UNDERGRADUATE DEGREE COURSES IN

COMPUTERSCIENCE&ENGINEERING

(Engineering &Technology)

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India

All India Council for Technical Education
Model curriculum for
Undergraduate Degree Courses in Engineering & Technology

COMPUTER SCIENCE AND ENGINEERING

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Model curriculum for
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COMPUTER SCIENCE AND ENGINEERING

Chapter -1
General, Course structure & Theme
&
Semester-wise credit distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week 2 Hours Practical(Lab)/week	0.5credit 1 credit

B. Range of credits-A student will be eligible to get Graduate degree in Engineering, if he/she completes 162 credits. A student will be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

C. Structure of Undergraduate Engineering program:

S. No.	Category	Credit Breakup for CSE students
1	Humanities and Social Sciences including Management courses	12
2	Basic Science courses	22
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	24
4	Professional core courses	58
5	Professional Elective courses relevant to chosen specialization/branch	18
6	Open subjects – Electives from other technical and /or emerging subjects	12
7	Project work, seminar and internship in industry or elsewhere	16
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution]	(non-credit)
	Total	**162**

**Minor variation is allowed as per need of the respective disciplines.*

D. Credit distribution in the First year of Undergraduate Engineering program:

	Lecture	Tutorial	Laboratory/Practical	Total credits
Chemistry-I	3	1	3	5.5
Physics	3	1	3	5.5
Maths-1	3	1	0	4
Maths-2	3	1	0	4
Programming for Problem solving	3	0	4	5
English	2	0	2	3
Engineering Graphics & Design	1	0	4	3
Workshop/ Practical	1	0	4	3
Basic Electrical Engg.	3	1	2	5
*Maths-3	3	1	0	4

These courses may be offered preferably in the later semesters

E. Course code and definition:

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
CSE	Professional core courses
CSE-ELV	Professional Elective courses
CSE-O-ELV	Open Elective courses
MC	Mandatory courses

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	HSMC 101	English	2	0	2	3	1
2	HSMC 201	Managerial Economics	3	0	0	3	4
3	HSMC 302	Management and Accountancy	3	1	0	4	5
4	HSMC 222	Technical English for Engineers	0	0	4	2	4
Total Credits:						**12**	

BASIC SCIENCE COURSE [BSC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	BSC101	Physics (Semi-conductor Physics)	3	1	3	5.5	1
2	BSC 201	Mathematics-II (Probability and Statistics)	3	1	0	4	2
3	BSC 102	Mathematics-I (Calculus and Linear Algebra)	3	1	0	4	1
4	BSC 202	Chemistry-I	3	1	3	5.5	2
5	BSC 301	Mathematics-III (Differential Calculus)	2	0	0	2	3
Total Credits:						**21**	

ENGINEERING SCIENCE COURSE [ESC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	ESC 101	Basic Electrical Engineering	3	1	2	5	1
2	ESC 102	Engineering Graphics & Design	1	0	4	3	1
3	ESC 201	Programming for Problem Solving	3	0	4	5	2
4	ESC 202	Workshop/Manufacturing Practices	1	0	4	3	2
5	ESC 302	Digital Electronics	3	0	4	5	4
6	ESC 501	Signals and Systems	3	0	0	3	5
Total Credits:						**24**	

PROFESSIONAL CORE COURSES [PCC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	CSE-301	Programming Language	2	0	4	4	3
2	CSE-302	Data Structure & Algorithms	3	0	4	5	3
3	CSE-313	Software tools	0	0	6	3	3
4	CSE-304	Computer Organization and Architecture	3	0	4	5	3
5	CSE-401	Discrete Mathematics	3	1	0	4	4
6	CSE-402	Operating Systems	3	0	4	5	4
7	CSE-403	Object Oriented Programming	2	0	4	4	4
8	CSE-404	Database Management Systems	3	0	4	5	4
9	CSE-501	Design and Analysis of Algorithms	3	0	4	5	5
10	CSE-502	Computer Network-I	3	0	4	5	5
11	CSE-503	Formal Language, Automats and Compiler	3	0	0	3	5
12	CSE-601	Compiler Design	3	0	4	5	6

13	CSE-602	Computer Networks-II	3	0	4	5	6
Total Credits						**58**	

PROFESSIONAL ELECTIVE [PEC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	CSE-ELV-501	Elective – I	3	0	0	3	5
2	CSE-ELV-601	Elective-II	3	0	0	3	6
3	CSE-ELV-602	Elective-III	3	0	0	3	6
4	CSE-ELV-701	Elective-IV	3	0	0	3	7
5	CSE-ELV-702	Elective-V	3	0	0	3	7
6	CSE-ELV-801	Elective-VI	3	0	0	3	8
Total Credits						**18**	

OPEN ELECTIVE COURSES [OEC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	CSE-O-ELV-601	Open Elective – I	3	0	0	3	6
2	CSE-O-ELV-701	Open-Elective-II	3	0	0	3	7
3	CSE-O-ELV-801	Open-Elective-III	3	0	0	3	8
4	CSE-O-ELV-802	Open-Elective-IV	3	0	0	3	8
Total Credits:						**12**	

4 year Curriculum structure
Undergraduate Degree in Engineering & Technology

Branch / course: Computer Science and Engineering
Total credits (4 year course): 162

I. Induction Program (Please refer Appendix-A for guidelines)

Induction program (mandatory)	**3 weeks duration** (Please refer Appendix-A for guidelines & also details available in the curriculum of Mandatory courses)
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch &Innovations

II Semester-wise structure of curriculum

[L= Lecture, T = Tutorials, P = Practical's & C = Credits]

Semester I (First year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Course Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Basic Science course	BSC 103	Mathematics-I	3	1	0	4
2	Engineering Science Course	ESC 102	Engg. Graphics & Design	0	0	4	2
3	Engineering Science Course	ESC 101	Basic Electrical Engineering	3	1	0	4
4	Engineering Science Course	ESC 111	Basic Electrical Engineering Laboratory	0	0	2	1
5	Engineering Science Course	ESC104	Workshop	1	0	4	3
6	Humanities & Social Sciences including Management courses	HSMC 101	English	2	0	0	2
7	Humanities & Social Sciences including Management courses	HSMC111	English	0	0	2	1
			Total credits				**17**

Semester II (First year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Basic Science course	BSC 102	Chemistry-I	3	1	0	4
2	Basic Science course	BSC 112	Chemistry-I Laboratory	0	0	3	1.5
3	Basic Science course	BSC101	Physics-I	3	1	0	4
4	Basic Science course	BSC111	Physics-I Laboratory	0	0	3	1.5
3	Basic Science course	BSC 104	Mathematics-II (Probability and Statistics)	3	1	0	4
4	Engineering Science Course	ESC 103	Programming for Problem Solving	3	0	0	3
4	Engineering Science Course	ESC 113	Programming for Problem Solving Laboratory	0	0	4	2
5	Engineering Science Course	ESC 112	Computer Aided Drawing	0	0	2	1
			Total credits				**21**

Semester III (Second year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Core Courses	CSE 301	Programming Language	2	0	0	2
2	Professional Core Courses	CSE 311	Programming Language Laboratory	0	0	4	2
3	Professional Core Courses	CSE-302	Data structure & Algorithms	3	0	0	3
4	Professional Core Courses	CSE-312	Data structure & Algorithms Laboratory	0	0	4	2
5	Engg. Science Course	ESC 301	Digital Electronics	3	0	0	3
6	Engg. Science Course	ESC 311	Digital Electronics	0	0	4	2

			Laboratory				
7	Professional Core Courses	CSE-313	Software tools	0	0	6	3
8	Basic Science course	BSC 301	Mathematics-III (Differential Calculus)	3	0	0	3
9	Professional Core Courses	CSE- 304	Computer Organization & Architecture	3	0	0	3
10	Professional Core Courses	CSE- 314	Computer Organization & Architecture Laboratory	0	0	4	2
			Total credits				**25**

Semester IV (Second year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Core Courses	CSE-401	Discrete Mathematics	3	1	0	4
2	Professional Core Courses	CSE-402	Operating Systems	3	0	0	3
3	Professional Core Courses	CSE-412	Operating Systems Laboratory	0	0	4	2
4	Professional Core Courses	CSE-403	Object Oriented Programming	2	0	0	2
5	Professional Core Courses	CSE-413	Object Oriented Programming Laboratory	0	0	4	2
6	Professional Core Courses	CSE-404	Database Management Systems	3	0	0	3
7	Professional Core Courses	CSE-414	Database Management Systems Laboratory	0	0	4	2
8	Humanities &Social Sciences including Management courses	HSMC 201	Managerial Economics	3	0	0	3
9	Humanities &Social Sciences including Management courses	HSMC 222	Technical English for Engineers	0	0	4	2
10	Mandatory Courses	MC201	Environmental Sciences	-	-	-	0
			Total credits				**23**

Semester V (Third year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Engineering Science Course	ESC501	Signals & Systems	3	0	0	3
2	Professional Core Courses	CSE-501	Design & Analysis of Algorithms	3	0	0	3
3	Professional Core Courses	CSE-511	Design & Analysis of Algorithms Laboratory	0	0	4	2
4	Professional Core Courses	CSE-502	Computer Network-I	3	0	0	3
5	Professional Core Courses	CSE-512	Computer Network-I Laboratory	0	0	4	2
4	Professional Core Courses	CSE-503	Formal Language & Automata Theory	3	0	0	3
5	Humanities &Social Sciences including Management courses	HSMC-302	Management & Accountancy	3	1	0	4
6	Professional Elective courses	CSE-ELV-501	Elective-I	3	0	0	3
7	Mandatory Courses	MC301	Constitution of India	-	-	-	0
Total credits							**23**

Semester VI (Third year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Core Courses	CSE-601	Compiler Design	3	0	0	3
2	Professional Core Courses	CSE-611	Compiler Design Laboratory	0	0	4	2
3	Professional Core Courses	CSE-602	Computer Network-II	3	0	0	3
2	Professional Core Courses	CSE-612	Computer Network-II Laboratory	0	0	4	2
3	Professional Elective courses	CSE-ELV-601	Elective-II	3	0	0	3
4	Professional Elective courses	CSE-ELV-602	Elective-III	3	0	0	3
5	Open Elective courses	CSE-O-ELV-601	Open Elective-I	3	0	0	3
6	Project/seminar/ Internship, etc.	CSE-613	Internship-I	0	0	1	1
			Total credits				**20**

Semester VII (Fourth year] Curriculum
Branch/Course: Computer Science Engineering

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Elective courses	CSE-ELV-701	Elective-IV	3	0	0	3
2	Professional Elective courses	CSE-ELV-702	Elective-V	3	0	0	3
3	Open Elective courses	CSE-O-ELV-701	Open Elective-II	3	0	0	3
	Project/seminar/ Internship, etc.	CSE-711	Internship-II	0	0	1	1
4	Project	CSE-712	Project-I	0	0	12	6
			Total credits				**16**

Semester VIII (Fourth year] Curriculum
Branch/Course: Computer Science Engineering
[Summer Industry Internship]

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Elective courses	CSE-ELV-801	Elective-VI	3	0	0	3
2	Open Elective courses	CSE-O-ELV-801	Open Elective-III	3	0	0	3
3	Open Elective courses	CSE-O-ELV-802	Open Elective-IV	3	0	0	3
4	Project	CSE-811	Project-II	0	0	12	6
5	Project/seminar/ Internship, etc.	CSE-812	Grand-VIVA	0	0	2	2
			Total credits				**17**

CHAPTER 2

DETAILED 4-YEAR CURRICULUM CONTENTS

Undergraduate Degree in Engineering & Technology

Branch/Course: COMPUTER SCIENCE AND ENGINEERING

THIRD SEMESTER

(Credits: 25)

BSC 301	Mathematics-III	2L:1T:0P	3 credits

PDE, Complex Variables and Transform Calculus

Module 1: ***Partial Differential Equations (10 hours)***

Solution to homogenous and non-homogenous linear partial differential equations second and higher order by complimentary function and particular integral method. Flows, vibrations and diffusions, second-order linear equations and their classification, Initial and boundary conditions (with an informal description of well-posed problems), D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, Solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables. Boundary-value problems: Solutionof boundary-value problems for various linear PDEs in various geometries.

Module 2: Complex Analysis (16 hours)

Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties. Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, Singularities, Laurent's series; Residues, CauchyResidue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour. Evaluation of definite integral involving sine and cosine. Evaluation of certain improper integrals using the Bromwich contour.

Module 3: Transform Calculus *(10 hours)*)

Polynomials – Orthogonal Polynomials – Lagrange's, Chebysev Polynomials; Trigonometric Polynomials; Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method. Fourier transforms, Fourier Integrals. Fourier integral theorem (without proof). Fourier Transform and inverse transform. Fourier Sine & Cosine Transform, inverse transform. Z-transform and Wavelet transforms: properties, methods, inverses and their applications.

Text Books

- B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 36thEdition, 2010.
- H. K. Dass, *Advanced Engineering Mathematics*, S Chand and Company Pvt. Ltd, Reprint 2014.
- M. D. Raisinghania, *Advanced Differential equations*, S Chand and Company Pvt. Ltd

Reference Books

- Erwin Kreyszig, *Advanced Engineering Mathematics*, 9thEdition, John Wiley & Sons,2006.
- W. E. Boyce and R. C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*, 9th Edition, Wiley India, 2009.
- S. L. Ross, *Differential Equations*, 3rd Edition, Wiley India, 1984.
- E. A. Coddington, *An Introduction to Ordinary Differential Equations*, Prentice HallIndia, 1995.
- N.P. Bali and Manish Goyal, *A text book of Engineering Mathematics*, 9th Editions Laxmi Publications, 2014.
- G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint, 2002.
- Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

CSE-301	Programming Language	2L:0T: 0P	2 credits

Programming Language

Module 1:

Introduction. Writing, compiling, and debugging C programs. Hello world. Variables and datatypes, operators. Control flow. Functions and modular programming. Variable scope. Static and global variables. Input and output.

Module 2: Pointers and memory addressing. Arrays and pointer arithmetic. Strings. Searching and sorting algorithms. User-defined datatypes, structs, unions, bitfields. Memory allocation. Linked lists, binary trees. Pointers to pointers, pointer and string arrays, multidimensional arrays. Stacks and queues.

Module 3: Void and function pointers. Hash tables. External libraries. B-trees, priority queues. C standard library: stdio.h, ctype.h, stdlib.h, assert.h, stdarg.h, time.h , Dynamic memory allocation, malloc and valgrind, garbage collection.

Module 4: Multithreading and concurrency. Multithreaded programming. Sockets and asynchronous I/O. Linux inter process communication.

Reference:

Kernighan, Brian, and Dennis Ritchie.* The C Programming Language*. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1988. ISBN: 9780131103627.

CSE-311	Programming Language Laboratory	0L:0T: 4P	2 credits

Assignment for Practical Programming in C Laboratory:

Assignment 1: Writing, compiling, and debugging programs; preprocessor macros; C file structure; variables; functions and problem statements; returning from functions

Assignment 2: Types, operators, expressions

Assignment 3: Control flow, functions, variable scope, static and global variables, I/O: printf and scanf, file I/O, character arrays, error handling, labels and goto

Assignment 4: Pointers, arrays, strings, searching and sorting algorithms

Assignment 5: Linked lists, trees

Assignment 6: Pointers to pointers, multidimensional arrays, stacks and queues

Assignment 7: Function pointers, hash table

Assignment 8: Using and creating libraries, B-trees and priority queues

This course introduces the C programming language, the workhorse of the UNIX operating system and lingua franca of embedded processors and micro-controllers. After learning this course student should be able to

CO1*: Apply basic syntax and grammar of C in general problem and expose students to practical programming techniques*

CO2*: Apply advanced concepts, such as dynamic memory allocation, concurrency, and synchronization to the real day-to-day engineering problem.*

C03: *Use UNIX signals and process control, and other libraries for development and usage in practical situation.*

CSE-302	Data Structure & Algorithms	3L:0T: 0P	3 credits

Pre-requisites	ESC 201

Objectives of the course:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures

Detailed contents:

Module 1:

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. **Searching:** Linear Search and Binary Search Techniques and their complexityanalysis.

Module 2:

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Module 3:

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Module 4:

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Suggested books:

1. "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

Suggested reference books:

1. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
2. "How to Solve it by Computer", 2nd Impression by R.G. Dromey, Pearson Education.

Course outcomes

1. For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
2. For a given Search problem (Linear Search and Binary Search) student will able to implement it.
3. For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.
4. Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.
5. Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

CSE-312	**Data Structure & Algorithms Laboratory**	**0L:0T: 4P**	**2 credits**

As per Data Structure & Algorithm, (CSE 302) syllabus.

ESC 301	**Digital Electronics**	**3L:0T:0P**	**3 credits**

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand working of logic families and logicgates.
- Design and implement Combinational and Sequential logic circuits.
- Understand the process of Analog to Digital conversion and Digital to Analog conversion.
- Be able to use PLDs to implement the given logical problem.

Module 1:Fundamentals of Digital Systems and logicfamilies (7Hours)

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples ofICgates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Module 2: Combinational Digital Circuits (7Hours)

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer,De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serialadder, ALU, elementary ALU design, popular MSI chips, digital comparator,paritychecker/generator, code converters, priority encoders, decoders/drivers for display devices,Q-M method of function realization.

Module 3: Sequential circuits and systems (7Hours)
A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T andD-typesflipflops,applicationsofflipflops,shiftregisters,applicationsofshiftregisters,serialtoparallel converter, parallel to serial converter, ring counter, sequence generator,ripple(Asynchronous) counters, synchronous counters, counters design using flip flops,specialcounter IC's, asynchronous sequential counters, applications ofcounters.

Module 4: A/D and D/A Converters (7Hours)
Digital to analog converters: weighted resistor/converter, R-2R Ladder D/Aconverter,specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digitalconverters: quantization and encoding, parallel comparator A/Dconverter,successive approximation A/D converter, counting A/D converter, dual slope A/Dconverter,A/Dconverterusing voltagetofrequencyandvoltagetotimeconversion,specificationsofA/Dconverters, example of A/D converter ICs

Module 5: Semiconductor memories and Programmable logic devices. (7Hours)
Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array(FPGA).

Text/References:
1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education,2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India,2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India,2016.

ESC 312: Digital Electronics Laboratory (0:0:4 – 2 credit)
Hands-on experiments related to the course contents of ESC 302.

ESC 311	**Digital Electronics Laboratory**	**0L:0T:4P**	**2 credits**

As per Digital Electronics, (ESC 301) syllabus.

CSE 313	**Software tools**	**0L:0T:6P**	**3 credits**

Course Content:
Introduction to Sci Lab: Install Scilab, Mailing list, Complementary resources.
Become familiar with Scilab: The general environment and the console 5Simple numerical calculations, the menu bar, the editor, the graphics window, Windows management and workspace customization.
Programming: Variables, assignment and display, Loops, Tests.
Useful Scilab functions: In analysis , In probability and statistics , To display and plot, Utilities.

Introduction to Latex: Creating first document, Document structure (sections and paragraphs),Packages, Math, Adding pictures, Table of contents, Bibliography, Footnotes, Tables,

Text Books:

1. Introduction to Scilab: For Engineers and Scientists by Sandeep Nagar.
2. LaTeX and Friends by **van Dongen**, Marc

CSE-304	Computer Organization &Architecture	3L:0T:0P	3 Credits

Pre-requisites	ESC 301

Objectives of the course:

To expose the students to the following:

1. How Computer Systems work & the basic principles
2. Instruction Level Architecture and Instruction Execution
3. The current state of art in memory system design
4. How I/O devices are accessed and its principles.
5. To provide the knowledge on Instruction Level Parallelism
6. To impart the knowledge on microprogramming
7. Concepts of advanced pipelining techniques.

Detailed contents:

Module 1

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU–registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Case study – instruction sets of some common CPUs.

Data representation: signed number representation, fixed and floating point representations, character representation. Computer arithmetic – integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic.

Module 2:

Introduction to x86 architecture.

CPU control unit design: hardwired and micro-programmed design approaches, Case study – design of a simple hypothetical CPU.

Memory system design: semiconductor memory technologies, memory organization.

Peripheral devices and their characteristics: Input-output subsystems, I/O device interface, I/O transfers–program controlled, interrupt driven and DMA, privileged and non- privileged instructions, software interrupts and exceptions. Programs and processes–role of interrupts in process state transitions, I/O device interfaces – SCII, USB

Module 3:

Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards.

Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency.

Module 4:

Memory organization: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.

Suggested books:

1. "Computer Organization and Design: The Hardware/Software Interface", 5th Edition by David A. Patterson and John L. Hennessy, Elsevier.
2. "Computer Organization and Embedded Systems", 6th Edition by Carl Hamacher, McGraw Hill Higher Education.

Suggested reference books:

1. "Computer Architecture and Organization", 3rd Edition by John P. Hayes, WCB/McGraw-Hill
2. "Computer Organization and Architecture: Designing for Performance", 10th Edition by William Stallings, Pearson Education.
3. "Computer System Design and Architecture", 2nd Edition by Vincent P. Heuring and Harry F. Jordan, Pearson Education.

Course outcomes

1. Draw the functional block diagram of a single bus **architecture of a computer and describe the function of the** instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set.
2. **Write** assembly language program for specified microprocessor for computing 16 bit multiplication, division and I/O device interface (ADC, Control circuit, serial port communication).
3. Write a flowchart for Concurrent access to memory and cache coherency in **Parallel Processors** and describe the process.
4. Given a CPU organization and instruction, design a memory module and analyze its operation by interfacing with the CPU.
5. Given a CPU organization, assess its performance, and apply design techniques to enhance performance using pipelining, parallelism and RISC methodology

CSE-314	**Computer Organization &Architecture Laboratory**	**0L:0T:4P**	**2 Credits**

As per Computer Organization & Architecture, (CSE 304) syllabus.

FOURTH SEMESTER
(Credits: 23)

CSE-401	Discrete Mathematics	3L:1T:0P	4 Credits

Objectives of the course

Throughout the course, students will be expected to demonstrate their understanding of Discrete Mathematics by being able to do each of the following:

1. Use mathematically correct terminology and notation.
2. Construct correct direct and indirect proofs.
3. Use division into cases in a proof.
4. Use counterexamples.
5. Apply logical reasoning to solve a variety of problems.

Detailed contents:

Module 1: Sets, Relation and Function (6 hours)

Sets, Operations and Laws of Sets, Cartesian Products, Power set. Binary Relation, Partial Ordering Relation, Equivalence Relation. Functions, Bijective functions, Inverse and Composite Function, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem. Principles of Mathematical Induction, The Well-Ordering Principle, Recursive definition, The Division algorithm: Prime Numbers, The Greatest Common Divisor: Euclidean Algorithm, The Fundamental Theorem of Arithmetic.

Module 2: Introduction to counting (6 hours)

Basic counting techniques, inclusion and exclusion principle, pigeon-hole principle, Permutations and Combinations. Recurrence relations: Linear recurrence relations with constant coefficients (both homogeneous and non-homogeneous case), discussion of several special cases to obtain particular solutions. Solution of linear recurrence relations using generating functions.

Module 3: Mathematical Logic (8 hours)

Propositional Logic: Syntax, Semantics, Validity and Satisfiability, Basic Connectives and Truth Tables, Logical Equivalence: The Laws of Logic, Logical Implication, Rules of Inference, Quantifiers. Proof Techniques: Some Terminology, Proof Methods and Strategies, Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

Module 4: Algebraic Structures (10 hours)

Algebraic Structures, Binary Operation, Semi group and Monoid, Groups, Subgroups, Cyclic groups, Permutation group, Group Homomorphism, Cosets and Normal Subgroups, Lagrange's Theorem. Definitions and examples of Ring, Integral Domain and Field. Boolean algebra and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form.

Module 5: Graphs and Trees (10 hours)

Graphs and their properties, Degree, Connectivity, Path, Cycle, Bipartite Graph, Complete and Regular Graph, Sub Graph, Graph isomorphism, Eulerian and Hamiltonian Graph, Euler formula. Matrix representation of Graphs, Planner Graphs, travelling salesman problem, shortest path algorithms. Graph Colouring, Colouring maps and Planar Graphs, Colouring Vertices, Colouring Edges, List Colouring, Perfect Graph. Trees, Spanning Trees, Minimum Spanning Trees, Rooted and Binary Trees, Tree traversing.

Suggested books:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw –Hill
2. Susanna S. Epp, Discrete Mathematics with Applications,4th edition, Wadsworth Publishing Co.Inc.
3. C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw –Hill.

Suggested reference books:

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structure and It's Application to Computer Science", TMG Edition,TataMcgraw-Hill
2. Norman L. Biggs, Discrete Mathematics, 2nd Edition, Oxford University Press. Schaum's Outlines Series, Seymour Lipschutz, MarcLipson,
3. Discrete Mathematics, Tata McGraw -Hill

Course Outcomes

1. For a given logic sentence express it in terms of predicates, quantifiers, and logical connectives
2. For a given a problem, derive the solution using deductive logic and prove the solution based on logical inference
3. For a given a mathematical problem, classify its algebraic structure
4. Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra
5. Develop the given problem as graph networks and solve with techniques of graph theory.

CSE-402	Operating Systems	3L:0T:0P	3 Credits

Pre-requisites	CSE-304

Objectives of the course

To learn the fundamentals of Operating Systems.

1. To learn the mechanisms of OS to handle processes and threads and their communication
2. To learn the mechanisms involved in memory management in contemporary OS
3. To gain knowledge on distributed operating system concepts that includes architecture, Mutual exclusion algorithms, deadlock detection algorithms and agreement protocols
4. To know the components and management aspects of concurrency management
5. To learn to implement simple OS mechanisms

Detailed contents

Module 1:

Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS-Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.

Module 2:
Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching
Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads,

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF.

Module 3:
Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Module 4:
Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.

Module 5:
Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging.
Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used(LRU).

Module 6:
I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms
File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance.

Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks

Suggested books:
1. Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia StudentEdition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings,

Prentice Hall of India.

Suggested reference books:

1. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
2. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison- Wesley
3. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
4. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

Course Outcomes

1. Create processes and threads.
2. Develop algorithms for process scheduling for a given specification of CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.
3. For a given specification of memory organization develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.
4. Design and implement file management system.
5. For a given I/O devices and OS (specify) develop the I/O management functions in OS as part of a uniform device abstraction by performing operations for synchronization between CPU and I/O controllers.

CSE-412	**Operating Systems Laboratory**	**0L:0T:4P**	**2 Credits**

As per Operating Systems, (CSE 402) syllabus.

CSE-403	**Object Oriented Programming**	**2L:0T:0P**	**2 Credits**

Pre-requisites	**CSE-302**

Objectives of the course

The course will introduce standard tools and techniques for software development, using object oriented approach, use of a version control system, an automated build process, an appropriate framework for automated unit and integration tests.

Detailed contents

- *Abstract data types and their specification.*
- *How to implement an ADT.* Concrete state space, concrete invariant, abstraction function. Implementing operations, illustrated by the Textexample.
- *Features of object-oriented programming.* Encapsulation, object identity,polymorphism – but not inheritance.
- *Inheritance in OOdesign.*
- *Design patterns.* Introduction and classification. The iteratorpattern.
- *Model-view-controllerpattern.*

- *Commands as methods* and as objects. •*Implementing OO languagefeatures.*
- *Memory management.*
- *Generic types andcollections*
- *GUIs. G*raphical programming with Scala and Swing •*The software development process.*

The concepts should be practised using C++ and Java. Pearl may also be introduced wherever possible.

Suggested books

1. Barbara Liskov, *Program Development in Java*, Addison-Wesley,2001

Suggested reference books

1. Any book on CoreJava
2. Any book onC++

Course Outcomes

After taking the course, students will be able to:

1. Specify simple abstract data types and design implementations, using abstraction functions to documentthem.
2. Recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on objectidentity.
3. Name and apply some common object-oriented design patterns and give examples of theiruse.
4. Design applications with an event-driven graphical userinterface.

CSE-413	**Object Oriented Programming Laboratory**	**0L:0T:4 P**	**2 Credits**

As per Object Oriented Programming, (CSE 403) syllabus.

CSE-404	**Database Management Systems**	**3L:0T:0P**	**3 Credits**

Pre-requisites	**CSE-402**

Objectives of the course

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and networkmodels
- To understand and use data manipulation language to query, update, and manage a database
- To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server (Database Server), DataWarehousing.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Detailed contents

Module 1
Database system architecture: Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML).
Data models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.

Module 2:
Relational query languages: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQLserver.

Relational database design: Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Losslessdesign.
Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimizationalgorithms.

Module 3:
Storage strategies: Indices, B-trees, hashing.

Module 4:
Transaction processing: Concurrency control, ACID property, Serializabilityof scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Databaserecovery.

Module 5:
Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection,SQL injection.

Module 6:
Advanced topics: Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.

Suggested books:
1. "Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan,McGraw-Hill.

Suggested reference books
1 "Principles of Database and Knowledge – Base Systems", Vol 1 by J. D. Ullman, Computer SciencePress.
2 "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe, PearsonEducation
3 "Foundations of Databases", Reprint by Serge Abiteboul, Richard Hull, Victor Vianu,Addison-Wesley

Course Outcomes
1. For a given query write relational algebra expressions for that query and optimize the

developed expressions

2. For a given specification of the requirement design the databases using E R method and normalization.
3. For a given specification construct the SQL queries for Open source and Commercial DBMS -MYSQL, ORACLE, andDB2.
4. For a given query optimize its execution using Query optimization algorithms
5. For a given transaction-processing system, determine the transaction atomicity, consistency, isolation, and durability.
6. Implement the isolation property, including locking, time stamping based on concurrency control and Serializability of scheduling.

CSE-414	**Database Management Systems Laboratory**	**0L:0T:4 P**	**2 Credits**

As per Database Management Systems, (CSE 404) syllabus.

HSMC 401	**Managerial Economics**	**3L:0T:0 P**	**3 Credits**

MANAGERIAL ECONOMICS

1. Nature, scope and methods of managerial economics.
2. Managerial Economic Concepts – Incremental concept; Opportunity Cost concept; Equi-marginal concept; discounting concept; Risk & Uncertainty.
3. Law of Diminishing Marginal Utility.
4. Demand Analysis – Meaning & type; Law of Demand – features; Exceptions; Market Demand Schedule & Curve; Elasticity of Demand – Price elasticity, cross elasticity& income elasticity.
5. Indifference Curve approach and its properties.
6. Supply – its law, elasticity & curve.
7. Types of markets; Pricing under various market conditions – Perfect competition, imperfect competition & monopolistic competition.
8. Profit & Profit measurement.
9. Inflation – meaning; Demand-pull, cost-push inflation; Inflationary gap; Causes and steps to control inflation.
10. National Income – Concepts & methods of measurement; Difficulties in measuring national income.

Text Book References-

1. Managerial Economics by William F. Samuelson and Stephen G. Marks
2. Managerial Economics: Theory, Applications, and Cases by W. Bruce Allen, Keith Weigelt, Neil Doherty and Edwin Mansfield
3. Managerial Economics by Christopher Thomas and S. Charles Maurice

HSMC 222	**Technical English for Engineers**	**0L:0T:4 P**	**2 Credits**

MC 401	**Environmental Science**	**0L:0T:0 P**	**0 Credits**

FIFTH SEMESTER
(Credits:23)

ESC 501	Signals and System	3L:0T:0P	3 credits

Signals and systems as seen in everydaylife, and in various branches of engineering and science.

Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability,realizability.

Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.

Periodic and semi-periodic inputs to an LSI system, the notion of a frequencyresponse and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval'sTheorem.The idea of signal space and orthogonalbases,

The Laplace Transform, notion ofeigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior.

The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.

State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Text/Reference books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall,1983.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall,1998.
3. Papoulis, "Circuits and Systems: A Modern Approach", HRW,1980.
4. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press,c1998.
5. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6. Simon Haykin, BarryvanVeen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited,c1998.
7. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons,1995.
8. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.

9. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi,2001.
10. Ashok Ambardar,"Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company),1999.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze different types ofsignals
2. Represent continuous and discrete systems in time and frequency domain using different transforms
3. Investigate whether the system isstable
4. Sampling and reconstruction of asignal

CSE-501	Design and Analysis of Algorithms	3L:0T: 0P	3 Credits

Pre-requisites	CSE-401

Objectives of the course

- Analyze the asymptotic performance ofalgorithms.
- Write rigorous correctness proofs foralgorithms.
- Demonstrate a familiarity with major algorithms and datastructures.
- Apply important algorithmic design paradigms and methods ofanalysis.
- Synthesize efficient algorithms in common engineering designsituations.

Detailed contents:

Module 1:

Introduction: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters'theorem.

Module 2:

Fundamental Algorithmic Strategies: Brute-Force, Greedy,Dynamic Programming, Branch- and-Bound and Backtracking methodologies for the design of algorithms; Illustrationsof these techniques for Problem-Solving , Bin Packing, Knap Sack TSP. Heuristics – characteristics and their application domains.

Module 3:

Graph and Tree Algorithms: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network FlowAlgorithm.

Module 4:

Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques.

Module 5:

Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE

Suggested books:

1. Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MITPress/McGraw-Hill.
2. Fundamentals of Algorithms – E. Horowitz etal.

Suggested reference books

1. Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos,Pearson.
2. Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia,Wiley.
3. Algorithms—A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading,MA.

Course Outcomes

2. For a given algorithms analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.
3. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedyalgorithms.
4. Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Synthesize divide-and-conquer algorithms. Derive and solve recurrence relation.
5. Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. For a given problems of dynamic-programming and develop the dynamic programming algorithms, and analyze it to determine its computational complexity.
6. For a given model engineering problem model it using graph and write the corresponding algorithm to solve the problems.
7. Explain the ways to analyze randomized algorithms (expected running time, probability oferror).
8. Explain what an approximation algorithm is.Computer the approximation factor of an approximation algorithm (PTAS and FPTAS).

CSE-511	**Design and Analysis of Algorithms Laboratory**	**0L:0T: 4P**	**2 Credits**

As per Design and Analysis of Algorithm, (CSE 501) syllabus.

CSE-502	**Computer Network-I**	**3L: 0T: 0P**	**3 Credits**

Pre-requisites: CSE-304, CSE-402

Computer Network-I

Module 1:

Data communication Components: Representation of data and its flow Networks ,

Module 2:

Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts
on spread spectrum.

Module 2:

Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC;

Module 3:

Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window,
Piggybacking, Random Access, Multiple access protocols -Pure ALOHA,
Slotted ALOHA, CSMA/CD,CDMA/CA

Suggested books

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw- Hill.
2. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice HallIndia.

Suggested reference books

1. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
2. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall ofIndia.
3. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States ofAmerica.

Course Outcomes

- Explain the functions of the different layer of the OSI Protocol.
- Draw the functional block diagram of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) describe the function of eachblock.
- For a given requirement (small scale) of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) design it based on the market available component

CSE-512	**Computer Network-I Laboratory**	**0L: 0T: 4P**	**2 Credits**

As per Computer Network-I, (CSE 502) syllabus.

CSE-503	**Formal Language & Automata Theory**	**3L:0T:0 P**	**3 Credits**

Pre-requisites	**CSE-402**

Objectives of the course

- Develop a formal notation for strings, languages and machines.

- Design finite automata to accept a set of strings of a language.
- Prove that a given language is regular and apply the closure properties of languages.
- Design context free grammars to generate strings from a context free language and convert them into normal forms.
- Prove equivalence of languages accepted by Push Down Automata and languages generated by context free grammars
- Identify the hierarchy of formal languages, grammars and machines.
- Distinguish between computability and non-computability and Decidability and undecidability.

Detailed contents

Module 1:

Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages. Regular languages and finite automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata. Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs. Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG. Turing machines: The basic model for Turing machines (TM), Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators. Undecidability: Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.

Suggested books

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.

Suggested reference books:

2. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.
3. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science,Springer.
4. Michael Sipser, Introduction to the Theory of Computation, PWSPublishing.
5. John Martin, Introduction to Languages and The Theoryof Computation, Tata McGrawHill.

Course Outcomes:

1. Write a formal notation for strings, languages and machines.
2. Design finite automata to accept a set of strings of a language.

3. For a given language determine whether the given language is regular ornot.
4. Design context free grammars to generate strings of context free language.
5. Determine equivalence of languages accepted by Push Down Automata and languages generated by context free grammars
6. Write the hierarchy of formal languages, grammars and machines.
7. Distinguish between computability and non-computability and Decidability and undecidability.

CSE-ELV-501	**Elective-I**	**3L:0T:0 P**	**3 Credits**

- Computer Graphics.
- Machine learning
- Cloud Computing

HSMC 501	**Fundamentals of Management & Accountancy**	**3L: 1T:0 P**	**4 Credits**

MANAGEMENT AND ACCOUNTANCY

Module I: **Introduction to Management Challenges for Engineers:** Introduction, definitions, employment trend in industries, STEM professionals as effective technical contributors, management and leadership, becoming effective manager in the new millennium.

Planning: Introduction, types of planning, who should do planning, inexact nature of strategic planning, planning roles for engineering managers, tools for planning, planning activities, some specific advice on planning.

Organizing: Introduction, definitions, activities of organizing, organizingone's own workplace for productivity, developing organizational structure, enhancing corporateperformance by organizingexamples, concurrent engineering teams, delegating, establishing working relationships, informal organizations.

Leading: Introduction, styles of leadership, leading activities, deciding, communicating, motivating, selecting engineering employees, developing people, special topics on leading.

Controlling: Introduction, setting performance standards, benchmarking, measuring performance, evaluating performance, correcting performance, means of control, general comments, control of management time, control of personnel, control of business relationships, control of projects, control of quality, control of knowledge.

Cost accounting for engineering managers: Introduction, product or service costing, application of ABC in industry, risk analysis and cost estimation under uncertainty, miscellaneous topics.

Financial Accounting and Management for Engineering Managers:
Introduction, financial marketing principles, key financial statements, fundamentals of financial analysis, balanced score card, capital formation, capital assets valuation

Module II: Accounting : Principles, Concepts and conventions, Double entry system of Accounting, Introduction of basis books of accounts of sole proprietary concern, Control accounts for debtors

l and creditors, closing of books of accounts and preparation of Trail Balance. Final Accounts : Trading, Profit and Loss Accounts and Balances Sheet of Sole Proprietary concern with normal closing entries, Introduction to Manufacturing accounts of partnership firms, Limited Company. Financial Management: Meaning and role. Ratio Analysis : Meaning advantage, limitations, types of ratios and their usefulness.

MC	**Constitution of India**	**0L:0T:0 P**	**0 Credits**

SIXTH SEMESTER
(Credits: 20)

CSE-601	Compiler Design	3L:0T: 0P	3 Credits

Pre-requisites	CSE-503

Objectives of the course

- To understand and list the different stages in the process of compilation.
- Identify different methods of lexical analysis
- Design top-down and bottom-up parsers
- Identify synthesized and inherited attributes
- Develop syntax directed translation schemes
- Develop algorithms to generate code for a target machine

Detailed contents

Module 1:

The aim is to learn how to design and implement a compiler and also to study the underlying theories. The main emphasis is for the imperative language. Introduction: Phases of compilation and overview. Lexical Analysis (scanner): Regular languages, finite automata, regular expressions, from regular expressions to finite automata, scanner generator (lex, flex).Syntax Analysis (Parser): Context-free languages and grammars, push-down automata, LL(1) gram-mars and top-down parsing, operator grammars, LR(O), SLR(1), LR(1), LALR(1) grammars and bottom-up parsing, ambiguity and LR parsing, LALR(1) parser generator (yacc, bison)Semantic Analysis: Attribute grammars, syntax directed definition, evaluation and flow of attribute in a syntax tree. Symbol Table: Its structure, symbol attributes and management. Run-time environment: Procedure activation, parameter passing, value return, memory allocation, and scope. Intermediate Code Generation: Translation of different language features, different types of intermediate forms. Code Improvement (optimization): Analysis:control-flow, data-flow dependence etc.; Code improvement local optimization, global optimization, loop optimization, peep-hole optimization etc. Architecture dependent code improvement: instruction scheduling (for pipeline), loop optimization (for cache memory) etc. Register allocation and target code generation Advanced topics: Type systems, data abstraction, compilation of Object Oriented features and non-imperative programming languages.

Course Outcomes

1. For a given grammar specification develop the lexical analyser
2. For a given parser specification design top-down and bottom-up parsers
3. Develop syntax directed translation schemes

4. Develop algorithms to generate code for a target machine

CSE-611	Compiler Design Laboratory	0L:0T: 4P	2 Credits

As per Compiler Design, (CSE 601) syllabus.

CSE-602	Computer Networks-II	3L:0T: 0P	3 Credits

Pre-requisites	CSE-502

Detailed contents

Module 1:

Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Module 2:

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.

Module 3:

Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography

Module 4

Basics of Cryptography: Terminologies used in Cryptography, Substitution Techniques, Transposition Techniques. Symmetric Key Encryption: Data Encryption Standard (DES) Algorithm, Double and Triple DES, Security of the DES, Advanced Encryption Standard (AES) Algorithm, DES and AES Comparison. Public Key Encryption: Characteristics of Public Key System, RSA Technique, Key Exchange, Diffie-Hellman Scheme, Cryptographic Hash Functions, Digital Signature, Certificates, Certificate Authorities.

Suggested books

3. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw- Hill.
4. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India.

Suggested reference books

4. Computer Networks, 8th Edition, Andrew S. Tanenbaum, Pearson New International Edition.
5. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
6. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

Course Outcomes

- For a given problem related TCP/IP protocol developed the network programming.
- Configure DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

CSE-612	**Computer Networks-II Laboratory**	**0L:0T: 4P**	**2 Credits**

As per Computer Networks-II, (CSE 602) syllabus.

CSE-ELV-601	**Elective-II**	**3L:0T: 0P**	**3 Credits**

- Image Processing
- Embedded System

CSE-ELV-602	**Elective-III**	**3L:0T: 0P**	**3 Credits**

- Natural language Processing.
- Data analytics
- Soft Computing

CSE-O-ELV-601	**Open Elective-I**	**3L:0T: 0P**	**3 Credits**

- Graph Theory
- Information Theory and Coding
- Wireless Network

CSE-613	**Internship-I**		**1 Credit**

SEVENTH SEMESTER
(Credit: 16)

CSE-ELV-701 & 702	**Elective-IV**	**3L:0T: 0P**	**3 Credits**

- Practical Reinforcement learning
- Internet Of Thinks
- Neural Network and deep learning
- Peer to peer network
- Data Mining
- Real time cyber thread detection and mitigation.
- Advanced Computer Architecture
- Ad-Hoc And Sensor Network
- Computational Geometry
- Advanced Design and analysis of Algorithm

CSE-O-ELV-701	**Open Elective-II**	**3L:0T: 0P**	**3 Credits**

- Programming in JAVA
- Biology for Engineers

CSE-711	**Internship-II**		**1 Credits**

CSE-712	**PROJECT- I**	**0L:0T: 12P**	**6 Credits**

EIGHT SEMESTER
(Credit: 17)

CSE-ELV-801	**Elective-VI**	**3L:0T: 0P**	**3 Credits**

- Artificial Intelligence
- Parallel and Distributed Algorithm
- Computational Complexity
- Real Time system.
- Web Technology
- Theory of Computation
- Distributed System

CSE-O-ELV-801	**Open Elective-III**	**3L:0T: 0P**	**3 Credits**

- Cryptography and Network Security
- Mobile computing
- Application of Fuzzy logic

CSE-O-ELV-802	**Open Elective-IV**	**3L:0T: 0P**	**3 Credits**

- Software Engineering
- Cyber law and Ethics

CSE-811	**PROJECT- II**	**0L:0T: 12P**	**6 Credits**

CSE-812	**GRAND VIVA**	**0L:0T: 2P**	**2 Credits**

PROFESSIONAL ELECTIVE COURSES

Additional Courses for B.Tech (Hons.)

Branch/Course: Computer Science Engineering

In order to have an Honours degree, a student choose 19-20 credits from the following courses in addition. The professional electives may be selected **excluding** these.

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	CSE-ELV	CSE-ELV T<number>	Graph Theory	3	0	0	3
2	CSE-ELV	CSE-ELV S<number>	Software Engineering	3	0	4	5
3	CSE-ELV	CSE-ELV S<number>	Embedded Systems	3	0	4	5
4.	CSE-ELV	CSE-ELV - D<number>	Artificial Intelligence	3	0	0	3
5.	CSE-ELV	CSE-ELV - A<number>	Cryptography & Network Security	3	0	0	3
6.	CSE-ELV	CSE-ELV - S<number>	Internet-of-Things	3	0	0	3
7.	CSE-ELV	CSE-ELV - D<number>	Data Analytics	3	0	0	3
8.	CSE-ELV	CSE-ELV - D<number>	Machine Learning	3	0	0	3

-Electives

Electives will be introduced in 4 threads besides the Open Elective. There are 6 slots for Electives and 4 slots for Open Electives. The department may permit students to take 50% of these (electives + open electives) from other disciplines, based on the choices of the students and consent of courseadvisors.

A. Theory B. **Systems** C. **Data Science** D. **Applications** and E. **Open Electives**

The students will have options of selecting the electives from the different threads depending on the specialization they wish to acquire. **There should be at least two electives from the open elective choices; the rest two can be taken from the other threads, if intended.** Pls. see the Table.

The Electives are shown in different threads.

The list is suggestive.

The actual list of electives will depend on the availability of faculty and their research interests. **However, there should be courses available in each thread.**

On-line MOOC courses may contribute upto 20% of the credits, with in-house examination being conducted.

Theory and Algorithms **Code: PEC-CS-T<number>**	**Systems** **Code: CSE-ELV S<number>**	**Data Science And Machine Intelligence** **Code: CSE-ELV D <number>**	**Applications** **Code: CSE-ELV-A<number>**	**Open Electives** **CSE-O-ELV-<number>**
Theory of Computation	Advanced Computer Architecture	Artificial Intelligence	Cloud Computing	PROGRAMMING IN JAVA/Paython
Advanced design and analysis 0f Algorithms	Distributed Systems	Data Analytics	Computer Graphics	Mobile computing
Parallel and Distributed Algorithms	Embedded Systems	Machine Learning	Web technology	Software Engineering
Computational	Real time Systems	Data Mining	Real-Time	Wireless Networks
Complexity Computational Geometry	Ad-Hoc Networks	Soft Computing and	Cyber Threat Detection and Mitigation Sensor	Information Theory and Coding
Practical Reinforcement Learning	Internet-of-Things	Natural Language Processing		Biology for Engineers
		Neural Network and deep learning		Application of Fuzzy Logic
		Image Processing		Cyber Law and Ethics
				Cryptography and Network Security
				Graph Theory

CSE-ELV-	**Artificial Intelligence**	**3L:0T: 0P**	**3 Credits**

Course Content:

UNIT I INTRODUCTION TO Al AND PRODUCTION SYSTEMS
Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms.

UNIT II REPRESENTATION OF KNOWLEDGE
Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.

UNIT III KNOWLEDGE INFERENCE
Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.

UNIT IV PLANNING AND MACHINE LEARNING
Basic plan generation systems - Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.

UNIT V EXPERT SYSTEMS
Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.

Course outcomes: The students should be able to:

- Identify the AI basedproblems
- Apply techniques to solve the AIproblems
- Define learning and explain various learningtechniques
- Discuss expertsystems

Texts/Reference:

1. Russel&Norvig: Artificial Intelligence a Modern Approach;Pearson
2. Rich and Knight: Artificial Intelligence; TMH.
2. N. J. Nilson: Principles of Artificial Intelligence; Narosa.
3. P. Norvig : Paradigms of AI programming; Elsevier.
4. Brakto: Prolog Programming: Pearson

CSE-ELV-	**NATURAL LANGUAGE PROCESSING**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module – 1

Overview and language modeling: Overview: Origins and challenges of NLP- Language and Grammar-Processing Indian Languages- NLP Applications- Information Retrieval. Language Modeling: Various Grammar- based Language Models-Statistical Language Model.

Module – 2

Word level and syntactic analysis: Word Level Analysis: Regular Expressions- Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. Syntactic Analysis:
Context-free Grammar-Constituency- Parsing-Probabilistic Parsing.

Module – 3

Extracting Relations from Text: From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation.

Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic RoleLabeling, Learning to Annotate Cases with Knowledge Roles and Evaluations.

A Case Study in Natural Language Based Web Search: InFact System Overview, The GlobalSecurity.org Experience.

Module – 4

Evaluating Self-Explanations in iSTART: Word Matching, Latent Semantic Analysis, and Topic Models: Introduction, iSTART: Feedback Systems, iSTART: Evaluation of Feedback Systems,

Textual Signatures: Identifying Text-Types Using Latent Semantic Analysis to Measure the Cohesion of Text Structures: Introduction, Cohesion, Coh- Metrix, Approaches to Analyzing Texts, Latent Semantic Analysis, Predictions, Results of Experiments.

Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence Modeling: Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results.

Evolving Explanatory Novel Patterns for Semantically-Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining.

Module-5

INFORMATION RETRIEVAL AND LEXICAL RESOURCES: Information Retrieval: Design features of Information Retrieval Systems-Classical, Non classical, Alternative Models of Information Retrieval – valuation Lexical

Resources: World Net-Frame Net- Stemmers-POS Tagger- Research Corpora.

Course outcomes: The students should be able to:

- Analyze the natural languagetext.
- Define the importance of naturallanguage.
- Understand the concepts Textmining.
- Illustrate information retrievaltechniques.

TextBooks:

- Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press,2008.
- Anne Kao and Stephen R. Poteet (Eds), "Natural LanguageProcessing and Text Mining", Springer-Verlag London Limited2007.

Reference Books:

- Daniel Jurafsky and James H Martin, "Speech and Language Processing: Anintroduction to Natural Language Processing, Computational Linguistics and SpeechRecognition", 2nd Edition, Prentice Hall,2008.

- James Allen, "Natural Language Understanding", 2nd edition, Benjamin/Cummingspublishingcompany,1995.

- Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers,2000.

CSE-ELV-	**Machine Learning**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module – 1

Introduction: Well posed learning problems, Designing a Learning system, Perspective and Issues in Machine Learning.

Concept Learning: Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.

Text Book1, Sections: 1.1 – 1.3, 2.1-2.5, 2.7

Module – 2

Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.

Text Book1, Sections: 3.1-3.7

Module – 3

Artificial Neural Networks: Introduction, Neural Network representation, Appropriate problems, Perceptrons, Backpropagationalgorithm.

Text book 1, Sections: 4.1 – 4.6

Module – 4

Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm

Text book 1, Sections: 6.1 – 6.6, 6.9, 6.11, 6.12

Module – 5

Evaluating Hypothesis: Motivation, Estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms.

Instance Based Learning: Introduction, k-nearest neighbor learning, locally weighted regression, radial basis function, cased-based reasoning,

Reinforcement Learning: Introduction, Learning Task, Q Learning

Text book 1, Sections: 5.1-5.6, 8.1-8.5, 13.1-13.3

Course Outcomes: After studying this course, students will be able to

- Recall the problems for machine learning. And select the either supervised, unsupersvised or reinforcementlearning.
- Understand theory of probability and statistics related to machinelearning
- Illustrate concept learning, ANN, Bayes classifier, k nearest neighbor,Q,

Text Books:

- Tom M. Mitchell, Machine Learning**,** India Edition 2013, McGraw Hill Education.

Reference Books:

- Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series instatistics.
- EthemAlpaydın, Introduction to machine learning, second edition, MITpress.

CSE-ELV-	**ADVANCED COMPUTER ARCHITECTURES**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module – 1

Theory of Parallelism: Parallel Computer Models, The State of Computing, Multiprocessors and Multicomputer ,Multivector and SIMD Computers ,PRAM and VLSI Models, Program and Network Properties ,Conditions of Parallelism, Program Partitioning and Scheduling, Program Flow Mechanisms, System Interconnect Architectures, Principles of Scalable Performance, Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches.

Module –2

Hardware Technologies: Processors and Memory Hierarchy, Advanced Processor Technology, Superscalar and Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.

Module –3

Bus, Cache, and Shared Memory ,Bus Systems ,Cache MemoryOrganizations ,Shared Memory Organizations ,Sequential and Weak ConsistencyModels ,Pipelining and Superscalar Techniques ,Linear Pipeline Processors ,Nonlinear Pipeline Processors ,Instruction Pipeline Design ,Arithmetic Pipeline Design (Upto 6.4).

Module –4

Parallel and Scalable Architectures: Multiprocessors and Multicomputers ,Multiprocessor System Interconnects, Cache Coherence and Synchronization Mechanisms, Three Generations of Multicomputers ,Message-Passing Mechanisms ,Multivector and SIMD Computers ,Vector Processing Principles ,Multivector Multiprocessors ,Compound Vector Processing ,SIMD Computer Organizations (Upto 8.4),Scalable, Multithreaded, and Dataflow Architectures, Latency-Hiding Techniques, Principles of Multithreading, Fine-Grain Multicomputers, Scalable and Multithreaded Architectures, Dataflow and Hybrid Architectures.

Module –5

Software for parallel programming: Parallel Models, Languages, and Compilers ,Parallel Programming Models, Parallel Languages and Compilers ,Dependence Analysis of Data Arrays ,Parallel Program Development and Environments, Synchronization and Multiprocessing Modes. Instruction and System Level Parallelism, Instruction Level Parallelism ,Computer Architecture ,Contents, Basic Design Issues ,Problem Definition ,Model of a TypicalProcessor, Compiler-detected Instruction Level Parallelism ,Operand Forwarding ,Reorder Buffer, Register Renaming ,Tomasulo's Algorithm ,Branch Prediction, Limitations in Exploiting Instruction Level Parallelism ,Thread Level Parallelism.

Course outcomes: The students should be able to:

- Understand the concepts of parallel computing and hardwaretechnologies
- Illustrate and contrast the parallel architectures
- Recall parallel programmingconcepts

TextBooks:

- Kai Hwang and NareshJotwani, Advanced Computer Architecture (SIE): Parallelism, Scalability, Programmability, McGraw Hill Education 3/e. 2015

Reference Books:

- John L. Hennessy and David A. Patterson, Computer Architecture: A quantitative approach, 5th edition, Morgan Kaufmann Elseveir, 2013

CSE-ELV-	**Cloud Computing**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module – 1

Introduction ,Cloud Computing at a Glance, The Vision of Cloud Computing, Defining a Cloud, A Closer Look, Cloud Computing Reference Model, Characteristics and Benefits, Challenges Ahead, Historical Developments, Distributed Systems, Virtualization, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing, Building Cloud Computing Environments, Application Development, Infrastructure and System Development, Computing Platforms and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop, Force.com and Salesforce.com, ManjrasoftAneka

Virtualization, Introduction, Characteristics of Virtualized, Environments Taxonomy of Virtualization Techniques, Execution Virtualization, Other Types of Virtualization, Virtualization and Cloud Computing, Pros and Cons of Virtualization,Technology

Module-2

Cloud Computing Architecture, Introduction, Cloud Reference Model, Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service, Types of Clouds, Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Economics of the Cloud, Open Challenges, Cloud Definition, Cloud Interoperability and Standards Scalability and Fault Tolerance Security, Trust, and Privacy Organizational Aspects

Aneka: Cloud Application Platform, Framework Overview, Anatomy of the Aneka Container, From the Ground Up: Platform Abstraction Layer, Fabric Services, foundation Services, Application Services, Building Aneka Clouds, Infrastructure Organization, Logical

Organization, Private Cloud Deployment Mode, Public Cloud Deployment Mode, Hybrid Cloud Deployment Mode, Cloud Programming and Management, Aneka SDK, Management Tools

Module-3

Concurrent Computing: Thread Programming, Introducing Parallelism for Single Machine Computation, Programming Applications with Threads, What is a Thread?, Thread APIs, Techniques for Parallel Computation with Threads, Multithreading with Aneka, Introducing the Thread Programming Model, Aneka Thread vs. Common Threads, Programming Applications with Aneka Threads, Aneka Threads Application Model, Domain Decomposition: Matrix Multiplication, Functional Decomposition: Sine, Cosine, and Tangent.

High-Throughput Computing: Task Programming, Task Computing, Characterizing a Task, Computing Categories, Frameworks for Task Computing, Task-based Application Models, Embarrassingly ParallelApplications,Parameter Sweep Applications, MPI Applications, Workflow Applications with Task Dependencies, Aneka Task-Based Programming, Task Programming Model, Developing Applications with the Task Model, Developing Parameter

Sweep Application, Managing Workflows.

Module-4

Data Intensive Computing: Map-Reduce Programming, What is Data-Intensive Computing?, Characterizing Data-Intensive Computations, Challenges Ahead, Historical Perspective, Technologies for Data-Intensive Computing, Storage Systems, Programming Platforms, Aneka MapReduce Programming, Introducing the MapReduce Programming Model, Example Application

Module-5

Cloud Platforms in Industry, Amazon Web Services, Compute Services, Storage Services, Communication Services, Additional Services, Google AppEngine, Architecture and Core Concepts, Application Life-Cycle, Cost Model, Observations, Microsoft Azure, Azure Core Concepts, SQL Azure, Windows Azure Platform Appliance.

Cloud Applications Scientific Applications, Healthcare: ECG Analysis in the Cloud, Social Networking, Media Applications, Multiplayer Online Gaming.

Course outcomes: The students should be able to:

- Explain the concepts and terminologies of cloudcomputing
- Demonstrate cloud frameworks andtechnologies
- Define data intensivecomputingDemonstrate cloud applications

TextBooks:

- Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi Mastering Cloud. Computing McGraw HillEducation

CSE-ELV-	**Data Mining**	**3L:0T: 0P**	**3 Credits**

Course Content:

Data Mining

Data Clustering: Partitioning, Hierarchical, Density-based, Grid Based and Model Based Methods;

Classification & Prediction: Decision Tree Techniques, Back-Propagation Method, Bayesian Method

Association Rule Mining Techniques: Frequent Itemset Generation, Apriori, Horizontal Method, Sampling Approach, Hashing Approach; Dynamic Association Rule Mining; Mining of Complex Types of Data: Mining of Spatial Databases, Multimedia Databases, Time-series and sequence Data, Text Databases, WWW Data;

Books/References:

1. Jiawei Han and MichelineKamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, India
2. A K Pujari, Data Mining Techniques, University Press, India
3. Han, Manilla and Smyth, Principles of Data Mining , PHI, India

CSE-ELV-	**Real Time System**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module I: Introduction to Embedded System Software-Embedded Hardware-Building Block, and Embedded Board-Embedded Processor-ISA Architecture Model-Processor Performance-Board Memory-ROM, RAM, AM, and Memory Performance.

Module II: : Device Driver-Interrupt Handling, Memory, On-Board Bus Device Driver- Example Device Driver. Embedded Operating System-Process-Process Mangement-I/O and File Mangement- OS standard Example: POSIX (Portable Operating System Interface). Middleware and Application Software-Application Layer Software Example.

Module III: Design and Development – Defining System-Architecture and Documentation-Implementation-Testing.

Books:

1. Tammy Neorgaard ,Embedded System Architecture, Elsevier
2. Jack Ganssle, The Art of Designing Embedded System, Elsevier
3. Doug Abbot, Linux for Embedded and Real Time Application, Elsevier
4. Jack Ganssle, The Firmware Handbook, Elsevier.

CSE-ELV-	**Theory of Computation**	**3L:0T: 0P**	**3 Credits**

Course Content:

Turning Machine(TM) - Model, Computable Languages and Functions, TM construction technique, Modification of TM, Church's Hypothesis; Undecidability – The Problem, Properties of Recursive & Recursively Enumerable Languages, Universal TM, Rice's Theorem, Post's Correspondence Problem; Intractable Problems, Polynomial Time and Space, The class *P* and the other problems, Boolean Satisfiability, The class *NP* , Polynomial-time Reduction, Introduction to Cook's Theorem, Some NP-Complete problems.

Books:

1. Lewis & Papadimitriou, Elements of The Theory of Computation, Pearson Education.
2. John C. Martin, Introduction to Languages and the Theory of Computation, TMH.

CSE-ELV-	**Computer Graphics**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module I

Basic of Computer Graphics: Basic of Computer Graphics, Applications of computer graphics, Display devices, Random and Raster scan systems, Graphics input devices, Graphics software and standards

Module II

Graphics Primitives: Points, lines, circles and ellipses as primitives, scan conversion algorithms for primitives, Fill area primitives including scan-line polygon filling, inside-outside test, boundary and flood-fill, character generation, line attributes, area-fill attributes, character attributers.

Module III

2D transformation and viewing:Transformations (translation, rotation, scaling), matrix representation, homogeneous coordinates, composite transformations, reflection and shearing, viewing pipeline and coordinates system, window-to-viewport transformation, clipping including point clipping, line clipping (cohen-sutherland, liang- bersky, NLN), polygon clipping

Module IV

3D concepts and object representation:3D display methods, polygon surfaces, tables, equations, meshes, curved lies and surfaces, quadric surfaces, spline representation, cubic spline interpolation methods, Bazier curves and surfaces, B-spline curves and surfaces

Module V

3D transformation and viewing:3D scaling, rotation and translation, composite transformation, viewing pipeline and coordinates, parallel and perspective transformation, view volume and general (parallel and perspective) projection transformations

Module VI

Advance topics: visible surface detection concepts, back-face detection, depth buffer method, illumination, light sources, illumination methods (ambient, diffuse reflection, specular reflection), Color models: properties of light, XYZ, RGB, YIQ and CMY color models

BOOKS:

1. **Author :D.Hearn And P.Baker "Computer Graphics " Publisher** : Pearson Eduction
2. Computer Graphics, with OpenGL, Hearn and Baker , Pearson Education
3. Computer Graphics, : Sinha &Udai , Pearson education
4. Computer Graphics" Foley and van Dam

CSE-ELV-	**Embedded System**	**3L:0T: 0P**	**3 Credits**

Course Content:

Introduction to Embedded Systems: What is an embedded system? Basic architecture of an embedded system. Some embedded systems around us. General characteristics of embedded systems, Concept of

real time systems, Classification of embedded systems, Challenges in embedded system design.
Embedded Systems Processors: Custom single purpose processor design – FSM method, FSMD method, HPL method and ASM chart method.
Embedded System Peripherals: Timers, Counters and Watchdog timers, UART, PWM, LCD Controllers, Keypad Controllers, Stepper Motor Controllers.
The ARM Processor: Processor architecture and memory organization, Data operations, Flow of control, Pipelining in ARM, Timing of execution, FIR filter implementation using ARM.
Programming Embedded Systems: Design patterns for embedded systems, Data flow graphs, Control/ Data flow graphs, Assembly and Linking, Basic Compilation techniques, Analysis and optimization of execution time.
Real-Time Operating Systems (RTOS): Real-time Kernels, Types of real-time operating systems, Real-time scheduling, RTOS issues, Implementing real-time operating system.
Embedded System Specification: UML as design tool, UML notation, Requirement analysis and Use case modelling, Static modelling, Object and Class structuring, Dynamic modelling.
Design Case Studies: i) Data Compressor, ii) Alarm Clock, iii) Software Modem, iv) Elevator Controller, v) Digital Camera

Text Books

1. Computers as Components: Principles of Embedded Computing Design by W. Wolf: Morgan Kaufmann Publishers
2. Embedded System Design: A Unified Hardware /Software Introduction by F. Vahid and T. Givargis: John Wiley & Sons
3. Embedded Systems: A Contemporary Design Tool by Peckol, K. James: John Wiley & Sons

CSE-ELV-	**COMPUTATIONAL GEOMETRY**	**3L:0T: 0P**	**3 Credits**

Course Content:

Geometric and Algorithm Basics: Fundamentals of Euclidean and Affine Geometry, Convexity; Basic concepts of Algorithms and its complexity, correctness proofs of algorithms; Paradigms of computational geometric algorithms; Degeneracies in Computational Geometry.
Convex Hulls Planar convex hulls definition, deterministic, randomized, output-sensitive and dynamic algorithms; applications of convex hull.
Intersection: Plane sweep algorithm for line segment intersection.
Geometric searching: Segment tree, Interval tree and Priority search tree; Point location query; Range searching -- Kd tree, range tree, fractional cascading; Proximity queries -- Nearest neighbor, closest pair; persistent data structure (if possible)
Triangulation and Partitioning: Polygon triangulation -- existence and algorithms, Art Gallery Theorem.
Voronoi Diagram and Delaunay Triangulation: Voronoi diagram, Delaunay triangulation and their dual relations; algorithms for computing Voronoi diagram and Delaunay triangulation. Duality and Arrangement: Duality relation between points and lines; Arrangements and their applications.
Basics of Combinatorial Geometry: Unit distance problem, Point line incidences.

Text Book:

- M. de Berg, O. Cheong, M. van Kreveld, and M. Overmars. Computational Geometry: Algorithms and Applications. Springer-Verlag, 3rd revised edition, 2008.

Reference Books:

- Preparata and Shamos, Computational Geometry – an introduction, Springer-Verlag (1985, revised ed., 1991).
- J. O'Rourke, Computational Geometry in C, Cambridge University Press, second edition,1998.
- Jean-Daniel Boissonnat, Mariette Yvinec, Algorithmic Geometry, Cambridge University Press, 1998.

CSE-ELV-	**Distributed System**	**3L:0T: 0P**	**3 Credits**

Course Content:

Characterization of Distributed Systems, Design issues and user requirements. Interprocess Communication-Synchronous and Asynchronous, Client-server communication, Group communication.
Remote rocedure Call-Design issues & Implementation. Distributed S-Design issues & Implementation. File Services Design issues, Implementations and case studies.

Name Service-Design issues and case studies. Time and Co-ordination Physical & Logical Clocks, Distibuted Co-ordination. Replicaton issues and implementations. Shared data and Trransactions, Distibutedtansactions, concurrency control. Recovery and Fault Tolerance. Security-Design issues and case studies.

Books/References:

1. Coulouris, Dollimore and Kindberg, Distributed Systems-Concepts and Design,Pearson Education Asia
2. P K Sinha, Distibuted Operating System, PHI, IEEE Press
3. Singhal and Shivaratri, Advanced Concepts in Operating Systems, TMH
4. Tanenbaum, Distributed Systems: Principles and Paradigms, Pearson Education

CSE-ELV-	**ADVANCED DESIGN AND ANALYSIS OF ALGORITHMS**	**3L:0T: 0P**	**3 Credits**

Course Content:

Introduction to hashing, bloom filters, scheduling, network design, online load balancing, algorithms in machine learning, boosting (in the context of learning), Markov chains and the MCMC method, byzantine agreement, internet algorithms, and nearest neighbor algorithms.
Enroute, we will encounter various useful ideas, including randomization, probabilistic analysis, amortized analysis, competitive analysis, eigenvalues, linear and semi-definite programming, high dimensional geometry, and random walks.

REFERENCES---

1. Approximation Algorithms
Vijay Vazirani, *Approximation Algorithms*, Springer, 2001. (on reserve)
Dorit S. Hochbaum(ed.), *Approximation Algorithms for NP-hard Problems*, PWS Publishing, 1997. (on reserve)
2.Randomized Algorithms
Rajeev Motwani and PrabhakarRaghavan, *Randomized Algorithms*, Cambridge University Press, 2000. (on reserve)
Michael Mitzenmacher and Eli Upfal, *Probability and Computing*, Cambridge University Press, 2005.
3.Online Algorithms
Allan Borodin and Ran El-Yaniv, *Online Computation and Competitive Analysis*, Cambridge University Press, 2005. (on reserve)
4.Learning theory
Michael Kearns and UmeshVazirani, *An Introduction to Computational Learning Theory*, The MIT Press, 1994. (on reserve)

CSE-ELV-	Data Analytics	3L:0T: 0P	3 Credits

Course Content:

Introduction: Sources, modes of availability, inaccuracies, and uses of data. **Data Objects and Attributes:** Descriptive Statistics; Visualization; and Data Similarity and Dissimilarity.

Pre-processing of Data: Cleaning for Missing and Noisy Data; Data Reduction – Discrete Wavelet Transform, Principal Component Analysis, Partial Least Square Method, Attribute Subset Selection; and Data Transformation and Discretization.

Inferential Statistics: Probability Density Functions; Inferential Statistics through Hypothesis Tests

Business Analytics: Predictive Analysis (Regression and Correlation, Logistic Regression, In-Sample and Out-of-Sample Predictions), Prescriptive Analytics (Optimization and Simulation with Multiple Objectives);

Mining Frequent Patterns: Concepts of Support and Confidence; Frequent Itemset Mining Methods; Pattern Evaluation.

Classification: Decision Trees – Attribute Selection Measures and Tree Pruning; Bayesian and Rule-based Classification; Model Evaluation and Selection; Cross-Validation; Classification Accuracy; Bayesian Belief Networks; Classification by Backpropagation; and Support Vector Machine.

Clustering: Partitioning Methods – k-means Hierarchical Methods and Hierarchical Clustering Using Feature Trees; Probabilistic Hierarchical Clustering; Introduction to Density-
, Grid-, and Fuzzy and Probabilistic Model-based Clustering Methods; and Evaluation of Clustering Methods.

Text Books/ Reference Books:

1. Han, J., M. Kamber, and J. Pei, Data Mining: Concepts and Techniques, Elsevier, Amsterdam.,2012
2. James, G., D. Witten, T. Hastie, and R. Tibshirani, An Introduction to Statistical learning with Application to R, Springer, New York. Year of Publication 2013
3. Jank, W., Business Analytics for Managers, Springer, New York. Year of Publication 2011

CSE-ELV-	Computational Complexity	3L:0T: 0P	3 Credits

Course Content:

Computational Models (machine models, logic); Problems, computability, Algorithms, Resources, and Complexity; Turing machines (time and space bounds, nondeterminism); Logic (Boolean logic, circuits, first and second order logic); Complexity classes (hierarchy theorem, reachability, P, NP, Co-NP); Reduction and completeness; Randomized computation;

Approximability; Cryptography and protocols; Parallel Computation; Polynomial Hierarchy; Logarithmic space; Polynomial space; Exponential time and space.

Books/References

1. Christos H. Papadimitriou, Computational Complexity, Addison-Wesley Longman.
2. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
3. John E. Hopcroft and Jeffrey D. Ullman, Introduction to Automata, Languages and Computation, Addison-Wesley, 1979.
4. J. Balcazar, J. Diaz, and J. Gabarro, Structural Complexity, Volumes I and II, Springer.

CSE-ELV-	**Parallel and Distributed Algorithms**	**3L:0T: 0P**	**3 Credits**

Course Content:

Fundamentals: Models of parallel and distributed computation, complexity measures; The PRAM Model: balancing, divide and conquer, parallel prefix computation, pointer jumping, symmetry breaking, list ranking, sorting and searching, graph algorithms, parallel complexity and complexity classes, lower bounds; Interconnection Networks: topologies (arrays and mesh networks, trees, systolic networks, hypercubes, butterfly) and fundamental algorithms, matrix algorithms, sorting, graph algorithms, routing, relationship with PRAM models; Asynchronous Parallel Computation; Distributed Algorithms: models and complexity measures, safety, liveness, termination, logical time and event ordering, global state and snapshot algorithms, mutual exclusion, clock synchronization, election, termination detection, routing, Distributed graph algorithms; Applications of Distributed algorithms

Text Book:

1. Parallel and Distributed Computing: Architectures and Algorithms by S.K Basu.
2. Design and Analysis of Distributed Algorithms (Wiley Series on Parallel and Distributed Computing.

CSE-ELV-	**Adhoc and Sensor Networks**	**3L:0T: 0P**	**3 Credits**

Course Content:

Introduction to Ad Hoc Wireless Networks:Characteristics of MANETS, Applications of MANETS, ChallengesRouting In MANETS:Topology based versus position based approaches, Topology based routing protocols, and positionbased routing, otherrouting protocols.

Data Transmission In MANETS: The broadcast storm, Multicasting, Geocasting.TCP Over Ad Hoc Networks: TCP protocol overview, TCP and MANETS, Solutions for TCP over Ad Hoc.

Basics Of Wireless Sensors And Applications: The Mica Mote, Sensing and Communication Range, Design Issues, Energy Consumption, Clustering of Sensors, Applications.Data Retrieval In Sensor Networks: Classification of WSNs, MAC Layer, Routing Layer, High-Level Application Layer Support, Adapting to the Inherent Dynamic Nature of WSNs

Security: Security in Ad Hoc Wireless Networks, Key Management, Secure Routing, Cooperation inMANETs, Intrusion Detection Systems

Text Books/References:

1. Ad Hoc and Sensor Networks: Theory and Applications, Carlos de Morais Cordeiro and Dharma Prakash Agrawal, World Scientific Publications / Cambridge University Press,2006.

2. Wireless Sensor Networks: An Information Processing Approach, Feng Zhao, Leonidas Guibas, Elsevier Science Imprint, Morgan Kauffman Publishers,2005.

CSE-ELV-	Soft Computing	3L:0T: 0P	3 Credits

Course Content:

Introduction To Soft Computing And Neural Networks : Evolution of Computing -Soft Computing Constituents –From Conventional AI to Computational Intelligence -Adaptive Networks –Feed forward Networks –Supervised Learning.

Neural Networks –Radia Basis Function Networks -Reinforcement Learning –Unsupervised Learning Neural Networks –Adaptive Resonance architectures.Fuzzy Sets And Fuzzy Logic: Fuzzy Sets –Operations on Fuzzy Sets –Fuzzy Relations -Fuzzy Rules and Fuzzy Reasoning

Fuzzy Inference Systems –Fuzzy Logic –Fuzzy Expert Systems –Fuzzy Decision MakingNeuro-Fuzzy Modeling : Adaptive Neuro-Fuzzy Inference Systems –Coactive Neuro-Fuzzy Modeling –Classification and Regression Trees.

Text Book:

1. Digital Neural Network -S.Y Kung , Prentice-Hall of India

2. James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Edn.,

3. Jyh-ShingRoger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, Prentice-Hall of India.

CSE-ELV-	Internet Of Things	3L:0T: 0P	3 Credits

Course Content:

Introduction:Introduction to IoT concept, Objective, IoT History , Introduction to IoT communication, Why IoT, IoT Architecture, Telemetry Vs IoT, IoT Technologies behind smart & Intelligence devices, IoT Application: Home Automation, Health monitoring system, Smart Transportation and Smart Shopping

Introduction IoTHardware/Devices:Basics Of Microcontroller, Microprocessor Vs Microcontroller, Types of Sensor, actuators and their application, Programming

Fundamentals(C Programming), Introduction to Arduino microcontroller, hands on Arduino, Arduino board layout and LED Blinking temperature sensor application

Basics of Networking/Communication Protocol: Types of IoT Network and topology, Communication protocol-MQTT, Introduction to cloud services-Blynk. Introduction to IoT security.

Text Books:

1. Introduction to Open Source Software & Open Standards (IBM ICE Publication)
2. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)

CSE-ELV-	**Practical Reinforcement Learning**	**2L:0T: 1P**	**3 Credits**

Course Content:

In this course we assume that you already know some things from machine learning and have some coding experience. We've assembled a list of prerequisites in this section.

If you see something you don't know, that's no big deal: just grab a primer (notebooks right after this reading section), cram through it and pretend you already knew this stuff for ages.

- Numpy, Pandas, Matplotlib, Scikit-learn - basic machine learning stack for pythoners (required right away)
- Tensorflow - a framework for automatic gradients & deep learning tools (required from week 4 on)

We do however expect you to know algebra, basic calculus and probability. If you lack any of these, taking this course might be excruciatingly painful.

Module 1:

In this module we define and "taste" what reinforcement learning is about. We'll also learn one simple algorithm that can solve reinforcement learning problems with embarrassing efficiency.

Learning Objectives

- Understand the difference between reinforcement learning and other machine learning areas
- Be able to tell what problems can be solved by reinforcement learning
- Learn how to solve reinforcement learning problems with stochastic optimization methods
- Implement your first reinforcement learning algorithm on tabular games
- Make a neural network that learns robot control tasks with Crossentropy Method

Reinforcement learning vs all, Introduction to Numpy (basics of common data science libraries: numpy, pandas, matplotlib and scikit-learn), Tensorflow (Tensorflow, default deep learning library. and keras as well.). Multi armed bandit, decision process and applications. Introduction to OpenAI Gym. Black Box Optimization-Markov Decision Process, Crossentropy method. Approximation crossentropy method.

Module 2:

RL: Dynamic Programming (The reinforcement learning formalisms in a more rigorous, mathematical way. You'll learn how to effectively compute the return your agent gets for a particular action - and how to pick best actions based on that return.)

Learning Objectives

- Explain what is the main measure of optimality in RL
- Define two types of Bellman equations
- Apply the dynamic programming to Markov Decision process at hand
- Analyze the RL algorithm from the Generalized Policy Iteration point of view

Striving for rewards: Reward design, Bellman equations : State and Action value functions, Measuring Policy Optimality, Generalized Policy Iteration: Policy: evaluation and improvement, Policy and value iteration.

Module 3: Model-free methods

Learning Objectives

- Learn how to apply value-based RL without knowing anything about environment
- Build tabular q-learning agent and try it out on simple robot control tasks
- Know the difference between on-policy and off-policy learning algorithms

Model based vs model free, Monte Carlo and temporal difference; Q Learning, Exploration and Exploitation, ON Policy Vs Off Policy: Accounting for exploration, Expacted value for SARSA.

Reading Materials:

1. Algorithms for Reinforcement Learning" Csaba Szepesvari, Ronald Brachman, Thomas Dietterich
2. Markov Decision Processes" Markov Decision Processes: Discrete Stochastic Dynamic Programming (9780471727828): Martin L. Puterman
3. Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning Series) by Sutton, Richard published by MIT Press

CSE-ELV-	**Web technology**	**3L:0T: 0P**	**3 Credits**

Course Content:

Introduction :History of the Internet and World Wide Web, HTML 5 protocols, HTTP, SMTP, POP3, MIME, IMAP. Introduction to JAVA Scripts, Object Based Scripting for the web. Control Structures, Functions, Arrays, Objects.

Event Handling and CSS: Event Model –On check –On load –Onerror –Mouse related events –Form processing –Event Bubblers. CSS-Inline styles –Embedded Style Sheet –Linking External Style Sheets –Positioning of Elements-Drop Down Menus –Text shadows –Multiple Background Images

Multimedia:Audio and video speech synthesis and recognition, Electronic Commerce, E-Business Model, E-Marketing, Online Payments and Security, Web Servers, HTTP request types, System Architecture, Client Side Scripting and Server side Scripting, Accessing Web servers, IIS, Apache web server.XMLStructure in Data –Name spaces –DTD –Vocabularies –DOM methods.Servlets and JSPIntroduction, Servlet Overview Architecture, Handling HTTP Requests, Get and post requests, redirecting request, multi-tier applications, JSP, Overview, Objects, scripting, Standard Actions, Directives.

Text/Reference Books:

1. Deitel&Deitel, Goldberg, "Internet and world wide web –How to Program", Pearson Education Asia.
2. Paul Deitel , Harvey Deitel, Abbey Deitel ,"Internet and world wide web –How to Program", Prentice Hall

CSE-ELV-	**Image Processing**	**3L:0T: 0P**	**3 Credits**

Course Outline:

- Digital Image Fundamentals
- Image Transforms
- Image Enhancement
- Image Restoration
- Image Compression
- Image Segmentation
- Representations and Descriptions
- Recognition & Interpretation

Books/References:

1. Digital Image Processing : R.C. Gonzalez & R./E. Woods : Addison - Wesley Pub. comp.
2. Fundamentals of Digital Image Processing : A.K. Jain : PHI.

CSE-O-ELV-	Real-Time Cyber Threat Detection and Mitigation	3L:0T: 0P	3 Credits

Course Content:

Module 1:

(This module introduces the basics of TCP/IP for security, including firewall design and use.)
Los:

- Explain the pros and cons of security through obscurity
- Summarize the basics of TCP/IP for cyber security
- Examine basic TCP/IP hacks including spoofs and floods
- Define firewall and basic operation
- Differentiate between stateful and stateless firewall operation

Security through Obscurity, TCP/IP Evolution and Security, TCP/IP Overview, IP Spoofing, TCP Sequence Number Attack, Packet Flooding, Packet Sniffing, SYN Packet for Access Control, Definition of Firewall, Firewall: Stateful vs Stateless.
Reading Requirements:
1. "Network Firewalls," Steve Bellovin and Bill Cheswick
2. "Introduction to TCP/IP Network Attacks," Guang Yang
3. "Hacking DNS," Eli the Computer Guy
4. Introduction to Cyber Security, Edward Amoroso and Matthew Amoroso, (Ch. 17 - 18)
5. TCP/IP Illustrated Volume 1 (2nd Edition), Kevin Fall and W. Richard Stevens, (Ch. 17 – 18)

Module 2:

(This module introduces packet filters, firewall rule sets, proxies, and additional network security methods.)

- Describe the basics of packet filtering for network security
- Compare application proxies in forward and reverse modes
- Review firewall rule design and administration
- Develop firewall policies for HTTP and other services
- Analyze the security issues with FTP for packet filters

Packet filtering, Sample Packet filtering and reference Architecture, Default Firewall Block, Firewall Rules to allow outbound web browsing, Firewall rules to allow telnet and other TCP Services, Establishing cooperate policy rules, FTP protocol, Firewall rules for FTP, Application Proxy Filtering, Forward and Reverse Proxies
Reading Required:
1. "Anomaly-based Network Intrusion Detection: Techniques, Systems, and Challenges."
2. "Intrusion Detection via Static Analysis," Wagner and Dean
3. "How Does Intrusion Prevention Systems Work," 2013 - SourceFire
4. Introduction to Cyber Security, Edward Amoroso and Matthew Amoroso, (Chapters 19 - 20)

Module 3:

This module introduces the foundations firewall architectures, intrusion detection, and SOC design.
LOs:

- Describe firewall architectural options
- Critique firewall architectural designs that are not recommended
- Explain the basics of intrusion detection and intrusion prevention
- Compare signature-based and profile-based security analysis
- Describe how audit records, alarms, and flow information are processed
- Identify trends in SOC design for the enterprise

Firewall Architectures, Management by Exception, System Auditing, Basic of Intrusion Detection, Signature versus Behavioural Detection, IDS versus IPS, Design of SIEM, Design of a SOC.
Reading Required:

1. "An Evening with Berferd," Bill Cheswick
2. "IDES Model," Dorothy Denning
3. "DEFCAMP 2015 – Building a Security Operations Center,"
4. Introduction to Cyber Security, Edward Amoroso and Matthew Amoroso, (Ch. 21 - 22)

Module 4:
This module introduces the limitations of perimeters, and the challenges in the enterprise of dealing with threats such as DDOS and APT.

LOs:

- Analyze the limitations of the perimeter for modern enterprise
- Explain APT solutions and how the perimeter helps the attack
- Review third party security solutions
- Examine common case studies in APT attacks
- Compare DDOS protection solutions and their limitations

Practical Limitation of Perimeter, APT Scheme through Perimeter Holes, Third Party Security, Target APT Attack, Large Government Agency Attack, Layer 3 DDOS Protection, Large Financial Website DDOS Attacks, Network Security Industries Overview
Reading: Reading Required:

1. "From the Enterprise Perimeter to Mobility Enabled Cloud," Ed Amoroso, IEEE
2. "A Study of Advanced Persistent Threats," Chen, Desmet, and Huygens
3. "Implementing Zero Trust," Ed Amoroso, 2018
4. Introduction to Cyber Security, Edward Amoroso and Matthew Amoroso, (Ch. 23 - 24)

Open Electives:

CSE-O-ELV-	**Cyber Law and Ethics**	**3L:0T: 0P**	**3 Credits**

Course Content:

Cyber laws and rights in today's digital age; IT Act, Intellectual Property Issues connected with use and management of Digital Data The similar Acts of other countries Information Warfare: Nature of information warfare, including computer crime and information terrorism

Threats to information resources, including military and economic espionage, communications eavesdropping, computer break-ins, denial-of-service, destruction and modification of data, distortion and fabrication of information, forgery, control and disruption of information How, electronic bombs, and sops and perception management.

Countermeasures, including authentication, encryption, auditing, monitoring, intrusion election, and firewalls, and the limitations of those countermeasures. Cyberspace law and law enforcement, information warfare and the military, and intelligence in the information age. Information warfare policy and ethical Issues.

Text Book:

1. Hon C Graff, Cryptography and E-Commerce - A Wiley Tech Brief, Wiley Computer Publisher, 2001
2. Michael Cross, Norris L Johnson, Tony Piltzecker, Security, Shroff Publishers and Distributors Ltd.

CSE-O-ELV-	**PROGRAMMING IN JAVA/Python**	**3L:0T: 0P**	**3 Credits**

Course Content:

An Overview of Java: Object-Oriented Programming, A First Simple Program, A Second Short Program, Two Control Statements, Using Blocks of Code, Lexical Issues, The Java Class Libraries, Data Types, Variables, and Arrays: Java Is a Strongly Typed Language, The Primitive Types, Integers, Floating-Point Types, Characters, Booleans, A Closer Look at Literals, Variables, Type Conversion and Casting, Automatic Type Promotion in Expressions, Arrays, A Few Words About Strings.

Operators: Arithmetic Operators, The Bitwise Operators, Relational Operators, Boolean Logical Operators, The Assignment Operator, The ? Operator, Operator Precedence, Using Parentheses, Control Statements: Java's Selection Statements, Iteration Statements, Jump Statements.

Introducing Classes: Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection, The finalize( ) Method, A Stack Class, A Closer Look at Methods and Classes: Overloading Methods, Using Objects as Parameters,

Inheritance: Inheritance, Using super, Creating a Multilevel Hierarchy, When Constructors Are Called, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance, The Object Class.
Introduction to packages.

Text Books:
1. Herbert Schildt, Java The Complete Reference, 7th Edition, Tata McGraw Hill, 2007.

CSE-O-ELV-	**BASIC ENVIRONMENTAL SCIENCE & ENGINEERING**	**3L:0T: 0P**	**3 Credits**

Course Content:

Environmental Management, Resources and Legislation Environmental disturbances, quantification of environmental issues, soil resources and their classification, equitable use of resources, natural resource management, food chain and trophic levels, environmental impacts of energy development, legislation.

Global Atmospheric Change The atmosphere of earth, global temperature, greenhouse effect, radiative forcing of climate change, global warming potential, carbon cycle, carbon emissions from fossil fuels, regional impacts of temperature change, global initiatives Physical, Chemical and Biological Processes Particle dispersion, methods of expressing particle concentrations, stoichiometry, chemical equilibria, solubility of gases in water, carbonate system, organic chemistry, nuclear chemistry, nuclear fission and fusion, basic atmospheric properties, fundamentals of microbiology.

Population and Economic GrowthThe nature of human population growth,population parameters, industrialisation, urbanisation, sustainable development, sustainable consumption, resettlement and rehabilitation issues, health and the environmental impacts.Solid and Hazardous

Waste Management Integrated solid waste management, hazardous waste management, biomedical waste treatment technologies and disposal options, e-waste management, waste minimisation for sustainability, waste management –Indian scenario.Pollution and MonitoringWater resources, characteristics of water, water pollutants, oxygen demanding wastes, surface water quality, groundwater quality, water and wastewater treatment systems. Air quality standards, emission standards, criteriapollutants, air pollution and meteorology, atmospheric dispersion, emission controls.Effect of noise on people, rating systems, community noise sources and criteria, traffic noise prediction, noise control.

Text Books/References:

2. Mackenzie L. Davis and David A. Cornwell.2010. Introduction to Environmental Engineering, 4e. Tata McGraw-Hill Education Private Limited New Delhi.

3. Gilbert M. Masters.2007. Introduction to Environmental Engineering and SciencePearson Education. Dorling Kindersley (India) Pvt. Ltd. Delhi.

4. J. Glynn Henry and Gary W. Heinke.2004. Environmental Science and Engineering, Pearson Education (Singapore) Pte. Ltd

CSE-O-ELV-	**Information Theory and Coding**	**3L:0T: 0P**	**3 Credits**

Course Content:

Concept of mutual information, Entropy and their properties,

Entropy based techniques of feature extraction in pattern recognition and image enhancements,

Noiseless coding, Huffman coding and its optimality, Kraft and McMillan's inequality, Shannon-Fano code, Elias code, Arithmetic coding and universal coding.

Ergodic and Markov sources and their entropy.

Algebraic codes-Linear Block codes, Cyclic codes-BCH codes, perfect code, galley codes, Finite geometry codes, Hadamard codes, Maximal distance separable codes, sphere packing

and singleton bounds.

Cryptographic codes-Random number generation, DES scheme, RSA scheme and Diffie& Hellman's Public Key Crypto systems.

Books:

1. Blahut, R.E, Theory and practice of error correcting codes, Addison Wesley.
2. Blahut, R.E, Principles of transmission of digital information , Addison Wesley.

CSE-O-ELV-	Mobile computing	3L:0T: 0P	3 Credits

INTRODUCTION

Introduction to Mobile Computing – Applications of Mobile Computing- Generations of Mobile Communication Technologies- Multiplexing – Spread spectrum -MAC Protocols – SDMA- TDMA- FDMA- CDMA

MOBILE TELECOMMUNICATION SYSTEM

Introduction to Cellular Systems – GSM – Services & Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Mobility Management – Security – GPRS- UMTS – Architecture – Handover – Security

MOBILE NETWORK LAYER

Mobile IP – DHCP – AdHoc– Proactive protocol-DSDV, Reactive Routing Protocols – DSR, AODV , Hybrid routing –ZRP, Multicast Routing- ODMRP, Vehicular Ad Hoc networks (VANET) –MANET Vs VANET – Security.

MOBILE TRANSPORT AND APPLICATION LLAYER

Mobile TCP– WAP – Architecture – WDP – WTLS – WTP –WSP – WAE – WTA Architecture – WML

MOBILE PLATFORMS AND APPLICATIONS

Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues

TEXT BOOKS:

1. Jochen Schiller, ―Mobile Communications‖, PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, ―Fundamentals of Mobile Computing‖, PHI Learning Pvt.Ltd, New Delhi – 2012

REFERENCES

1. Dharma Prakash Agarval, Qing and An Zeng, "Introduction to Wireless and Mobile systems",Thomson Asia Pvt Ltd, 2005.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, ―Principles of Mobile Computing‖, Springer, 2003.
3. William.C.Y.Lee,―Mobile Cellular Telecommunications-Analog and Digital Systems‖, Second Edition,TataMcGraw Hill Edition ,2006.
4. C.K.Toh, ―AdHoc Mobile Wireless Networks‖, First Edition, Pearson Education, 2002.

CSE-O-ELV-	Wireless Networks	3L:0T: 0P	3 Credits

WIRELESS LAN

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security – IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX

MOBILE NETWORK LAYER

Introduction – Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol – mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing

MOBILE TRANSPORT LAYER

TCP enhancements for wireless protocols – Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility – Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP – TCP over 3G wireless networks.

WIRELESS WIDE AREA NETWORK

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)-LTE network architecture and protocol.

4G NETWORKS

Introduction – 4G vision – 4G features and challenges – Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

TEXT BOOKS:

- Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012.(Unit I,II,III)
- Vijay Garg , "Wireless Communications and networking", First Edition, Elsevier 2007.(Unit IV,V)

REFERENCES:

- Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.
- Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", First Edition, Elsevier 2011.
- Simon Haykin , Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013

CSE-O-ELV-	Application of fuzzy Logic	3L:0T: 0P	3 Credits

Course Outline:

- Introduction and review of set theory
- Fuzzy sets and operations
- Fuzzy numbers and arithmetics
- Fuzzy relations and fuzzy graphs
- Fuzzy reasoning and fuzzy systems
- Fuzzy events and fuzzy regression
- Fuzzy sets and decision analysis
- Fuzzy linear programming and extensions
- Pattern recognition and fuzzy clustering

TEXT BOOKS:

- Rajasekaran. S.. Vijayalakshmi Pai. G.A. "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003
- Timothy J.Ross, "Fuzzy logic with Engineering Applications", McGraw Hill, 1995

REFERENCES:

- Klir.G, Yuan B.B. "Fuzzy sets and Fuzzy Logic Prentice Hall of India private limited, 1997.

CSE-O-ELV-	**Software Engineering**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module I (SOFTWARE PROCESS): Introduction –S/W Engineering Paradigm – life cycle models (water fall, incremental, spiral, WINWIN spiral, evolutionary, prototyping, object oriented) - system engineering – computer based system – verification – validation – life cycle process – development process –system engineering hierarchy.

Module II (SOFTWARE REQUIREMENTS) : Functional and non-functional - user – system – requirement engineering process – feasibility studies – requirements – elicitation – validation and management – software prototyping – prototyping in the software process – rapid prototyping techniques – user interface prototyping -S/W document. Analysis and modeling – data, functional and behavioral models – structured analysis and data dictionary.

Module III (DESIGN CONCEPTS AND PRINCIPLES): Design process and concepts – modular design – design heuristic – design model and document. Architectural design – software architecture – data design – architectural design – transform and transaction mapping – user interface design – user interface design principles. Real time systems - Real time software design – system design – real time executives – data acquisition system - monitoring and control system. SCM – Need for SCM – Version control – Introduction to SCM process – Software configuration items.

Module IV (TESTING): Taxonomy of software testing – levels – test activities – types of s/w test – black box testing – testing boundary conditions – structural testing – test coverage criteria based on data flow mechanisms – regression testing – testing in the large. S/W testing strategies – strategic approach and issues - unit testing – integration testing – validation testing – system testing and debugging.

Module V (SOFTWARE PROJECT MANAGEMENT) : Measures and measurements – S/W complexity and science measure – size measure – data and logic structure measure – information flow measure. Software cost estimation – function point models – COCOMO model- Delphi method.- Defining a Task Network – Scheduling – Earned Value Analysis – Error Tracking - Software changes – program evolution dynamics – software maintenance – Architectural evolution. Taxonomy of CASE tools.

Book:

1. Roger S.Pressman, Software engineering- A practitioner's Approach, McGraw-Hill International Edition, 5th edition

2. Ian Sommerville, Software engineering, Pearson education Asia, 6th edition

3. PankajJalote- An Integrated Approach to Software Engineering, Springer Verlag,

4. James F Peters and WitoldPedryez, "Software Engineering – An Engineering Approach", John Wiley and Sons, New Delhi

5. Ali Behforooz and Frederick J Hudson, "Software Engineering Fundamentals", Oxford University Press, New Delhi

CSE-O-ELV-	**Graph Theory**	**3L:0T: 0P**	**3 Credits**

Course Content:

Graph : Incidence and degree; Handshaking Lemma; Isomorphism; Subgraphs and Union of graphs; Connectedness; Walks, Paths and Circuits; Components and Connectedness; Walks, Walks, Paths and Circuits; Components and Connectedness algorithms; Shortest Path Algorithms, Eulerian graph, Fleury's algorithm and Chinese postman problem; Hamiltonian graph - necessary and sufficient conditions; Traveling salesman; Bipartite graph.

Tree : Properties of trees; Pedant vertices in a tree; Center of a tree; Rooted binary trees; Spanning trees - Spanning tree algorithms; Fundamental circuits; Spanning trees of a weighted graph; cut-sets and cut-vertices; Fundamental cut-sets; Connectivity and separativity; network flow; max-flow min-cut theorem.
*Planner graph***:** Combinatorial and geometric dual; Kuratowski's graph; detection of planarity; Thickness and crossings.
Matrix representations of graph: Incidence; Adjacency; matrices and their properties.
Colourings: Chromatic number : Chromatic polynomial; The six and five colour theorems; The four colour problem.
Directed graphs : Binary relations; Directed graphs and connectedness; directed trees; Aborecence; Polish method; Tournaments.
Counting of labeled trees : Cayley's theorem; Counting methods; Polya theory.

Books :

1. Deo, N.: Graph Theory with Applications to Engineering and Computer Science.
2. Harary : Graph Theory, PHI (EEE)

CSE-O-ELV-	**CRYPTOGRAPHY, NETWORK SECURITY**	**3L:0T: 0P**	**3 Credits**

Course Content:

Module -1

Introduction - Cyber Attacks, Defence Strategies and Techniques, Guiding Principles, Mathematical Background for Cryptography - Modulo Arithmetic's, The Greatest Comma Divisor, Useful Algebraic Structures, Chinese Remainder Theorem, Basics of Cryptography - Preliminaries, Elementary Substitution Ciphers, Elementary Transport Ciphers, Other Cipher Properties, SecretKey Cryptography – Product Ciphers, DES Construction.

Module -2

Public Key Cryptography and RSA – RSA Operations, Why Does RSA Work?, Performance, Applications, Practical Issues, Public Key Cryptography Standard (PKCS), Cryptographic Hash - Introduction, Properties, Construction, Applications and Performance, The Birthday Attack, Discrete Logarithm and its Applications - Introduction, Diffie-Hellman Key Exchange, Other Applications.

Module -3

Key Management - Introduction, Digital Certificates, Public Key Infrastructure, Identity–based Encryption, Authentication–I - One way Authentication, Mutual Authentication, Dictionary Attacks, Authentication – II – Centalised Authentication, The Needham-Schroeder Protocol, Kerberos, Biometrics, IPSec- Security at the Network Layer – Security at Different layers: Pros and Cons, IPSec in Action, Internet Key Exchange (IKE) Protocol, Security Policy and IPSEC, Virtual Private Networks, Security at the Transport Layer - Introduction, SSL Handshake Protocol, SSL Record Layer Protocol,OpenSSL.

Module -4

IEEE 802.11 Wireless LAN Security - Background, Authentication, Confidentiality and Integrity, Viruses, Worms, and Other Malware, Firewalls – Basics, Practical Issues, Intrusion Prevention and Detection - Introduction, Prevention Versus Detection, Types of Instruction Detection Systems, DDoS Attacks Prevention/Detection, Web Service Security – Motivation, Technologies for Web Services, WS- Security, SAML, Other Standards.

Course outcomes: The students should be able to:

- Discuss the cryptography and its need to variousapplications
- Design and Develop simple cryptographyalgorithms

Text Books:

- . Cryptography, Network Security and Cyber Laws – Bernard Menezes, Cengage Learning, 2010 edition

Reference Books:

- Cryptography and Network Security- Behrouz A Forouzan, DebdeepMukhopadhyay, Mc-GrawHill, 3rd Edition, 2015
- Cryptography and Network Security- William Stallings, Pearson Education, 7th Edition