regret Minimization, and Equilibria - External Regret Minimization, Regret Minimization and Game Theory, **Generic** Reduction from External to Swap Regret, The Partial

Information Model, **On** Convergence of Regret-Minimizing Strategies to Nash Equilibrium in Routing Games

Combinatorial Algorithms for Market Equilibria - Fisher's Linear Case and the Eisenberg–Gale Convex Program, Checking If Given Prices Are Equilibrium Prices, Primal-Dual Schema in the Enhanced Setting, Tight Sets and the Invariant, Balanced Flows, Linear Case of the Arrow–Debreu Model, Auction-Based Algorithm, Resource Allocation Markets, Algorithm for Single-Source Multiple-Sink Markets

Computation of Market Equilibria by Convex Programming - Fisher Model with Homogeneous Consumers, Exchange Economies Satisfying WGS, Specific Utility Functions, Models with Production

Graphical Games - Computing Nash Equilibria in Tree Graphical Games, **Graphical** Games and Correlated Equilibria, Graphical Exchange Economies.

Cryptography and Game Theory - Cryptographic Notions and Settings, Game Theory Notions and Settings, Contrasting MPC and Games, Cryptographic Influences on Game Theory, Game Theoretic Influences on Cryptography

Mechanism Design - Social Choice, Mechanisms with Money, Implementation in Dominant Strategies, Characterizations of Incentive Compatible Mechanisms, Bayesian–Nash Implementation

Combinatorial Auctions - The Single-Minded Case, Walrasian Equilibrium and the LP Relaxation, Bidding Languages, Iterative Auctions: The Query Model, Communication Complexity, **Ascending** Auctions

Inefficiency of Equilibria - Fundamental Network Examples, Inefficiency of Equilibria as a Design Metric

Routing Games - Models and Examples, Existence, Uniqueness, and Potential Functions, Price of Anarchy of Selfish Routing, Reducing the Price of

Network Formation Games and the Potential Function Method - Local Connection Game, Potential Games and a Global Connection Game, Facility Location

Selfish Load Balancing - Pure Equilibria for Identical Machines, Pure Equilibria for Uniformly Related Machines, Mixed Equilibria on Identical Machines, Mixed Equilibria on Uniformly Related Machines

Reading:

1. N. Nisan, T. Roughgarden, E. Tardos, V.V. Vazirani, *Algorithmic Game Theory*, Cambridge University Press, 2007..
2. Y. Shoham and K. Leyton-Brown, *Multi-agent Systems: algorithmic, game-theoretic, and logical foundations*, Cambridge University Press, 2009.
3. T. Roughgarden. *Twenty Lectures on Algorithmic Game Theory*, Cambridge University. Press, 2016.

CS477	FORMAL METHODS IN SOFTWARE ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Model the state of a software component using the unifying concept of mathematical relation
CO2	Design of automatic verification tools to establish the validity of a given software property
CO3	Apply automatic software verification tools based on model checking
CO4	Design tools for the deductive verification of programs annotated with contracts

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	1	1	1	1	1	1	1	1	2	3	3	1
CO2	1	2	2	3	2	1	1	1	1	1	1	1	3	3	2	2
CO3	1	1	2	3	1	1	2	1	2	1	1	1	2	3	2	2
CO4	1	1	1	3	3	1	1	1	1	1	1	1	3	2	2	3

Detailed syllabus:

Specification and Modeling:

- Introduction: the role of formal methods in software engineering; the role of abstraction in formal modeling; propositional and first-order logic.
- Relational logic: syntax and semantics; modeling using relations; introduction to the relational calculus; taxonomy and relational algebra.
- Alloy: speficiation of invariants and operations using pre- and post-conditions using relational logic; idioms for modeling dynamic behaviour; semantics and type system; automatic verification techniques; comparison with other modeling languages.
- Specification of reactive systems: temporal logic (LTL and CTL); explicit state model checking; symbolic model checking; tools for model checking.

Theorem proving:

- Introduction to the interactive construction of proofs.
- First order theories: employing SMT solvers.

- Deductive verification: program logics; verification condition generation; behavioral interface specification languages and design by contract. Tools covered: Dafny; Frama-C; SPARK.
- Model Checking: symbolic model checking; partial order reduction; bounded model checking. Tool covered: SMV.
- Software Model Checking: bounded model checking of software; existential abstraction mechanisms; predicate abstraction; abstraction refinement. Tools covered: CBMC; BLAST

Reading:

1. Daniel Jackson. **Software abstractions: logic, language, and analysis**. Revised edition, MIT Press, 2012.
2. Christel Baier and Joost-Pieter Katoen. **Principles of model checking**. MIT Press, 2008.
3. Michael Huth and Mark Ryan. 2004. **Logic in Computer Science: Modelling and Reasoning about Systems**. Cambridge University Press, New York, NY, USA.
4. Edmund M. Clarke, Jr., Orna Grumberg, and Doron A. Peled. 2000. **Model Checking**. MIT Press, Cambridge, MA, USA.
5. José Bacelar Almeida, Maria João Frade, Jorge Sousa Pinto, and Simão Melo de Sousa. 2011. **Rigorous Software Development: An Introduction to Program Verification** (1st ed.). Springer Publishing Company, Incorporated.
6. Aaron R. Bradley and Zohar Manna. 2010. **The Calculus of Computation: Decision Procedures with Applications to Verification** (1st ed.). Springer Publishing Company, Incorporated

CS481	ADVANCED COMPILER DESIGN	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS351**-** Language Processors

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand code generation methods
CO2	Apply scalar variable optimizations and procedural optimizations on intermediate code.
CO3	Apply machine level optimizations on the low level intermediate code.
CO4	Perform loop restructuring transformations

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	-	-	-	-	-	-	2	2	-	2
CO2	3	3	3	3	3	3	-	-	-	-	-	-	2	3	-	3
CO3	3	2	2	2	2	2	-	-	-	-	-	-	2	2	-	3
CO4	3	2	3	3	3	3	-	-	-	-	-	-	2	3	-	2

Detailed syllabus:

Introduction: Interpreters - Recursive and iterative interpreters

Code generation: Arithmetic statement translation, acyclic graph representation, pattern matching in the acyclic graph, graph rewriting, linearization following the dependencies, code generation for purely register machine, purely stack machine and with memory addressing. Code generation for a basic block.

Simple optimizations : Constant folding, Scalar replacement of aggregates and Algebraic simplifications, Value numbering, Loop invariants identification, loop invariant code motion, partial redundancy elimination, procedure optimizations - call and return optimizations, Code hoisting, Induction variable identification and optimizations, Unnecessary bounds checking elimination

Register Allocation and Code scheduling : Local methods and global methods, representation of the register allocation problem as graph colouring problem, heuristics, register tracking and spilling, Pipeline and Code scheduling effect on performance of the program, Software pipelining, speculative scheduling, boosting

Inter-procedural data flow analysis - static and dynamic, optimizations, Optimizing for memory hierarchies

High performance systems – Scalar, vector, multiprocessor, SIMD, Message Passing Architectures. Sequential and parallel loops. Data dependence, Use-Def chains. Dependence system, GCD test, Banerjee's Inequality, Exact algorithm, exact algorithm, Vectorization, Concurrentization, Array region analysis, Loop restructuring transformations.

Reading:

1. Steven S. Muchnick, *Advanced Compiler Design & Implementation,* Morgan Kaufmann, Elsevier Science, 2003.
2. Michael Wolfe, *High Performance Compilers for Parallel Computing,* Addison Wesley, 1995.

CS482	COMPUTER VISION AND IMAGE PROCESSING	DEC	3-0-0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand Image representation and modeling
CO2	Apply Image transformation methods
CO3	Implement image processing algorithms
CO4	Design of face detection and recognition algorithms
CO5	Analyze the features and propose new features of images.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	-	-	-	-	2	3	2	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	3	2	2	2
CO3	2	2	-	-	-	-	-	-	-	-	-	-	3	3	3	-
CO4	2	-	3	-	-	-	-	-	-	-	-	-	2	2	2	2
CO5	2	3	3	3	-	2	-	-	-	-	-	-	-	-	-	-

Detailed syllabus:

The image model and acquisition, image shape, sampling, intensity images, color images, range images, image capture, scanners. Statistical and spatial operations, Gray level transformations, histogram equalization, multi image operations. Spatially dependent transformations, templates and convolution, window operations, directional smoothing, other smoothing techniques. Segmentation and Edge detection, region operations, Basic edge detection, second order detection, crack edge detection, edge following, gradient operators, compass & Laplace operators. Morphological and other area operations, basic morphological operations, opening and closing operations, area operations, morphological transformations. Image compression: Types and requirements, statistical compression, spatial compression, contour coding, quantizing compression. Representation and Description, Object Recognition, 3-D vision and Geometry, Digital Watermarking. Texture Analysis, Image Retrieval.

Reading:

1. D. A. Forsyth, J. Ponce, *Computer Vision: A Modern Approach*, PHI Learning 2009.
2. Milan Soanka, Vaclav Hlavac and Roger Boyle, *Digital Image Processing and Computer Vision*, Cengage Learning.

3. R.C. Gonzalez and R.E. Woods, *Digital Image Processing*, Third Edition, Pearson Education, 2009.
4. R.C. Gonzalez and R.E. Woods and Steven L. Eddins, Digital Image Processing Using MATLAB, 2nd Edition, McGraw Hill Education, 2010.

CS483	SERVICE-ORIENTED ARCHITECTURE	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand software oriented architectures
CO2	Design medium scale software project development using SOA principles
CO3	Develop SOA messages from business use cases
CO4	Design and implementation of modern SOA and SOA-specific methodologies, technologies and standards
CO5	Create composite services by applying composition style

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	1	2	-	1	-	-	3	1	1	-	2
CO2	3	2	3	1	3	-	1	-	1	-	-	3	1	1	-	2
CO3	3	2	3	2	3	1	2	-	2	-	-	3	1	1	-	2
CO4	3	2	3	2	3	-	1	-		-	-	2	1	1	-	2
CO5	3	2	3	2	3	1	2	-	1	-	-	2	1	1	-	1

Detailed syllabus:

Introduction to SOA, Evolution of SOA: Fundamental SOA; Common Characteristics of contemporary SOA; Common tangible benefits of SOA; An SOA timeline (from XML to Web services to SOA); The continuing evolution of SOA (Standards organizations and Contributing vendors); The roots of SOA (comparing SOA to Past architectures).

Web Services and Primitive SOA: The Web services framework· Services (as Web services); Service descriptions (with WSDL); Messaging (with SOAP).

Web Services and Contemporary SOA – I Message exchange patterns; Service activity; Coordination; Atomic Transactions; Business activities; Orchestration; Choreography. Web Services and Contemporary SOA-2: Addressing; Reliable messaging; Correlation; Polices; Metadata exchange; Security; Notification and eventing.

Principles of Service - Orientation: Services orientation and the enterprise; Anatomy of a service oriented architecture; Common Principles of Service orientation; how service orientation principles interrelate; Service orientation and object orientation; Native Web service support for service orientation principles.

Service Layers: Service orientation and contemporary SOA; Service layer abstraction; Application service layer, Business service layer, Orchestration service layer; Agnostic services; Service layer configuration scenarios.

Business Process Design: WS-BPEL language basics; WS Coordination overview; Service oriented business process design; WS addressing language basics; WS Reliable Messaging language basics.

SOA Platforms: SOA platform basics; SOA support in J2EE; SOA support in. ET; Integration considerations

Reading:

1. Thomas Erl, *Service-Oriented Architecture: Concepts, Technology and Design*, Prentice Hall Publication, 2005.
2. Michael Rosen, Boris Lublinsky, *Applied SOA Service Oriented Architecture and Design Strategies*, Wiely India Edition, 2008.

CS484	SECURE SOFTWARE ENGINEERING	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate secure software engineering problems, including the specification, design, implementation, and testing of software systems
CO2	Elicit, analyze and specify security requirements through SRS
CO3	Design and Plan software solutions to security problems using various paradigms
CO4	Model the secure software systems using Unified Modeling Language Sec(UMLSec)
CO5	Develop and apply testing strategies for Secure software applications

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	2	3	1	1	2	2	2	1	1	1	2	2	3
CO2	2	2	2	2	3	1	1	2	2	2	1	1		2	2	3
CO3	2	1	3	3	3	1	1	2	2	2	1	1	2	3	3	3
CO4	1		1	2	3	1	1	1	2	2	1	1	2	2	2	3
CO5	1	1	2	1	3	1	1	1	2	2	1	1	2	2	2	3

Detailed syllabus:

Software assurance and software security, threats to software security, sources of software insecurity, benefits of detecting software security, managing secure software development

Defining properties of secure software, how to influence the security properties of software, how to assert and specify desired security properties

Secure software Architecture and Design: Software security practices for architecture and design: Architectural risk analysis, software security knowledge for Architecture and Design: security principles, security guidelines, and attack pattens, secure design through threat modeling

Writing secure software code: Secure coding techniques, Secure Programming: Data validation, Secure Programming: Using Cryptography Securely, Creating a Software Security Programs.

Secure Coding and Testing: code analysis- source code review, coding practices, static analysis, software security testing, security testing consideration through SDLC

Reading:

1. Julia H Allen, Sean J Barnum, Robert J Ellison, Gary McGraw, Nancy R Mead, and Software Security Engineering: A Guide for Project Managers, Addison Wesley, 2008.
2. Ross J Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems, 2nd Edition, Wiley, 2008.
3. Howard, M. and LeBlanc, D., Writing Secure Code, 2nd Edition, Microsoft Press, 2003.

CS485	**DESIGN PATTERNS**	**DEC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand common design patterns in the context of incremental/iterative development
CO2	Evaluate and retractor software source code using patterns
CO3	Analyze and combine design patterns to work together in software design
CO4	Implement the design patterns in an object oriented language.
CO5	Understand the benefits of a pattern approach over program in a software application.

Course Articulation Matrix

CO \ **PO/PSO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	-	2	-	-	2	2	2	1	2	-	1
CO2	3	2	3	2	3	-	2	-	-	2	2	3	2	2	-	2
CO3	3	2	3	2	3	-	2	-	-	2	3	3	2	3	-	1
CO4	3	2	3	2	3	-	2	-	-	2	2	3	2	3	-	-
CO5	1	2	1	1	2	-	2	-	-	2	2	2	1	2	-	-

Detailed syllabus:

Introduction: What Is a Design Pattern, Design Patterns in Smalltalk MVC, Describing Design Patterns, the Catalog of Design Patterns, Organizing the Catalog, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design Pattern.

A Case Study: Designing a Document Editor: Design Problems, Document Structure, Formatting, Embellishing the User Interface, and Supporting Multiple Look-and-Feel Standards, Supporting Multiple Window Systems, User Operations, Spelling Checking and Hyphenation.

Creational Patterns: Abstract Factory, Builder, Factory Method, Prototype, Singleton.

Structural Pattern: Adapter, Bridge, Composite, Decorator, Façade, Flyweight, Proxy.

Behavioral Patterns: Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template Method, Visitor, a Brief History, and the Pattern Community

Reading:

1. Erich Gamma, *Design Patterns*, Addison-Wesley, 1994.
2. Frank Buschmann, RegineMeunier, Hans Rohnert, Peter Sommerlad, Michael Stal, *Pattern-Oriented Software Architecture: A System of Pattern*, John Wiley & Sons; 1996.

CS486	GPU PROGRAMMING	DEC	2 – 0 – 2	3

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze for the performance of GPU memory hierarchy
CO2	Develop parallel programs using OpenCL library
CO3	Generate parallel programs for matrix, graph and sorting problems using Cuda library
CO4	Compare the performance of different algorithms for the numerical and data processing problems on GPGPUs and suggest methods for improving the performance.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	2	3	3	-	-	-	-	2	-	2	2	-	3
CO2	2	2	3	3	2	2	-	-	-	-	1	-	3	3	2	2
CO3	3	3	3	3	3	3	-	-	-	-	3	-	3	3	-	2
CO4	3	3	2	3	3	3	-	-	-	-	-	-	2	-	-	3

Detailed syllabus

GPU Computing - Introduction : Introduction to General Purpose Computing on Graphic Processing Units (GPGPU); GPU as parallel computers – CUDA enabled NVIDIA GPUs; AMD-ATI-OpenCL, GPGPU Architecture of a Modern GPU – Threaded Streaming Multi-processors; communication bandwidth; Unified Graphics and Computing Processors; GPGPU- GPU computing – Scalable GPUs; Speed-up & Parallelism; CPU/GPU programing; SPMD programming model

CUDA APIs & CUDA Threads - GPUs-Data Parallelism; GPU-CUDA Program Structure; GPU device memories & Data transfer; Kernel functions and threading; CUDA Runtime API; CUDA Thread Execution; CUDA Thread organization; Synchronization; Thread Scheduling;

CUDA Memory and Performance Considerations : GPUs-Memory Access Efficiency; CUDA Device Memory types; CUDA memory model – constant memory; shared memory; local memory; global memory – Performance Issues; Unified Address space- NVIDIA GPUS; Global Memory Bandwidth; Thread Granularity; Memory Coalescing; Using Multiple GPUs; CUDA – matrix into matrix multiplication using shared memory without shared memory

Performance Issues - Matrix Computations : Performance Considerations; Data Prefetching; Shared memory resources; Programming on Dense Matrix computations (Vector-Vector Multiplication; Matrix-Vector Multiplication; Matrix-Matrix Multiplication

OpenCL (Open Computing Language) : Heterogeneous Computing – Programming; Data Parallelism Model – OpenCL; OpenCL, Device Architecture; OpenCL Kernel Functions; OpenCL APIs – Matrix-Matrix, Computations using different partitioning techniques– OpenCL; OpenCL – Device Management and Kernel launch; Compilation Model and programming features of OpenCL – Device query; Object Query, and task parallelism model

Reading:

1. Benedict R Gaster, Lee Howes, David R Kaeli Perhaad Mistry Dana Schaa, *Heterogeneous Computing with OpenCL,* MGH, 2011
2. Jason Sanders, Edward Kandrot, *CUDA By Example – An Introduction to General-Purpose GPU Programming,* Addison Wesley, 2011

CS487	Program Analysis and Verification	DEC	3 – 0 – 0	3 Credits

Pre-requisites: CS201**-** Discrete Mathematics, CS316- Principles of Programming Languages, CS351- Launguage Processors

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply the theory of abstract interpretation.
CO2	Examine existing techniques
CO3	Combine algorithms for program analysis
CO4	Experiment with Soot and Java software packages.

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	1	-	1	-	-	1	-	-	2	1	3	3
CO2	2	3	3	2	3	-	-	1	-	1	1	1	3	2	1	1
CO3	2	2	3	3	2	1	1	-	1	-	1	1	3	1	1	1
CO4	3	3	3	3	3	1	1	-	1	1	1	-	3	`3	2	3

Detailed syllabus

Introduction - Nature of Program Analysis, Data Flow Analysis, Equational Approach, and Constraint Based, Type and Effect Systems, Effect Systems, Algorithms.
Data Flow Analysis – Intraprocedural Analysis, Available Expressions Analysis, Reaching Definitions Analysis, Very Busy Expressions Analysis, Live Variables Analysis, Structural Operational Semantics, Correctness of Live Variables Analysis, Monotone Frameworks, Equation Solving, Interprocedural Analysis, Shape Analysis.
Constraint Based Analysis - Abstract 0-CFA Analysis, Theoretical Properties, Constraint Based 0-CFA Analysis, Adding Context Information.
Abstract Interpretation – Correctness, Approximation of Fixed Points, Galois Connections, Induced Operations.
Type and Effect Systems - Control Flow Analysis, Theoretical Properties, Inference Algorithms, Effects, Behaviours.
Algorithms - Worklist Algorithms, Iterating in Reverse Postorder.

Reading:

1. Flemming Nielson, Hanne R. Nielson and Chris Hankin, *Principles of Program Analysis*, Springer, 2005.

2. Edmund M. Clarke, Jr., Orna Grumberg, Daniel Kroening, Doron Peled and Helmut Veith, *Model Checking*, MIT Press, Second Edition, 2018
3. Aaron R. Bradley and Zohar Manna, *The Calculus of Computation*, Springer, 2007
4. Daniel Kroening and Ofer Strichman, *Decision Procedures: An Algorithmic Point of View*, Springer, 2008

OPEN ELECTIVES

CE390	ENVIRONMENTAL IMPACT ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	-	-	3	3	1	-	2	1	-	-	-	-	-
CO2	2	1	2	-	-	3	3	1	-	2	1	-	-	-	-	-
CO3	2	1	2	-	-	3	3	1	-	2	1	-	-	-	-	-
CO4	2	1	2	-	-	3	3	1	-	2	1	-	-	-	-	-
CO5	2	1	2	-	-	3	3	1	-	2	1	-	-	-	-	-

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid

Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies**:** Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain R.K., Urban L.V., Stracy G.S., *Environmental Impact Analysis*, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal R. R., *Environmental Impact Assessment*, New Age International Publishers, 2002
3. Rau J.G. and Wooten D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu Y., and Manickam V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

EE390	LINEAR CONTROL SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	1	-	-	-	-	-	-	1	3	2	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	1	3	2	-
CO3	3	3	2	-	-	1	-	-	-	-	-	-	1	3	2	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-	1	3	2	-

Detailed syllabus:

Introduction: Control system, types, feedback and its effects-linearization

Mathematical Modeling of Physical Systems: Block diagram Concept and use of Transfer function. Signal Flow Graphs, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Introduction to state variables technique, Analysis of R-L, R-L-C networks.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C.Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co.2008.

EE391	SOFT COMPUTING TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	-	-	-	-	-	-	-	1	1	3	-
CO2	3	3	1	2	2	-	-	-	-	-	-	-	1	1	3	-
CO3	3	3	1	2	2	-	-	-	-	-	-	-	1	1	3	-
CO4	3	3	1	2	2	-	-	-	-	-	-	-	1	1	3	-

Detailed syllabus:

Fundamentals Of Soft Computing Techniques: Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

Genetic Algorithm And Particle Swarm Optimization: Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions - PSO topologies - control parameters. Application to SINX maximization problem.

Ant Colony Optimization And Artificial Bee Colony Algorithms: Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global

- Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm: Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Application to multi-modal function optimization

Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Reading:

1. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation, Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natural to Artificial Systems, Oxford university Press, 1999.
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimization and Intelligence: Advances and Applications, Information science reference, IGI Global, 2010.
7. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

ME390	AUTOMOTIVE MECHANICS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical and electronics systems.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-
CO2	1	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-
CO3	1	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-
CO4	1	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-
CO5	1	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-
	1	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-

Detailed syllabus

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermosyphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto and Electronic, Engine Starting drives

Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.

Engine testing and Performance: Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods

Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch- Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.

Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.

Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M. Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H. Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME391	ENTREPRENEURSHIP DEVELOPMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO2	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO3	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO4	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO5	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO6	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-

Detailed syllabus

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small Scale Enterprises**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E. Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rdEdition, Pearson Edu., 2013.

EC390	COMMUNICATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	-	-	1	1	-	-	-	-	-	-	-	1	-	-
CO2	1	1	-	-	1	1	-	-	-	-	-	-	-	1	-	-
CO3	1	1	-	-	1	1	-	-	-	-	-	-	-	1	-	-
CO4	1	1	-	-	1	1	-	-	-	-	-	-	-	1	-	-

Detailed syllabus

Signal Analysis**:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S. Haykin, Communication Systems, 4thEdn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rdEdition, Oxford University Press, Chennai, 1998.
3. Leon W. Couch II. Digital and Analog Communication Systems, 6thEdition, Pearson Education Inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4thEdition, MGH, New York, 2002.

EC391	MICROPROCESSOR SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO2	1	1	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO3	1	1	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO4	1	1	1	-	2	-	-	-	-	-	-	-	-	1	-	-

Detailed syllabus

Microcomputer Organization: CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387

Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors

Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI,ARM9TDMI.
Case study-Industry Application of Microcontrollers

Reading:

1. Barry B. Brey, Intel Microprocessor Architecture, Programming and Interfacing-8086/8088, 80186, 80286, 80386 and 80486, PHI, 1995.
2. Muhammad Ali Mazidi and Mazidi, The 8051 Microcontrollers and Embedded systems,PHI,2008
3. Intel and ARM Data Books on Microcontrollers.

MM364	FUNDAMENTALS OF MATERIALS PROCESSING TECHNOLOGY	OPC	3 – 0 –0	03 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Describe engineering materials.
CO2	Appreciate material processing techniques.
CO3	Select material processing technique for a given material and application.
CO4	Explain surface engineering techniques and their engineering significance.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	1	1	-	-	-	-	-	1	1	-	-
CO2	3	3	2	-	-	1	1	-	-	-	-	-	1	1	-	-
CO3	3	3	2	-	-	1	1	-	-	-	-	-	1	1	-	-
CO4	3	3	2	-	-	1	1	-	-	-	-	-	1	1	-	-

Detailed syllabus

Introduction to engineering materials: Metals, alloys and phase diagrams, ferrous metals, non-ferrous metals, superalloys, guide to processing of metals; ceramics-structure and properties of ceramics, traditional ceramics, new ceramics, glass, some important elements related to ceramics; polymers-fundamentals of polymer science and technology, thermoplastic and thermosetting polymers, elastomers; composite materials-classification of composite materials, metal matrix, polymer matrix and ceramic matrix composites.

Fundamental properties of materials: mechanical properties-stress-strain relationships, hardness, tensile properties, effect of temperature on properties, visco-elastic behaviour of polymers, thermal properties and electrical properties of metals, polymers, ceramics and composites.

Metal casting fundamentals and metal casting processes: Overview of casting technology, melting and pouring, solidification and casting, sand casting, other expendable-mold casting processes, permanent-mold casting processes, casting quality, metals for casting.

Particulate processing of metals and ceramics: Powder metallurgy-characterization of engineering powders, production of metallic powders, conventional processing and sintering, alternative processing and sintering techniques, materials and products for powder metallurgy, design considerations in powder metallurgy, processing of traditional ceramics, processing of new ceramics, cermets and their processing.

Fundamentals of metal forming and shaping processes, such as rolling, forging, extrusion, drawing, sheet metal forming: Overview of metal forming, friction and lubrication in metal forming; bulk deformation processes in metal forming-rolling, other deformation processes related to rolling, forging, other deformation processes related to forging, extrusion, wire and bar drawing; cutting and bending operations, sheet-metal drawing, other sheet metal forming operations, dies and presses for sheet-metal processes, sheet-metal operations not performed in presses.

Fundamentals welding: Overview of welding technology, the weld joint, physics of welding, features of a fusion-welded joint; Welding processes-arc welding, resistance welding, oxy-fuel gas welding, other fusion welding processes, solid-state welding, weld quality, weldability; brazing, soldering and adhesive bonding.

Surface engineering and tribology: Importance of surface engineering, classification of surface engineering processes, introduction to thermal, mechanical, thermo-chemical and electro-chemical surface engineering processes with their advantages, limitations and applications.

Reading:

1. Kalpakjian and Schmid, Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons, Inc., New Jersey, 2010.
3. DeGarmo, Black, and Kohser, Materials and Processes in Manufacturing, John Wiley & Sons, Inc, New York, 2011.
4. R. S. Parmar, Welding processes and Technology, Khanna Publishers, 2010.
5. H.S. Bawa, Manufacturing Technology-I, Tata McGraw Hill Publishers New Delhi, 2007.
6. Serope Kalpakjian, Manufacturing processes for Engineering Materials, Addison Wesley, 2001.

CH390	NANOTECHNOLOGY AND APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the properties of nanomaterials
CO2	Synthesize nanoparticles
CO3	Characterize nanomaterials.
CO4	Scale up the production of nanoparticles
CO5	Evaluate safety and health related issues of nanoparticles

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	`-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nanosizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones.

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

Applications: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials.

Nanoinroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,

Nanobiology: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts

Reading:

1. Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak, H.F. Tibbals, JoydeepDutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
5. Davies, J.H., The Physics of Low Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998.

CH391	INDUSTRIAL SAFETY MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Prerequisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and prevention.
CO4	Assess the risks using fault tree diagram.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, The Nature of the Accident Process, Inherent Safety.

Industrial Hygiene-Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Toxic Release and Dispersion Models-Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.

Fires and Explosions-The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.

Risk Assessment- Review of Probability Theory, Event Trees, and Fault Trees.

Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures-Operating, Procedures-Permits, Procedures-Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Elsevier India, Volume 6, 2006.

CH392	INDUSTRIAL POLLUTION CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Analyze the effects of pollutants on the environment.
CO2	Distinguish air pollution control methods
CO3	Assess treatment technologies for wastewater
CO4	Identify treatment technologies for solid waste
CO5	Select treatment methodologies for hazardous and E-waste

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																
CO5																

Detailed Syllabus:

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, ambient air sampling, Stack sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment.Control of specific gaseous pollutants: Control of NOx emissions, Control of hydrocarbons and mobile sources.

Water pollution: Water resources, Origin of wastewater, types of water pollutants and their effects.

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, advanced wastewater treatment, Recovery of materials from process effluents.

Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal.

Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.

E-waste: Sources, environmental and social issues, management practices

Reading:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 1993.
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, Prentice Hall of India, 2nd Edition, 2004.
4. Rao M.N., Rao H.V.N, Air Pollution, Tata McGraw Hill Publishing Ltd., 1993.
5. De A.K., Environmental Chemistry, Tata McGraw Hill Publishing Ltd., 1999.
6. George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Metcalf & Eddy, Inc., Franklin Burton, Waste Water Engineering: Treatment and Reuse, McGraw Hill Education; 4thEdition, 2003.
7. E-waste recycling, NPCS Board of consultants and Engineers, Asia pacific business press Inc. 2015

CH393	SOFT-COMPUTING METHODS FOR CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Use neural networks to control the process plants
CO2	Develop fuzzy logic based controllers for different processes
CO3	Combine fuzzy logic with neural networks for plant control
CO4	Design controllers using genetic algorithms

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																

Detailed syllabus

Introduction to Artificial Neural Networks: Basic properties, Neuron Models, Feed forward networks.

Neural Networks Based Control: Representation and identification, modeling the plant, control structures – supervised control, Model reference control, internal model control, Predictive control: Examples – Inferential estimation of viscosity and chemical process, Auto – turning feedback control.

Introduction to Fuzzy Logic: Fuzzy Controllers, Fuzzy sets and Basic notions – Fuzzy relation calculations – Fuzzy members – Indices of Fuzziness – comparison of Fuzzy quantities – Methods of determination of membership functions.

Fuzzy Logic Based Control: Fuzzy sets in commercial products – basic construction of fuzzy controller – Analysis of static properties of fuzzy controller – Analysis of dynamic properties of fuzzy controller – simulation studies – case studies – fuzzy control for smart cars.

Neuro – Fuzzy and Fuzzy – Neural Controllers: Neuro – fuzzy systems: A unified approximate reasoning approach – Construction of role bases by self-learning: System structure and learning.

Introduction to Genetic algorithms. Controller design using genetic algorithms.

Reading:

1. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, John Wiley & Sons, 2007.
2. Bose and Liang, Artificial Neural Networks, Tata McGraw Hill, 1996.
3. Huaguang Zhang, Derong Liu, Fuzzy Modeling and Fuzzy Control, Birkhauser Publishers, 2006.
4. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Prentice Hall of India, 1992.
5. Lakshmi C. Jain, N. M. Martin, Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms: Industrial Applications, CRC Press, 1998.
6. MuhammetÜnal, AyçaAk, VedatTopuz, Hasan Erdal, Optimization of PID Controllers using Ant Colony and Genetic Algorithms, Springer, 2013.

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3 – 0 – 0	3 Credits

(Not offered to Computer Science and Engineering Students)

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO2	3	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO4	3	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO5	3	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling-event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, Understanding object-oriented programming with Java, Pearson, 2000.
2. Herbert Schildt, The complete reference Java 2, TMH, 2017.

BT390	GREEN TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: Chemistry

Course Outcomes: At the end of the course, the student will be able to:

CO1	Address smart energy, green infrastructure and non-renewable energy challenges
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand history, global, environmental & economic impacts of green technology
CO4	Explore the usage of microorganism for the bioremediation
CO5	Synthesis the nanoparticles by various biological methods
CO6	Apply the green techniques for the production of renewable fuels

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	1	-	1	2	-	-	-	-	-	2	-	1	-
CO2	1	1	-	1	3	2	1	-	-	-	-	-	2	2	-	-
CO3	2	1	-	1	-	1	2	-	-	-	-	-	3	-	3	-
CO4	2	1	-	1	-	1	2	-	-	-	-	-	1	2	3	-
CO5	1	-	-	1	-	2	-	-	-	-	-	-	2	-	-	-
CO6	-	2	-	2	-	-	3	-	-	-	-	-	1	3	3	-

Detailed Syllabus:

Green Technology definition, factors affecting green technologies, co/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies); design for sustainability reuse, recovery, recycle, raw material substitution, cleaner production, ISO 14000, wealth from waste, case studies.

Clean Technology: Biotechnology and Microbiology of Degradation of coal – Aerobic and Anaerobic pathway of coal degradation, Biogas technology, Microbial and biochemical aspects, Operating parameters for biogas production, kinetics and mechanism - Dry and wet fermentation. Digesters for rural application - High rate digesters for industrial waste water treatment.

Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in Indian context; tidal and geothermal energy, Design and operation of Fixed and Fluidized Bed Gasifiers. Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for ecosystems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-industrial settings. Future utilization of biomass in India. Future of landscape management: optimal management.

Nano particles preparation techniques, Greener Nano synthesis: Greener Synthetic Methods for Functionalized Metal Nan particles, Greener Preparations of Semiconductor and Inorganic Oxide Nano particles, green synthesis of Metal nanoparticles, Nanoparticle characterization methods, Green materials: biomaterials, biopolymers, bioplastics, and composites. Nanomaterials for Fuel Cells and Hydrogen; Generation and storage, Nano-structures for efficient solar hydrogen production, Metal Nanoclusters in Hydrogen Storage Applications, Metal Nanoparticles as Electro-catalysts in Fuel Cells, Nanowires as Hydrogen Sensors.

Reading:

1. Ristinen, Robert Kraushaar, Jack J.A Kraushaar, Jack P. Ristinen, Robert A.,Energy and the Environment, 2nd Edition, John Wiley, 2006, ISBN: 9780471172482; Publisher: Wiley, Location: New York, 2006.
2. B. R Wilson & W J Jones, Energy, Ecology and the Environment, Academic PressInc, 2005.
3. Sarkar S, Fuels and combustion, 2nd ed., University Press, 2009.

SM390	MARKETING MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior- Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning.

Importance of new product development process and the various stages involved.

The concept of product lifecycle and the various strategies used by the marketer in each stage.

Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.

Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14^{th} Edition, 2013.
2. William Stonton & Etzel, Marketing Management, TMH, 13^{th} Edition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-
CO5	3	3	1	1	1	-	-	-	-	-	-	-	-	1	2	-

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	FUZZY MATHEMATICS AND APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	2	1	-	-	-	-	-	-	-	1	2	-
CO2	3	3	1	1	2	1	-	-	-	-	-	-	-	1	2	-
CO3	3	3	1	1	2	1	-	-	-	-	-	-	-	1	2	-
CO4	3	3	1	1	2	1	-	-	-	-	-	-	-	1	2	-
CO5	3	3	1	1	2	1	-	-	-	-	-	-	-	1	2	-

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution

-cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, cylindric closure, FR on a domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	MEDICAL INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	1	2	-	-	-	-	-	-	1	-	-	-
CO2	3	2	2	-	1	2	-	-	-	-	-	-	1	-	-	-
CO3	3	2	2	-	1	2	-	-	-	-	-	-	1	-	-	-
CO4	3	2	2	-	1	2	-	-	-	-	-	-	1	-	-	-
CO5	3	2	2	-	1	2	-	-	-	-	-	-	1	-	-	-
CO6	3	2	2	-	1	2	-	-	-	-	-	-	1	-	-	-

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are & Junctional transmission.

The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC ECG Amplier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic non invasive pressure measurement, Direct measurement of blood pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.

Pulse Oximetr: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pacemaking, Defibrillators, cardioverters, electrosurgical unit, Therapeutic applications of laser, Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design, John Wiley, 3rd Edition, 2012.
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, 4th Edition, Prentice Hall India, 2001

PH391	ADVANCED MATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-
CO2	3	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-
CO3	3	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-
CO4	3	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-
CO5	3	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-

Detailed Syllabus:

Nano Materials: Origin of nanotechnology, Classification of nanomaterials, Physical, chemical, electrical, mechanical properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nanotubes (CNT). Synthesis, preparation of nanotubes, nanosensors, Quantum dots, nanowires, nanobiology, nanomedicines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopedic implants, dental materials.

Composites: General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices (CCD), laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, and Pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets.

Reading:

1. T. Pradeep, Nano: The Essentials; TATA McGraw-Hill, 2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press, 2012.
3. Krishan K Chawla, Composite Materials; 2ndEdition, Springer 2006.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the concepts of ultraviolet and visible absorption and fluorescence techniques for material characterization.
CO2	Understand the various liquid, gas and size-exclusion chromatographic techniques the automated continuous analysis of environmental, industrial, production-line materials
CO3	Understand the concepts of various electroanalytical techniques for characterization of interfaces and traces of surface adsorbed-materials.
CO4	Understands the principles of thermogravimetry and differential thermal analyses (TGA and DTA) for applications into pharmaceuticals, drugs, polymers, minerals, toxins and in Finger Print Analysis
CO5	Identification of suitable analytical technique for characterization of chemical, inorganic and engineering materials

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-	-
CO2	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-	-
CO3	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-	-
CO4	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-	-
CO5	3	3	-	3	1	1	1	-	-	-	-	-	1	2	-	-

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence: Beer-Lambert's law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.

Atomic spectrometry, atomic absorption, X-ray fluorescence methods: Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, instrumentation, quantitative analysis.

Chromatorgraphy methods: Gas chromatography, High performance liquid chromatography, size exclusion chromatography, Principle, Basic instrumentation, terminology, NPC, RPC, Qualitative and Quantitative applications. Capillary Electrophoresis: Principle and application.

Thermoanalytical methods: Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations

Electroanalytical methods: Coulometric methods, Polarography, Pulse voltammetric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric Sensors, Applications.

Spectroscopic methods: Molecular absorption, Woodward rules, applications, Infrared absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications

Mass spectrometry: Principles, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Gurdeep Chatwal and Sham Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, 1986.
2. Skoog, Holler and Kouch, Instrumental methods of analysis, Thomson, 2007.
3. Mendham, Denny, Barnes and Thomas, Vogel: Text book of quantitative chemical analysis, Pearson, 6Edotion, 2007.
4. William Kemp, Organic spectroscopy, McMillan Education, UK, 1991.
5. Instrumental methods of analysis – Willard, Meritt and Dean, PHI, 2005.

HS390	SOFT SKILLS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO2	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO3	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO4	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO5	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English. Art of Communication, Communication process- Non-verbal Communication- Effective Listening.

Interpersonal and Intra Personal Communication Skills- Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles-Leadership.

Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette- Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview handling skills- Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody 4th Edition, Pearson, 2009.
2. K. Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009.

CE440	BUILDING TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans
CO2	Identify different materials, quality and methods of fabrication & construction.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify effective measures for fire proofing, damp proofing, and thermal insulation.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-	-	1	1	-	-	-	-	-	-	-	-	-
CO2	2	2	1	-	-	1	1	-	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	1	1	-	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	1	1	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance. Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building.

Termite proofing: Inspection, control measures and precautions, Lightning protection of buildings: General principles of design of openings, various types of fire protection measures to be considered while planning a building.

General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication. Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.

Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.

Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.

Plumbing services – water supply system, maintenance of building pipe line, sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008.
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpatrai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

EE440	NEW VENTURE CREATION	OPC	3–0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines for launching a new venture
CO4	Expose the students with the functional management issues of running a new venture

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO2	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO3	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-
CO4	-	-	-	-	-	3	1	3	2	2	3	-	1	2	-	-

Detailed syllabus:

Entrepreneur and entrepreneurship: Entrepreneurship and Small Scale Enterprises (SSE), Role in Economic Development, Entrepreneurial Competencies, and Institutional Interface for SSE.

Establishing the Small Scale Enterprise: Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework.

Operating the Small Scale Enterprises: Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE.

Reading:

1. Holt, Entrepreneurship: New Venture Creation, PHI (P), Ltd., 2001.

2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material, 1995
3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
4. P.C. Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986.
5. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
6. J B Patel, S S Modi, A Manual on Business Opportunity Identification and Selection, EDII, Ahmedabad, 1995.

EE441	PRINCIPLES OF ELECTRIC POWER CONVERSION	OPC	3–0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand the basics in the electric power conversion using power switching devices
CO2	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives
CO3	Analyze the different energy storage systems
CO4	Identify the various Industrial and domestic applications

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	1	1	1	1	-	-	-	-	-	1	2	-	-
CO2	1	2	1	1	1	1	1	-	-	-	-	-	1	2	-	-
CO3	1	2	1	1	1	1	1	-	-	-	-	-	1	2	-	-
CO4	1	2	1	1	1	1	1	-	-	-	-	-	1	2	-	-

Detailed syllabus:

Power Electronic Devices and Converters: V-I characteristics of SCR, MOSFET and IGBT. Phase controlled rectifiers, DC-DC converters and Inverters.

Applications to Electric Drives: Speed control of DC motor, Induction motors, PMSM and BLDC drives

Applications to Renewable Energy: Introduction to solar cell, solar panels, MPPT, wind and other renewable energy sources, Integration of renewable energy sources to the grid.

Energy Storage Systems: Study of automotive batteries, SMF, pumped storage systems, super-capacitors, fly wheels - applications, Li-ion batteries and applications to electric vehicles.

Domestic And Industrial Applications: Induction heating, melting, hardening, lighting applications and their control, UPS, battery chargers

Reading:

1. M.H.Rashid: Power Electronics-circuits, Devices and applications, Prentice Hall India, New Delhi, 2009.
2. P.S.Bhimbra: Power Electronics, Khanna publishers, New Delhi, 2012.
3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and design, John Willey & Sons, New York, 2006.

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	2	-	-	3	3	-	-	-	-	-	1	2	2	-
CO2	2	-	2	-	-	3	3	-	-	-	-	-	1	2	2	-
CO3	2	-	2	-	-	3	3	-	-	-	-	-	1	2	2	-
CO4	2	-	2	-	-	3	3	-	-	-	-	-	1	2	2	-
CO5	2	-	2	-	-	3	3	-	-	-	-	-	1	2	2	-
CO6	2	-	2	-	-	3	3	-	-	-	-	-	1	2	2	-

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K. Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Processes, John Wiley, 2001.

ME441	ROBUST DESIGN	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO2	1	1	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO3	1	1	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO4	1	1	3	2	1	-	2	-	-	-	-	-	-	1	1	-
CO5	1	1	3	2	1	-	2	-	-	-	-	-	-	1	1	-

Detailed syllabus

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

EC440	ELECTRONIC MEASUREMENTS AND INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-	1	1	1	-	-	-	-	-	1	2	-	-
CO2	2	2	1	-	1	1	1	-	-	-	-	-	1	2	-	-
CO3	2	2	1	-	1	1	1	-	-	-	-	-	1	2	-	-
CO4	2	2	1	-	1	1	1	-	-	-	-	-	1	2	-	-

Detailed syllabus

Measurement And Error: Sensitivity, Resolution, Accuracy and precision, Absolute and Relative types of errors, Statistical analysis, Probability of and Limiting errors, Linearity.

Instruments: D'Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.
Transducers (Qualitative Treatment Only): Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.
Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS.
General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell, Electronic Instrumentation and Measurements, 3rd Edition, Oxford, 2013.

MM499	METALLURGY FOR NON-METALLURGISTS	OPC	3-0-0	03 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Discuss the characteristics and applications of metals and alloys.
CO2	Explain different fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-	1	1	1	-	-	-	-	-	1	1	-	-
CO2	2	2	1	-	1	1	1	-	-	-	-	-	1	1	-	-
CO3	2	2	1	-	1	1	1	-	-	-	-	-	1	1	-	-
CO4	2	2	1	-	1	1	1	-	-	-	-	-	1	1	-	-

Detailed syllabus

Introduction to Metallurgy: Metals and Alloys classification, engineering applications of metals/alloys.

Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals.

Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture

Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening

Fabrication and Finishing of metal products: Metal Working and Machining

Testing of Metals: Destructive and Non-Destructive Testing, Inspection and Quality Control of Metals.

Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, selective non-ferrous metals and alloys.

Heat Treatment: Annealing, Normalizing, Hardening and Tempering.

Material selection processes: Case studies

Reading:

1. M. F. Ashby, Engineering Metals, 4th Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd, 2007.
3. R. Abbaschian, L. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, East-West Press, 2009.
4. V Raghavan, Elements of Materials Science and Engineering- A First Course, 5th Edition, PHI Publications, 2011

CH440	DATA DRIVEN MODELLING	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify disturbance models
CO2	Estimate parametric and non-parametric models
CO3	Determine the model structure
CO4	Validate the developed models

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	2	-	-	-	-	-	-	1	-	-	3	-
CO2	2	2	1	2	2	-	-	-	-	-	-	1	-	-	3	-
CO3	2	2	1	2	2	-	-	-	-	-	-	1	-	-	3	-
CO4	2	2	1	2	2	-	-	-	-	-	-	1	-	-	3	-

Detailed syllabus

System Identification - Motivation and Overview. Models of Discrete-Time LTI Systems – Convolution equation. Difference equations, Transfer functions, State-space models, Discretization, Sampling and Hold operations, sampling theorem.

Disturbance models - random processes, representation of stationary processes, white-noise process, auto-covariance function (ACF), ARMA models. Parametric model structures - ARX, ARMAX, OE, BJ and PEM – structures and their applicability in real-time.

Linear Regression - Least Squares estimates, Statistical properties of LS Estimates. Weighted Least Squares, Recursive Least Squares, Maximum Likelihood Estimation and properties.

Estimation of non-parametric models - impulse / step response coefficients, frequency response models.

Estimation of parametric models - notions of prediction and simulation, predictors for parametric models, prediction-error methods, Instrumental Variable method.

Model Structure Selection and Diagnostics -estimation of delay and order, residual checks, properties of parameter estimates, model comparison and selection, model validation.

Reading:

1. Arun K. Tangirala. System Identification: Theory and Practice, CRC Press, 2014.
2. Karel J. Keesman, System Identification – An Introduction, Springer, 2011.
3. Nelles, O. Nonlinear System Identification, Springer-Verlag, Berlin, 2001.
4. Zhu, Y. Multivariable System Identification for Process Control, Pergamon, 2001.
5. Ljung, L. System Identification: Theory for the User, Prentice-Hall, 2nd Edition, 1999.
6. J. R. Raol, G. Girija, J. Singh, Modeling and Parameter Estimation of Dynamic Systems, The Institution of Electrical Engineers, 2004.
7. Rolf Johansson, System Modeling and Identification, Prentice Hall, 1993.

CH441	FUEL CELL TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

(Not offered to Chemical Engineering Students)

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Demonstrate the operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Course Articulation Matrix:

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																

Detailed syllabus

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. Hoogers G, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, 2006.
3. F. Barbir, PEM Fuel Cells: Theory and Practice, Elsevier/Academic Press, 2nd Edition, 2013.
4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications
5. Laminie J, Dicks A, Fuel Cell Systems Explained, 2nd Edition, John Wiley, New York, 2003.

CH442	DESIGN OF EXPERIMENTS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Design experiments for a critical comparison of outputs
CO2	Propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																

Detailed syllabus

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments.

Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.

Experiments with Single Factor; An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Nonparameteric methods in the analysis of variance, Problems.

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments.

Parameter Estimation.

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a second-order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, Designs for fitting the second-order model, Blocking in response surface designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems.

Design and Analysis: Introduction, Preliminary examination of subject of research, Screening experiments: Preliminary ranking of the factors, active screening experiment-method of random balance, active screening experiment Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Latin Square, Youdens Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Nongradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations.

Reading:

1. Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 2005.
2. Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heinemann, 2004.
3. Montgomery D. C., Design and Analysis of Experiments, Wiley, 5thEdition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-Hill, 1995.

CH443	**CARBON CAPTURE, SEQUESTRATION AND UTILIZATION**	**OPC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify the necessity of CO_2 capture, storage and utilization
CO2	Distinguish the CO_2capture techniques
CO3	Evaluate CO_2 Storage and sequestration methods
CO4	Assess Environmental impact of CO_2 capture and utilization

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																

Detailed syllabus

Introduction: Global status of CO_2 emission trends, Policy and Regulatory interventions in abatement of carbon footprint, carbon capture, storage and utilization (CCS&U)

CO_2 capture technologies from power plants: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemical looping combustion, calcium looping combustion

CO_2 capture agents and processes: Capture processes, CO_2 capture agents, adsorption, ionic liquids, metal organic frameworks

CO_2 storage and sequestration: Geological sequestration methods, Biomimetic carbon sequestration

CO_2 Utilization: CO_2 derived fuels for energy storage, polymers from CO_2, CO_2 based solvents, CO_2 to oxygenated organics, Conversion into higher carbon fuels, High temperature catalysis

Environmental assessment of CO_2 capture and utilization: Need for assessment, Green chemistry and environmental assessment tools, Life cycle assessment (LCA), ISO standardization of LCA, Method of conducting an LCA for CO_2 capture and Utilization.

Reading:

1. Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Carbon dioxide utilization: Closing the Carbon Cycle, Elsevier, 2015.
2. Goel M, Sudhakar M, Shahi RV, Carbon Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry, TERI, Energy and Resources Institute, 2015.
3. Amitava Bandyopadhyay, Carbon Capture and Storage, CO_2 Management Technologies, CRC Press, 2014.
4. Fennell P, Anthony B, Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO_2) Capture, Woodhead Publishing Series in Energy: No. 82, 2015.
5. Mercedes Maroto-Valer M, Developments in Innovation in Carbon Dioxide Capture and Storage Technology: Carbon Dioxide Storage and Utilization, Vol 2, Woodhead Publishing Series in Energy, 2014.

CS440	MANAGEMENT INFORMATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	1		3	-	-	2	-	-	2	-	1	-	-	-
CO2	-	-	1		3	-	-	2	-	-	2	-	1	-	-	-
CO3	-	-	1		3	-	-	2	-	-	2	-	1	-	-	-
CO4	-	-	1		3	-	-	3	-	-	2	-	1	-	-	-
CO5	-	-	1		3	-	-	2	-	-	3	-	1	-	-	-

Detailed syllabus

Organization and Information Systems, Foundation Concepts, Information Systems in Business, the Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, and Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, the Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT,

Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology.

Reading:

1. Kenneth J Laudon, Jane P. Laudon, Management Information Systems, 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, Management Information Systems, 3rd Edition, TMH, 2004.

BT440	BIOSENSORS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand biosensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bioanalytical devices and design of biosensors

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	-	-	-	-	-	-	-	-	-	-	3	1	-	-
CO2	2	2		2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	2	1	3	1	2	1	-	-	-	-	-	-	-	-	-	-
CO4	1	1	3	2	-	-	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; piezoelectric transducers.

Biorecognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.

Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	2	1	2	-	-	-	-	-

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM, Functions of HRM, Problems and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniques, Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Management, Development, Performance Appraisal and Employee Compensation, Factors Influencing, Employee Remuneration and Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human Resource Management, Workers Participation in Management, Employee safety and health, Managing Global Human Resources and Trade Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH. 2010.
2. Garry Dessler and BijuVarkkey, Human Resource Management, PEA. 2011.
3. Noe & Raymond, HRM: Gaining a Competitive Advantage, TMH, 2008.

4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage Learning, 2009.

MA440	OPTIMIZATION TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-

Detailed Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .

Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. Kanti Swarup, Man Mohan and P.K. Gupta, Introduction to Operations Research, S. Chand & Co., 2006

2. J.C.Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S. Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

MA441	OPERATIONS RESEARCH	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	1	1	2	-	-	-	-	-	-	-	-	-	3	-

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions.Degenracy in Transportation problems. Queueing Theory: Poisson process and exponential distribution. Poisson queues - Model (M/M/1) :(∞/FIFO) and its characteristics.

Elements of Inventory Control: Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages -

production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. K. Swarup, Manmohan & P.K. Gupta, Introduction to Operations Research, S. Chand & Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S. Kambo: Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	-	-	-	-	-	-	-	-	1	1	-	-
CO2	3	1	1	1	-	-	-	-	-	-	-	-	1	1	-	-
CO3	3	1	1	1	-	-	-	-	-	-	-	-	1	1	-	-
CO4	3	1	1	1	-	-	-	-	-	-	-	-	1	1	-	-

Detailed Syllabus:

General properties of Nano materials: Origin of nanotechnology. Classification of nanomaterials. Fullerene, carbon nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase, Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.

Nanosensors: Nanosensors based on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.

Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer, 2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	-	1	2	1	-	-	-	-	1	1	-	-
CO2	3	3	1	1	-	1	2	1	-	-	-	-	1	1	-	-
CO3	3	3	1	1	-	1	2	1	-	-	-	-	1	1	-	-
CO4	3	3	1	1	-	1	2	1	-	-	-	-	1	1	-	-

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.

Tissue response to implants: Normal wound healing processes, body response to implants, blood compatibility, and structure – property relationship of tissues.

Reading:

1. Joon Park, R.S. Lakes, Biomaterials an introduction; 3rd Edition, Springer, 2007
2. Sujatha V Bhat, Biomaterials; 2nd Edition, Narosa Publishing House, 2006.

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Demonstrate a systematic knowledge of the range and breadth of application of nanomaterials.
CO2	Review critically the potential impact, in all classes of materials, of the control of nanostructure
CO3	Describe the methods for the synthesis and nanostructural characterisation of such materials.
CO4	Identify the possible opportunities for nanomaterials in society development and enhancement.

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	-	2	2	-	-	-	-	-	1	-	-	-
CO2	3	1	1	1	-	2	2	-	-	-	-	-	1	-	-	-
CO3	3	1	1	1	-	2	2	-	-	-	-	-	1	-	-	-
CO4	3	1	1	1	-	2	2	-	-	-	-	-	1	-	-	-

Detailed Syllabus:

Introduction: Review the scope of nanoscience and nanotecnology, understand the nanoscience in nature, classification of nanostructured materials and importance of nanomaterials.

Synthetic Methods: Teach the basic principles for the synthesis of Nanostructure materials by Chemical Routes (Bottom-Up approach):-Sol-gel synthesis, microemulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis and Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.

Techniques for characterization: Learning of characterization method by various techniques like, Diffraction Technique:-Powder X-ray diffraction for particle size analysis, Spectroscopy

Techniques:-Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement, Electron Microscopy Techniques:-Scanning electron microscopy (SEM)and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM)BET method for surface area determination and Dynamic light scattering technique for particle size analysis.

Studies of nano-structured Materials:Synthesis, properties and applications of the following nanomaterials: fullerenes, carbon nanotubes, core-shell nanoparticles, nanoshells, self-assembled monolayers, and monolayer protected metal nanoparticles, nanocrystalline materials.

Reading:

1. T Pradeep, NANO: The Essentials, MaGraw Hill, 2007.
2. B S Murty, P Shankar, BaldevRai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology, Univ. Press, 2012.
3. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applications, Imperial College Press, 2007.
4. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, Narosa Pub., 2010.
5. Manasi Karkare, Nanotechnology: Fundamentals and Applications, IK International, 2008.
6. C. N. R. Rao, Achim Muller, K. Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007.

HS440	CORPORATE COMMUNICATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO2	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO3	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO4	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO5	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-
CO6	-	-	-	-	-	-	-	3	1	3	2	-	-	-	-	-

Detailed Syllabus:

Importance of Corporate communication: Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Oral Communication: Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.

Written Communication: Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Corporate responsibility: Circulating to employees vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette: Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Listening Skills: Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Leadership Communication Styles: Business leadership -Aspects of leadership-qualities of leader- training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. FlatleyLesikar's Basic Business Communication - 7thEdition: Irwin, 1993
2. Krishna Mohanand Meera Banerji, Developing Communication Skills: Macmillan Publishers India,2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill,2008
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999

SERVICE COURSES

Common to II year – I SEM B.Tech. (ECE, EEE) programmes

CS235	**DATA STRUCTURES**	**ESC**	**3 – 0– 0**	**3 Credits**

Pre-requisites: CS101-Problem Solving and Computer Programming

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic techniques of algorithm analysis and assess how the choice of data structures impact the performance of programs
CO2	Solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, AVL trees and writing programs for these solutions.
CO3	Implement graphs as adjacency matrix, adjacency list, Searching technique - Breadth First Search and Depth First Search.
CO4	Analyze, evaluate and choose appropriate data structures and algorithms for a specific application

Course Articulation Matrix

PO|PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	1	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	-	3	3	2	3
CO4	3	3	3	3	2	1	-	-	-	-	-	1	3	3	2	3

Detailed syllabus:

Detailed Syllabus: Introduction to Data Structures, Asymptotic Notations, Theorems and Examples based on Asymptotic Notations, Stack Data Structure and its Applications, Queue Data Structure and its Applications, Linked Lists, Trees and tree traversals, Dynamic Sets and Operations on Dynamic Sets, Binary Search Tree and its Operations ,Heap Data Structure Priority Queue, AVL Trees., Direct Addressing; Introduction to Hashing , Collision Resolution by Chaining, Collision Resolution by Open Addressing, Lower Bound for Comparison based Sorting Algorithms, Insertion Sort, Merge Sort, Quick Sort. Heap Sort and Counting Sort, Radix Sort, Introduction to Graphs and Representation of Graphs, Depth First Search (DFS), Breadth

First Search (BFS), Applications: BFS and DFS. Prim's Algorithm for finding Minimum Spanning Tree (MST), Kruskal's Algorithm for finding MST, Dijkstra's Algorithm for Single Source Shortest Paths Floydd-Warshall Algorithm for All-Pairs Shortest Path Problem

Reading:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Third Edition, Pearson Education, 2006

2. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Universities Press, 2 nd Edition, 2011.

Common to II year – I SEM B.Tech. (ECE, EEE) programmes

CS236	**DATA STRUCTURES LAB**	**ESC**	**0 – 0– 2**	**1 Credit**

Pre-requisites: CS101-Problem Solving and Computer Programming

Course Outcomes: At the end of the course the student will be able to:

CO1	Write structured programs using the concepts of data structures
CO2	Implement and analyze sorting algorithms.
CO3	Identity the data structure for a given problem
CO4	Understand and implement the Stack ADT using array based and linked-list based data structures and also implement Stack applications.

Course Articulation Matrix

PO|PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	1	-	-	-	-	-	-	3	3	2	3
CO2	3	3	3	2	1	-	-	-	-	-	-	-	3	3	2	3
CO3	3	3	3	2	1	2	-	-	-	-	-	-	3	3	2	3
CO4	3	3	3	3	2	1	-	-	-	-	-	1	3	3	2	3

List of Experiments:

1. Write a program to implement stack using arrays.
2. Write a program to evaluate a given postfix expression using stacks.
3. Write a program to convert a given infix expression to postfix form using stacks.
4. Write a program to implement circular queue using arrays.
5. Write a program to implement double ended queue (de queue) using arrays.
6. Write a program to implement a stack using two queues such that the push operation runs in constant time and the pop operation runs in linear time.

7. Write a program to implement a stack using two queues such that the push operation runs in linear time and the pop operation runs in constant time.

8. Write a program to implement a queue using two stacks such that the enqueue operation runs in constant time and the dequeue operation runs in linear time.

9. Write a program to implement a queue using two stacks such that the enqueue operation runs in linear time and the dequeue operation runs in constant time.

10. Write programs to implement the following data structures: (a) Single linked list (b) Double linked list

11. Write a program to implement a stack using a linked list such that the push and pop operations of stack still take O (1) time.

12. Write a program to implement a queue using a linked list such that the enqueue and dequeue operations of queue take O (1) time.

13. Write a program to create a binary search tree (BST) by considering the keys in given order and perform the following operations on it. (a) Minimum key (b) Maximum key (c) Search for a given key

(d) Find predecessor of a node (e) Find successor of a node (f) delete a node with given key

14. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVL tree.

15. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressing methods.

16. Implement the following sorting algorithms: (a) Insertion sort (b) Merge sort (c) Quick sort (d) Heap sort

17. Write programs for implementation of graph traversals by applying: (a) BFS (b) DFS

18. Write programs to find out a minimum spanning tree of a simple connected undirected graph by applying: (a) Prim's algorithm (b) Kruskal's algorithm

19. Write a program to implement Dijkstra's algorithm for solving single source shortest path problem using priority queue.

20. Write a program to implement Floydd-Warshall algorithm for solving all pairs shortest path problem.