CURRICULUM

for

UNDERGRADUATE DEGREE COURSES
IN

COMPUTER SCIENCE & ENGINEERING

[July 2019]

ARYABHATTA KNOWLEDGE UNIVERSITY
Chanakya National Law University Campus
Mithapur, Patna-800001
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Curriculum for Undergraduate Degree in Computer Science and Engineering

Contents

Curriculum for Undergraduate Degree in 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	0.5 credit 1 credit

B. **Range of credits**-A range of credits from 170 to 180 for a student to be eligible to get Under Graduate degree in Engineering.

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	24
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	26
4	Professional core courses	58
5	Professional Elective courses and laboratory relevant to chosen specialization/branch	17
6	Open Electives subjects from other technical and /or emerging subjects	6
7	Massive Open Online Courses (MOOCs / SWAYAM / NPTEL etc. Courses)	6
8	Project work, seminar and internship in industry or elsewhere	31
9	Mandatory Courses [Induction Program, Environmental Science, Constitution of India]	(non-credit)
	Total	**180**

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

	Lecture	Tutorial	Laboratory/Practical	Total credits
Chemistry	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 Eng.	3	1	2	5
*Biology for Engineers	2	1	0	3
*Maths-3	3	1	0	4

These courses may be offered preferably in the later semesters

E. Course code and definition:

Course code	Definitions
HSMC	Humanities and Social Sciences including Management courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC CS	Professional Core Courses
PEC CS	Professional Elective courses
PEL CS	Professional Elective Laboratory
OEC CS	Open Elective courses
MOOC CS	Massive Open Online Courses
MC	Mandatory courses
PNS-CS	Project and Seminar
SI	Summer Industry Internship

F. HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES [HSMC]

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 301	Technical Writing	3	0	0	3	3
3	HSMC 401	Human Resource Development and Organizational Behavior	3	0	0	3	4
4	HSMC 501	Professional Skill Development	3	0	0	3	5
					Total Credits:	**12**	

G. BASIC SCIENCE COURSES [BSC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	BSC 101	Chemistry	3	1	3	5.5	1
2	BSC 102	Mathematics-I (Calculus and Linear Algebra)	3	1	0	4	1
3	BSC 201	Physics (Semi-conductor Physics)	3	1	3	5.5	2
4	BSC 202	Mathematics-II (Probability and Statistics)	3	1	0	4	2
5	BSC 301	Mathematics-III (Differential Calculus)	2	0	0	2	3
6	BSC 701	Biology for Engineers	2	1	0	3	7
					Total Credits:	**24**	

H. ENGINEERING SCIENCE COURSES [ESC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	ESC 101	Programming for Problem Solving	3	0	4	5	1
2	ESC 102	Workshop/Manufacturing Practices	1	0	4	3	1
3	ESC 201	Basic Electrical Engineering	3	1	2	5	2
4	ESC 202	Engineering Graphics & Design	1	0	4	3	2
5	ESC 301	Analog Electronic Circuits	3	0	4	5	3
6	ESC 401	Digital Electronics	3	0	4	5	4
					Total Credits:	**26**	

I. PROFESSIONAL CORE COURSES [PCC CS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	PCC CS 301	Data Structure & Algorithm	3	0	4	5	3
2	PCC CS 302	Object Oriented Programming using C++	3	0	4	5	3
3	PCC CS 401	Discrete Mathematics	3	1	0	4	4
4	PCC CS 402	Computer Organization & Architecture	3	0	4	5	4
5	PCC CS 403	Operating System	3	0	4	5	4
6	PCC CS 404	Design & Analysis of Algorithm	3	0	4	5	4
7	PCC CS 501	Database Management System	3	0	4	5	5
8	PCC CS 502	Formal language & Automata Theory	3	1	0	4	5
9	PCC CS 503	Artificial intelligence	3	0	0	3	5
10	PCC CS 504	Software Engineering	3	0	0	3	5
11	PCC CS 601	Compiler Design	3	0	4	5	6
12	PCC CS 602	Computer Networks	3	0	4	5	6
13	PCC CS 603	Machine Learning	3	1	0	4	6
					Total Credits:	**58**	

J. PROFESSIONAL ELECTIVE COURSES [PEC CS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	PEC CS 6XX	Elective-I	3	0	0	3	6
2	PEC CS 6XX	Elective-II	3	0	0	3	6
3	PEC CS 7XX	Elective-III	3	0	0	3	7
4	PEC CS 8XX	Elective-IV	3	0	0	3	8
5	PEC CS 8XX	Elective-V	3	0	0	3	8
					Total Credits:	**15**	

K. PROFESSIONAL ELECTIVE LABORATORY [PEL CS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	PEL CS 6XX	**Professional Elective Lab-I**	0	0	2	1	6
2	PEL CS 7XX	**Professional Elective Lab-II**	0	0	2	1	7
					Total Credits:	**2**	

L. OPEN ELECTIVE COURSES [OEC CS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	OEC CS 7XX	Open Elective-I	3	0	0	3	7
2	OEC CS 8XX	Open Elective-II	3	0	0	3	8
					Total Credits:	**6**	

M. MASSIVE OPEN ONLINE COURSES [MOOC CS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	MOOC CS 5XX	MOOCs / SWAYAM / NPTEL etc. Courses - 1	3	0	0	3	5
2	MOOC CS 7XX	MOOCs / SWAYAM / NPTEL etc. Courses - 2	3	0	0	3	7
					Total Credits:	**6**	

N. PROJECT AND SEMINAR [PNS CS]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	PNS CS 501	**Seminar**	0	0	2	1	5
2	PNS CS 601	**Project** - I	0	0	4	2	6
3	PNS CS 701	**Project** - II	0	0	12	6	7
4	PNS CS 801	**Project** - III	0	0	12	6	8
					Total Credits:	**15**	

Note: Only internal evaluation will be done for successful completion of **Seminar** of one credit.

N. MANDATORY COURSES [MC]

Sl. No	Code No.	Course Title	Hours per week			Total Credits	Semester
			Lecture	Tutorial	Practical		
1	MC 401	Environmental Science	3	0	0	0	4
2	MC 501	Constitution of India – Basic Features and Fundamental Principles	3	0	0	0	5
					Total Credits:	**0**	

Note: Mandatory Courses have no credit but L-T-P is 3-0-0. Only internal evaluation will be done for successful completion of Mandatory Courses.

O. SUMMER INDUSTRY INTERNSHIP [SI]

S. No.	Code No.	Schedule	Duration	Total Credits	Evaluation in Semester	Activities
1	SI 301	After 2nd Semester and duration of 3rd semester	4 Week	4	3rd	Inter/ Intra Institutional Activities
2	SI 501	After 4th Semester and duration of 5th semester	4 Week	4	5th	Internship/Innovation/Entrepreneurship Activities
3	SI 701	After 6th Semester and duration of 7th semester	8 Week	8	7th	Internship/Innovation /Entrepreneurship Activities
			Total Credits:	**16**		

Chapter 2

Semester wise structure of Curriculum

I. Induction Program

Induction program (mandatory)	**3 weeks duration**
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

Semester I (First year)

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Basic Science courses	BSC101	Chemistry	3	1	3	5.5
2	Basic Science courses	BSC102	Mathematics-1 (Calculus & Linear Algebra)	3	1	0	4
3	Engineering Science Courses	ESC 101	Programming for Problem Solving	3	0	4	5
4	Engineering Science Courses	ESC 102	Workshop Manufacturing Practices	1	0	4	3
5	Humanities & Social Sciences including Management courses	HSMC 101	English	2	0	2	3
						Total credits	**20.5**

Semester II (First year)

Sl. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Basic Science courses	BSC 201	Physics (semi-conductor Physics)	3	1	3	5.5
2	Basic Science courses	BSC 202	Mathematics-II (Probability and Statistics)	3	1	0	4
3	Engineering Science Courses	ESC 201	Basic Electrical Engineering	3	1	2	5
4	Engineering Science Course	ESC 202	Engineering Graphics & Design	1	0	4	3
						Total credits	**17.5**

Semester III (Second year)

SI. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Engineering Science Course	ESC 301	Analog Electronic Circuits	3	0	4	5
2	Professional Core Courses	PCC CS 301	Data Structure & Algorithm	3	0	4	5
3	Professional Core Courses	PCC CS 302	Object Oriented Programming using C++	3	0	4	5
4	Basic Science Courses	BSC 301	Mathematics-III (Differential Calculus)	2	0	0	2
5	Humanities &Social Sciences including Management courses	HSMC 301	Technical Writing	3	0	0	3
6	Summer Industry Internship	SI 301	Summer Industry Internship - 1	-	-	-	4
						Total credits	**24**

Semester IV (Second year)

SI. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Core Courses	PCC CS 401	Discrete Mathematics	3	1	0	4
2	Professional Core Courses	PCC-CS 402	Computer Organization & Architecture	3	0	4	5
3	Professional Core Courses	PCC-CS 403	Operating Systems	3	0	4	5
4	Professional Core Courses	PCC-CS 404	Design & Analysis of Algorithms	3	0	4	5
5	Engineering Science Courses	ESC 401	Digital Electronics	3	0	4	5
6	Humanities &Social Sciences including Management Courses	HSMC 401	Human Resource Development and Organizational Behavior	3	0	0	3
7	Mandatory Courses	MC 401	Environmental Science	3	0	0	0
						Total credits	**27**

Semester V (Third year)

SI. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Core Courses	PCC CS 501	Database Management Systems	3	0	4	5
2	Professional Core Courses	PCC CS 502	Formal Language & Automata Theory	3	1	0	4
3	Professional Core Courses	PCC CS 503	Artificial intelligence	3	0	0	3
4	Professional Core Courses	PCC CS 504	Software Engineering	3	0	0	3
5	Humanities &Social Sciences including Management courses	HSMC 501	Professional Skill Development	3	0	0	3
6	Mandatory Courses	MC 501	Constitution of India-Basic Features and Fundamental Principles	3	0	0	0
7	Massive Open Online Courses	MOOC CS 501	MOOCs / SWAYAM / NPTEL etc. Courses - 1	3	0	0	3
8	Summer Industry Internship	SI 501	Summer Industry Internship - 2	-	-	-	4
9	Project and Seminar	PNS CS 501	Seminar	-	-	2	1
						Total credits	**26**

Semester VI (Third year)

SI. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Core Courses	PCC-CS 601	Compiler Design	3	0	4	5
2	Professional Core Courses	PCC-CS 602	Computer Networks	3	0	4	5
3	Professional Core Courses	PCC-CS 603	Machine Learning	3	1	0	4
4	Professional Elective Courses	PEC CS 6XX	Elective-I	3	0	0	3
5	Professional Elective Courses	PEC CS 6XX	Elective-II	3	0	0	3
6	Project and Seminar	PNS CS 601	Project - I	0	0	4	2
7	Professional Elective Laboratory	PEL CS 6XX	Professional Elective Lab-I	0	0	2	1
						Total credits	**23**

Semester VII (Fourth year)

SI. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Elective Courses	PEC CS 7XX	Elective-III	3	0	0	3
2	Open Elective courses	OEC-CS 7XX	Open Elective-I	3	0	0	3
3	Basic Science Courses	BSC 701	Biology for Engineers	2	1	0	3
4	Massive Open Online Courses	MOOC CS 701	MOOCs / SWAYAM / NPTEL etc. Courses - 2	3	0	0	3
5	Project and Seminar	PNS-CS-701	Project-II	0	0	12	6
6	Summer Industry Internship	SI 701	Summer Industry Internship - 3	-	-	-	8
7	Professional Elective Laboratory	PEL CS 7XX	Professional Elective Lab II	0	0	2	1
						Total credits	**27**

Semester –VIII (Fourth year)

SI. No.	Type of course	Code	Course Title	Hours per week			Credits
				Lecture	Tutorial	Practical	
1	Professional Elective Courses	PEC CS 8XX	Elective-IV	3	0	0	3
2	Professional Elective Courses	PEC CS 8XX	Elective-V	3	0	0	3
3	Open Elective courses	OEC-CS 8XX	Open Elective-II	3	0	0	3
4	Project and Seminar	PNS CS 801	Project-III	0	0	12	6
						Total credits	**15**

Professional Elective and Open Elective Subjects

Professional Elective – 1 6th Sem	Signals and Systems	Graph Theory	Computer Graphics	Introduction to Java Programming Language	Probability and Statistical Inference	Numerical Methods	Information Theory and Coding	
Professional Elective – 2 6thSem	Soft Computing	Distributed Database	Advanced Data Structures and Algorithms	Advance Java Programming Language	Web and Internet Technology	Multimedia Technology and its Applications	Cryptography and Network Security	Mobile and Wireless Computing
Professional Elective – 3 7thSem	Data Science	Computational Complexity	Advanced Computer Architecture	Theory of Computation	Internet of Things	Natural Language Processing	E-Commerce and ERP	Robotics and Robot Application
Professional Elective – 4 8thSem	Data Mining	Computational Number Theory	Advanced Operating Systems	Genetic Algorithm	Cloud Computing	Quantum Computing	Transaction Processing System	Pattern Recognition
Professional Elective – 5 8thSem	Deep Learning	Computational Geometry	Big Data Analytics	Real Time Systems	Block Chain	Optimization Techniques	Information Retrieval	Bitcoin and Crypto Currencies
Open Elective – 1 7thSem	Soft Skills and Interpersonal Communication	History of Science and Technology in India	Economic Policies in India	Cyber Law and Ethics	Cyber Security	Virtual Reality	3D Printing and Design	Simulation and Modelling
Open Elective – 2 8thSem	VLSI System Design	Embedded Systems	Digital Image Processing	Digital Signal Processing	High Speed Networks	High Performance Computing	Introduction to Communication Systems	Ad-hoc and Sensor Networks
	Human Computer Interaction							

Note: There are a number of subjects for each elective subject (shown above in row wise for each respective electives). Select only one subject for each elective from the corresponding row.

List of Professional Elective Courses [PEC CS] :-

Sr. No.	PEC CS	Course Code	Course Title	Hrs. / Week L – T – P	Credits	Semester
1	Elective -I	PEC CS 601	Signals and Systems	3-0-0	3	6
2	Elective -I	PEC CS 602	Graph Theory	3-0-0	3	6
3	Elective -I	PEC CS 603	Computer Graphics	3-0-0	3	6
4	Elective -I	PEC CS 604	Introduction To Java Programming Language	3-0-0	3	6
5	Elective -I	PEC CS 605	Probability and Statistical Inference	3-0-0	3	6
6	Elective -I	PEC CS 606	Numerical Methods	3-0-0	3	6
7	Elective -I	PEC CS 607	Information Theory and Coding	3-0-0	3	6
8	Elective -II	PEC CS 608	Soft Computing	3-0-0	3	6
9	Elective -II	PEC CS 609	Distributed Database	3-0-0	3	6
10	Elective -II	PEC CS 610	Advanced Data Structures and Algorithms	3-0-0	3	6
11	Elective -II	PEC CS 611	Advance Java Programming Language	3-0-0	3	6
12	Elective -II	PEC CS 612	Web and Internet Technology	3-0-0	3	6
13	Elective -II	PEC CS 613	Multimedia Technology and its Applications	3-0-0	3	6
14	Elective -II	PEC CS 614	Cryptography and Network Security	3-0-0	3	6
15	Elective -II	PEC CS 615	Mobile and Wireless Computing	3-0-0	3	6
16	Elective -III	PEC CS 701	Data Science	3-0-0	3	7
17	Elective -III	PEC CS 702	Computational Complexity	3-0-0	3	7
18	Elective -III	PEC CS 703	Advanced Computer Architecture	3-0-0	3	7
19	Elective -III	PEC CS 704	Theory of Computation	3-0-0	3	7
20	Elective -III	PEC CS 705	Internet of Things	3-0-0	3	7
21	Elective -III	PEC CS 706	Natural Language Processing	3-0-0	3	7
22	Elective -III	PEC CS 707	E-Commerce and ERP	3-0-0	3	7
23	Elective -III	PEC CS 708	Robotics and Robot Application	3-0-0	3	7
24	Elective -IV	PEC CS 801	Data Mining	3-0-0	3	8
25	Elective -IV	PEC CS 802	Computational Number Theory	3-0-0	3	8

26	Elective -IV	PEC CS 803	Advanced Operating Systems	3-0-0	3	8
27	Elective -IV	PEC CS 804	Genetic Algorithm	3-0-0	3	8
28	Elective -IV	PEC CS 805	Cloud Computing	3-0-0	3	8
29	Elective -IV	PEC CS 806	Quantum Computing	3-0-0	3	8
30	Elective -IV	PEC CS 807	Transaction Processing Systems	3-0-0	3	8
31	Elective -IV	PEC CS 808	Pattern Recognition	3-0-0	3	8
32	Elective –V	PEC CS 809	Deep Learning	3-0-0	3	8
33	Elective –V	PEC CS 810	Computational Geometry	3-0-0	3	8
34	Elective –V	PEC CS 811	Big Data Analytics	3-0-0	3	8
35	Elective –V	PEC CS 812	Real Time Systems	3-0-0	3	8
36	Elective –V	PEC CS 813	Block Chain	3-0-0	3	8
37	Elective –V	PEC CS 814	Optimization Techniques	3-0-0	3	8
38	Elective –V	PEC CS 815	Information Retrieval	3-0-0	3	8
39	Elective –V	PEC CS 816	Bitcoin and Crypto Currencies	3-0-0	3	8

List of Open Elective Courses [OEC CS] :-

Sr. No.	OEC CS	Course Code	Course Title	Hrs. / Week L – T – P	Credits	Semester
1	Open Elective -I	OEC CS 701	Soft Skills and Interpersonal Communication	3-0-0	3	7
2	Open Elective -I	OEC CS 702	History Of Science and Technology in India	3-0-0	3	7
3	Open Elective -I	OEC CS 703	Economic Policies in India	3-0-0	3	7
4	Open Elective -I	OEC CS 704	Cyber Law and Ethics	3-0-0	3	7
5	Open Elective -I	OEC CS 705	Cyber Security	3-0-0	3	7
6	Open Elective -I	OEC CS 706	Virtual Reality	3-0-0	3	7
7	Open Elective -I	OEC CS 707	3D Printing and Design	3-0-0	3	7
8	Open Elective -I	OEC CS 708	Simulation and Modelling	3-0-0	3	7

9	Open Elective -II	OEC CS 801	VLSI System Design	3-0-0	3	8
10	Open Elective -II	OEC CS 802	Embedded Systems	3-0-0	3	8
11	Open Elective -II	OEC CS 803	Digital Image Processing	3-0-0	3	8
12	Open Elective -II	OEC CS 804	Digital Signal Processing	3-0-0	3	8
13	Open Elective -II	OEC CS 805	High Speed Networks	3-0-0	3	8
14	Open Elective -II	OEC CS 806	High Performance Computing	3-0-0	3	8
15	Open Elective -II	OEC CS 807	Introduction to Communication Systems	3-0-0	3	8
16	Open Elective -II	OEC CS 808	Ad-hoc and Sensor Networks	3-0-0	3	8
17	Open Elective -II	OEC CS 809	Human Computer Interaction	3-0-0	3	8

Professional Elective Laboratories

Professional-Elective-Lab I	**Professional-Elective-Lab II**
Website development using PHP (HTML, XHTML, XML, JavaScript, CSS[Bootstrap]) laboratory	Advance Networking (Cisco)
Python Programming.	Python as tool for Machine learning
Working on MATLAB	Working on R
Working on Android Studio	Image Processing Lab
Working with UNIX/ LINUX	Advanced AI Laboratory

Note: Any new programming language/ Software package/ Technology can be incorporated as **Professional-Elective-Lab** as per requirement or demand.

Chapter 3

Subject wise Detail Syllabus

(Third semester onwards)

Undergraduate Degree in Engineering & Technology

Branch/Course: COMPUTER SCIENCE AND ENGINEERING

ESC 301	Analog Electronic Circuits	3L:0T:4P	5 Credits

Objectives of the course:

1. To learn the fundamentals of analog electronic circuits.
2. To design, construct and debug the analog electronic circuits.
3. Principles of operation, terminal characteristics, and equivalent circuit models for diodes, transistors, and op-amps.
4. Differential amplifiers, frequency response of cascaded amplifiers and gain-bandwidth considerations.
5. Linear and nonlinear applications of op-amp.

Module 1 **Lectures: 4 hrs.**

Diode circuits: P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

Module 2 **Lectures: 8 hrs.**

BJT circuits: Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits.

Module 3 **Lectures: 8 hrs.**

MOSFET circuits: MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 4 **Lectures: 8 hrs.**

Differential, multi-stage and operational amplifiers: Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 5 **Lectures: 8 hrs.**

Linear applications of op-amp: Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion.

Module 6 **Lectures: 4 hrs.**

Nonlinear applications of op-amp: Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector, Monoshot.

Suggested Books:

1. A S Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.

2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

Course Outcomes

After the completion of course, students can able to able to:

1. Understand the characteristics of transistors.
2. Design and analyze various rectifier and amplifier circuits.
3. Design sinusoidal and non-sinusoidal oscillators.
4. Understand the functioning of OP-AMP and design OP-AMP based circuits.

ESC 301P	**Analog Electronic Circuits Lab**

Hands-on experiments related to the course contents of ESC 301.

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PCC CS 301	**Data Structure & Algorithms**	**3L:0T: 4P**	**5 credits**
Pre-requisite	**Programming for Problem Solving**		

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 **Lecture 4 hrs.**

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off.

Module 2 **Lecture 10 hrs.**

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 Type of Queues: Algorithms and their analysis.

Module 3 **Lecture 6 hrs.**

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.

Module 4 **Lecture 12 hrs.**

Searching, Sorting and Hashing: Linear Search and Binary Search Techniques and their complexity analysis. 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.

Module 5 **Lecture 8 hrs.**

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.

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

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

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.

PCC CS 301P	Data Structure & Algorithms Lab

Hands-on experiments related to the course contents of PCC CS 301.

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PCC CS 302	Object Oriented Programming using C++	3L:0T: 4P	5 credits
Pre-requisite	Programming for Problem Solving		

Objectives of the course:

1. To impart the basic concepts of Object Oriented Programming.
2. To understand concepts about Classes and Data Abstraction
3. To understand basic concepts about Inheritance.
4. To enable them to write algorithms for solving problems using object oriented approach.

Detailed contents:

Module 1 **Lecture: 3 hrs.**

Introduction to C++ : Object Oriented Technology, Advantages of OOP, Input- output in C++, Tokens, Keywords, Identifiers, Data Types C++, Derives data types. The void data type, Type Modifiers, Typecasting, Constant, Operator, Precedence of Operators, Strings.

Module 2 **Lecture: 6 hrs.**

Control Structures and Functions: Decision making statements like if-else, Nested if-else, goto, break, continue, switch case, Loop statement like for loop, nested for loop, while loop, do-while loop. Parts of Function, User- defined Functions, Value- Returning Functions, void Functions, Value Parameters, Function overloading, Virtual Functions.

Module 3 **Lecture: 12 hrs.**

Classes and Data Abstraction : Structure in C++, Class, Build- in Operations on Classes, Assignment Operator and Classes, Class Scope, Reference parameters and Class Objects (Variables), Member functions, Accessor and Mutator Functions, Constructors, default Constructor, Destructors.

Module 4 **Lecture: 8 hrs.**

Overloading, Templates and Inheritance: Operator Overloading, Function Overloading, Function Templates, Class Templates. Single and Multiple Inheritance, virtual Base class, Abstract Class, Pointer and Inheritance, Overloading Member Function.

Module 5 **Lecture: 11 hrs.**

Pointers, Arrays and Exception Handling: Void Pointers, Pointer to Class, Pointer to Object, Void Pointer, Arrays. The keywords try, throw and catch. Creating own Exception Classes,

Exception Handling Techniques (Terminate the Program, Fix the Error and Continue, Log the Error and Continue), Stack Unwinding.

Suggested books:

1. Thinking in C++, Volume 1 & 2 by Bruce Eckel, Chuck Allison, Pearson Education
2. Mastering C++, 1/e by Venugopal, Tata McGraw Hill.
3. Object Oriented Programming with C++, 3/e by E. Balaguruswamy, Tata McGraw Hill.
4. Starting Out with Object Oriented Programming in C++, by Tony Gaddis, Wiley India.

Suggested Reference Books:

1. The C++ Programming language 3/e by Bjarne Stroustrup, Pearson Education.
2. C++, How to Programme, 4e, by Deitel, Pearson Education.
3. Big C++ by Cay Horstmann, Wiley India.
4. C++ Primer, 3e by Stanley B. Lippmann, JoseeLajoie, Pearson Education.
5. C++ and Object Oriented Programming Paradigm, 2e by Debasish Jana, PHI.
6. Programming with C++, 2/e by Ravichandran, Tata McGraw Hill.
7. C++ Programming Black Book by Steven Holzner, Dreamtech Press.

Course outcomes

After the completion of course, students can able to able to:

1. Understand the concepts of Class, Object, Inheritance and Polymorphism.
2. Apply overload operators in C++
3. Understand the difference between function overloading and function overriding
4. Incorporate exception handling in object-oriented programs
5. Able to use template classes.
6. Able to write object-oriented programs of moderate complexity in C++

PCC CS 302P	Object Oriented Programming using C++ Lab

Hands-on experiments related to the course contents of PCC CS 302.

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BSC 301	Mathematics-III (Differential Calculus)	2L:0T: 0P	2 credits

Detailed contents:

Module 1 **Lecture: 6 hrs.**

Successive Differentiation, Leibnitz's Theorem. Limit, Continuity and Differentiability of function for one variable.

Module 2 **Lecture: 8 hrs.**

Limit, Continuity and Differentiability of function for several variables. Partial Derivatives, Euler's Theorem for Homogeneous functions, Total derivatives, Change of Variables. Maxima and Minima of Several Variables. Methods of Lagrange Multipliers. Taylor's and Maclaurin's Theorem with remainders of several variables.

Module 3 **Lecture: 8 hrs.**

Vector Calculus: Gradient, Divergence and Curl of a Vector and their Physical Interpretations, Vector Identities. Directional Derivatives. Line, Surface and Volume integrals, Application of Green's, Stokes and Gauss Divergence Theorem (Without Proof).

Module 4 **Lecture: 6 hrs.**

First Order Ordinary Differential Equations: Exact, Linear and Bernoulli's Equations, Euler's Equations, Equations not of First Degree: Equations Solvable for P, Equations Solvable for Y, Equations Solvable for X and Clairaut's Type.

Module 5 **Lecture: 8 hrs.**

Ordinary Differential Equations of Higher Orders: Second Order Linear Differential Equations with Variable Coefficients, Method of Variation of Parameters, Cauchy-Euler Equation; Power Series Solutions; Legendre Polynomials, Bessel Functions of the First Kind and their properties.

Module 6 **Lecture: 6 hrs.**

Partial Differential Equations – First Order: First Order Partial Differential Equations, Solutions of First Order Linear and Non-Linear PDEs.

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HSMC 301	Technical Writing	3L:0T: 0P	3 credits

Objectives of the course:

1. To understand the variety of structure of technical documents
2. To convey clearly, cogently and correctly, through written media, the technical aspects of a practice to audiences.
3. To recognize and use of the verbal and technical elements necessary for the successful practice of scientific and technical communication
4. To work collaboratively and individually to research, to analyze, and to write about, public debates regarding the conduct of science and technology

Detail contents

Module 1 **Lecture 10 hrs.**

Introduction: Fundamentals of Technical Writing: Need for Clear and Concise Technical Writing, Attributes of Technical Writing, Types of Technical Writing, Benefits of Technical Writing, Technical, Managerial and General Readers, Expressing versus Impressing, Correct use of Noun, Pronoun, Verb, Adjective, Adverbs, Tense and Punctuation.

Module 2 **Lecture 10 hrs.**

Performing Technical Studies: Types of Technical Studies, General Methodology- Proposing a Project, Gathering Background Information, Designing Test Plans, Performing Experiments, Reporting Results. **Writing Strategy:** Analysis of Readers, Scope of Writing, Purpose and Objective. **Document Options:** Document Hierarchy, Report Types and Selection. **Criteria for Good Technical Writing:** Technical Content, Presentation, Language Skills. **Writing Style:** Elements of Style, Examples of Writing Styles, Recommended Style, Learn to Prepare Effective Illustrations

Module 3 **Lecture 10 hrs.**

Formal Reports: The Outline and Introduction (Outline, Title, Front Matter, Writing the Introduction), Writing the Body (Writing a Procedure, Describing Machines/Processes, Writing Test Results, Writing the Discussion Section), Closure (Conclusions, Recommendations, References, Abstract, Back Matter, Report Distribution, Saving Reports). **Informal Reports:** Elements of an Informal Report, Investigation Reports, Service Work, Action Letters and Proposals. Typical Memo Reports.

Module 4 **Lecture 10 hrs.**

Review and Editing: Types of Review and Edit, Review and Editing Methodology, Examples of Reviews. **Oral Presentations:** Types of Oral Presentations, Preparation, Visual Aids, Impediments to Technical Writing, Maintaining Writing Skills, Measuring Report Results.

Suggested books:

1. "Engineers' Guide to Technical Writing", Kenneth G. Budinski, ASM International.
2. "Handbook for Technical Writing", James H. Shelton, NTC Contemporary Press
3. "The Technical Writer's Handbook: Writing With Style and Clarity", Matt Young, University Science Books

Suggested reference books:

1. "A Guide to Technical Writing", T. A. Rickard, Franklin Classics.
2. "Technical Writing", S. Jayprakash, Himalaya Publishing House Pvt. Ltd.
3. "Technical Writing", O. N. Pandey.

Course outcomes

1. Student should able to demonstrate improved competence in Standard Written English, including grammar, sentence and paragraph structure, coherence, and document design (including the use of the visual), and use this knowledge to revise texts.
2. Student should identify and practice the stages required to produce competent, professional writing through planning, drafting, revising, and editing.
3. It determine and implement the appropriate methods for each technical writing task.

4. Students learn to practice the ethical use of sources and the conventions of citation appropriate to each genre.

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PCC CS 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 counter examples.
5. Apply logical reasoning to solve a variety of problems.

Detailed contents:

Module 1 **Lecture 6 hrs.**

Sets, Relation and Function: Operations and Laws of Sets, Cartesian Products, Binary Relation, Partial Ordering Relation, Equivalence Relation, Image of a Set, Sum and Product of Functions, Bijective functions, Inverse and Composite Function, Size of a Set, Finite and infinite Sets, Countable and uncountable Sets, Cantor's diagonal argument and The Power Set theorem, Schroeder-Bernstein theorem.

Module 2 **Lecture 8 hrs.**

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.

Basic counting techniques-inclusion and exclusion, pigeon-hole principle, permutation and combination.

Module 3 **Lecture 8 hrs.**

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

Module 4 **Lecture 8 hrs.**

Algebraic Structures and Morphism: Algebraic Structures with one Binary Operation, Semi Groups, Monoids, Groups, Congruence Relation and Quotient Structures, Free and Cyclic Monoids and Groups, Permutation Groups, Substructures, Normal Subgroups, Algebraic Structures with two Binary Operation, Rings, Integral Domain and Fields. Boolean Algebra

and Boolean Ring, Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjunctive and Conjunctive Normal Form

Module 5 **Lecture 10 hrs.**

Graphs and Trees: Graphs and their properties, Degree, Connectivity, Path, Cycle, Sub Graph, Isomorphism, Eulerian and Hamiltonian Walks, Graph Coloring, Coloring maps and Planar Graphs, Coloring Vertices, Coloring Edges, List Coloring, Perfect Graph, definition properties and Example, rooted trees, trees and sorting, weighted trees and prefix codes, Bi-connected component and Articulation Points, Shortest distances.

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", TMGEdition,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.

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PCC CS 402	Computer Organization & Architecture	3L:0T:4P	5 Credits

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 **Lecture 10 hrs.**

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 **Lecture 14 hrs.**

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 **Lecture 10 hrs.**

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 **Lecture 6 hrs.**

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.

PCC CS 402P	Computer Organization & Architecture Lab

Hands-on experiments related to the course contents of PCC CS 402.

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PCC CS 403	Operating Systems	3L:0T:4P	5 Credits

Objectives of the course

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

Detailed Contents

Module 1 **Lecture 4 hrs.**

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 **Lecture 10 hrs.**

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 **Lecture 6 hrs.**

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, Shared Memory, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Module 4 **Lecture 4 hrs.**

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

Module 5 **Lecture 9 hrs.**

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 and Segmentation: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Advantages and Disadvantages of paging and segmentation.

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 **Lecture 9 hrs.**

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

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.

Suggested books:

1. Operating System Concepts Essentials, 9th Edition by Avi Silberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
3. Operating Systems: Design and Implementation 3rd Edition, 3rd Edition, Andrew S. Tanenbaum

Suggested reference books:

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

Course Outcomes

After the completion of course, students can able to able to:

1. Understand algorithms for process scheduling for a given specification of CPU utilization, Throughput, Turnaround Time, Waiting Time, and Response Time.
2. Develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.
3. Understand and implement file management system
4. Understand the I/O management functions in OS by performing operations for synchronization between CPU and I/O controllers.

PCC CS 403P	**Operating Systems Lab**

Hands-on experiments related to the course contents of PCC CS 403.

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PCC CS 404	**Design and Analysis of Algorithms**	**3L:0T: 4P**	**5 Credits**
Pre-requisites	**PCC CS 301 and Programming for Problem Solving**		

Objectives of the course

- Analyze the asymptotic performance of algorithms.
- Write rigorous correctness proofs for algorithms.
- Demonstrate a familiarity with major algorithms and data structures.
- Apply important algorithmic design paradigms and methods of analysis.
- Synthesize efficient algorithms in common engineering design situations.

Detailed contents:

Module 1 **Lecture 10 hrs.**

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 **Lecture 10 hrs.**

Introduction to Divide and Conquer paradigm: Binary Search, Quick and Merge sorting techniques, linear time selection algorithm, Strassen's Matrix Multiplication, Karatsuba Algorithm for fast multiplication etc. Introduction to Heap: Min and Max Heap, Build Heap, Heap Sort

Module 3 **Lecture 10 hrs.**

Overview of Brute-Force, Greedy Programming, Dynamic Programming, Branch- and-Bound and Backtracking methodologies. Greedy paradigm examples of exact optimization solution: Minimum Cost Spanning Tree, Knapsack problem, Job Sequencing Problem, Huffman Coding, Single source shortest path problem.

Dynamic Programming, difference between dynamic programming and divide and conquer, Applications: Fibonacci Series, Matrix Chain Multiplication, 0-1 Knapsack Problem, Longest Common Subsequence, Travelling Salesman Problem, Rod Cutting, Bin Packing.

Heuristics – characteristics and their application domains.

Module 4 **Lecture 8 hrs.**

Graph and Tree Algorithms: Representational issues in graphs, Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms: Bellman-Ford algorithm, Dijkstra's algorithm & Analysis of Dijkstra's algorithm using heaps, Floyd-Warshall's all pairs shortest path algorithm. Transitive closure, Topological sorting, Network Flow Algorithm, Connected Component

Module 5 **Lecture 5 hrs.**

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.

Approximation algorithms, Randomized algorithms

Suggested books:

1. Introduction to Algorithms, 4th Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MITPress/McGraw-Hill.
2. Horowitz & Sahani, "Fundamental of Computer Algorithm", Galgotia.
3. Basse, "Computer Algorithms: Introduction to Design & Analysis", Addision Wesley.

Suggested reference books

1. Algorithm Design, 1st Edition, Jon Kleinberg and Éva Tardos, 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

1. For a given algorithms analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.
2. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedy algorithms.
3. 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.
4. 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.
5. For a given model engineering problem model it using graph and write the corresponding algorithm to solve the problems.
6. Explain the ways to analyze randomized algorithms (expected running time, probability of error).
7. Explain what an approximation algorithm is. Compute the approximation factor of an approximation algorithm (PTAS and FPTAS).

PCC CS 404P	Design and Analysis of Algorithms Lab

Hands-on experiments related to the course contents of PCC CS 404.

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ESC 401	Digital Electronics	3L:0T:4P	5 Credits

Course Outcomes:

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

1. Understand working of logic families and logic gates.
2. Design and implement Combinational and Sequential logic circuits.
3. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
4. Be able to use Programmable logic devices to implement the given logical problem.

Module 1 **Lecture: 7 hrs.**

Fundamentals of Digital Systems and logic families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, 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 **Lecture: 7 hrs.**

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

Module 3 **Lecture: 7 hrs.**

Sequential circuits and systems: A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K-T and D types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.

Module 4 **Lecture: 7 hrs.**

A/D and D/A Converters: Digital to analog converters: weighted resistor/converter, R-2RLadder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using

Voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.

Module 5 **Lecture: 7 hrs.**

Semiconductor memories and Programmable logic devices: 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).

Suggested books:

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 401P	Digital Electronics Lab

Hands-on experiments related to the course contents of ESC 401.

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HSMC 401	Human Resource Development and Organizational Behavior	3L:0T:0P	3 Credits

Module 1 **Lecture: 8 hrs.**

Introduction: HR Role and Functions, Concept and Significance of HR, Changing role of HR managers - HR functions and Global Environment, role of a HR Manager. Human Resources Planning: HR Planning and Recruitment: Planning Process - planning at different levels - Job Analysis

Module 2 **Lecture: 8 hrs.**

Recruitment and selection processes - Restructuring strategies - Recruitment-Sources of Recruitment-Selection Process-Placement and Induction-Retention of Employees. Training and Development: need for skill upgradation - Assessment of training needs - Retraining and Redeployment methods and techniques of training employees and executives – performance appraisal systems.

Module 3 **Lecture: 8 hrs.**

Performance Management System: Definition, Concepts and Ethics-Different methods of Performance Appraisal- Rating Errors Competency management. Industrial Relations : Factors influencing industrial relations - State Interventions and Legal Framework - Role of Trade unions - Collective Bargaining - Workers; participation in management.

Module 4 **Lecture: 8hrs.**

Organizational Behaviour: Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB. Personality and Attitudes: Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction.

Module 5 **Lecture: 8hrs.**

Leadership: Definition, Importance, Theories of Leadership Styles. Organizational Politics: Definition, Factors contributing to Political Behavior. Conflict Management: Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation - Bargaining Strategies, Negotiation Process.

Suggested books:

1. Gary Dessler, "Human Resource Management" - (8th ed.,) Pearson Education, Delhi.
2. Robbins, S. P., Judge & T. A., "Organizational Behavior", Pearson Education, 15th Edn.

Suggested reference books:

1. Decenzo & Robbins, Personnel Human Resource Management, 3rd ed., John Wiley & Sons (Pvt.) Ltd.
2. Biswajeet Patanayak, Human Resource Management, PHI, New Delhi
3. Luis R. Gomez, Mejia, Balkin and Cardy, Managing Human Resources PHI, New Delhi
4. Luthans, Fred: Organizational Behavior, McGraw Hill, 12th Edn.
5. Shukla, Madhukar: Understanding Organizations - Organizational Theory & Practice in India, PHI

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MC 401	Environmental Science	3L : 0T : 0P	0 Credits (Mandatory non-credit course)

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students
on the above issues through following two type of activities:

(a) Awareness Activities:

i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
ii) Slogan making events
iii) Poster making events
iv) Cycle rally
v) Lectures from experts

(b) Actual Activities:

i) Plantation
ii) Gifting a tree to see its full growth
iii) Cleanliness drive
iv) Drive for segregation of waste
v) To live some big environmentalist for a week or so to understand his work
vi) To work in kitchen garden for mess
vii) To know about the different varieties of plants
viii) Shutting down the fans and ACs of the campus for an hour or so

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PCC CS 501	Database Management Systems	3L:0T:4 P	5 Credits

Objectives of the course

1. To understand the different issues involved in the design and implementation of a database system.
2. To study the physical and logical database designs, database modeling, relational, hierarchical, and network models
3. To understand and use data manipulation language to query, update, and manage a database
4. To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server (Database Server), Data Warehousing.
5. 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 **Lecture 6 hrs.**

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 **Lecture 10 hrs.**

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

Relational database design: Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design.

Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.

Module 3 **Lecture 4 hrs.**

Storage strategies: Indices, B-trees, hashing.

Module 4 **Lecture 8 hrs.**

Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.

Module 5 **Lecture 6 hrs.**

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

Module 6 **Lecture 6 hrs.**

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, Pearson Education
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, and DB2.
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.

PCC CS 501P	Database Management Systems Lab

Hands-on experiments related to the course contents of PCC CS 501.

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PCC CS 502	Formal Language & Automata Theory	3L: 1T:0 P	4 Credits

Objectives of the course

- To develop a formal notation for strings, languages and machines.
- To design finite automata to accept a set of strings of a language.
- To 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 undesirability

Detailed contents

Module 1 **Lecture 10 hrs.**

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.

Module 2 **Lecture 10 hrs.**

Context-free languages and pushdown automata: Context-free grammars (CFG) and Context-free 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.

Module 3 **Lecture 2 hrs**

Context-sensitive languages: Context-sensitive grammars (CSG) and Context-sensitive languages, linear bounded automata and equivalence with CSG.

Module 4 **Lecture 10 hrs.**

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.

Module 5 **Lecture 8 hrs.**

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:

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson EducationAsia.
2. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
3. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
4. John Martin, Introduction to Languages and the Theory of Computation, Tata McGraw Hill.

Course Outcomes:

After the completion of course, students can able to able to:

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 or not.
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.

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PCC CS 503	Artificial Intelligence	3L: 0T:0 P	3 Credits

Objectives of the course

- Understand the broader context of Artificial Intelligence
- Develop a basic understanding of the building blocks of AI such as intelligent agents, search, inference, logic, and learning.
- Learn core concepts in artificial intelligence, such as heuristic search, game playing, formal logic, knowledge representation, knowledge discovery, decision theory, machine learning, and natural language processing.

Detailed contents

Module 1 **Lecture 10 hrs.**

Introduction: Overview, Turing test, Intelligent agents. **Problem Solving**: Solving Problems by Searching: Uninformed search - Depth First Search, Breadth First Search, DFID, Heuristic search - Generate and Test, Best First Search, Beam Search, Hill Climbing, A*, Problem reduction search – AND/OR Graphs, AO*, Constraint satisfaction, Means-ends analysis, Stochastic search methods - Simulated Annealing, Particle Swarm Optimization, Game Playing - Minimax algorithm, Alpha-beta pruning

Module 2 **Lecture 10 hrs.**

Knowledge and Reasoning: Building a knowledge base - Propositional logic, first order logic, Inference in first order logic, Resolution – refutation proofs, Theorem Proving in First Order Logic; Planning, partial order planning, Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks

Module 3 **Lecture 10 hrs.**

Learning: Overview of different forms of learning: unsupervised, supervised, semi-supervised, K-means clustering algorithm, Decision Trees, Neural Networks, Deep Learning.

Module 4 **Lecture 10 hrs.**

Advanced topics: Introduction to Computer Vision, Natural Language Processing, Expert Systems, Robotics, Genetic Algorithm,

Text Books

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach," Prentice Hall
2. E. Rich, K. Knight and S. B. Nair, "Artificial Intelligence," TMH

References

1. C. Bishop,"Pattern Recognition and Machine Learning," Springer
2. D. W. Patterson, "Introduction to artificial intelligence and expert systems," Prentice Hall
3. A. C.Staugaard, Jr., "Robotics and AI: An Introduction to Applied Machine Intelligence," Prentice Hall
4. I. Bratko, "Prolog Programming for Artificial Intelligence," Addison-Wesley
5. S. O. Haykin, "Neural Networks and Learning Machines," Prentice Hall
6. D.Jurafsky and J. H. Martin,"Speech and Language Processing," Prentice Hall

Course Outcomes:

After undergoing this course, the students will be able to:

- Build intelligent agents for search and games
- Solve AI problems through programming with Python
- Learning optimization and inference algorithms for model learning
- Design and develop programs for an agent to learn and act in a structured environment.

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PCC CS 504	Software Engineering	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 8 hrs.**

Introduction: What is Software Engineering and its history, software crisis, Evolution of a Programming System Product, Characteristics of Software, Brooks' No Silver Bullet, and Software

Myths, Software Development Life Cycles: Software Development Process, The Code-and-Fix model, The Waterfall model, The Evolutionary Model, The Incremental Implementation, Prototyping, The Spiral Model, Software Reuse, Critical Comparisons of SDLC models, An Introduction to Non-Traditional Software Development Process: Rational Unified Process, Rapid Application Development, Agile Development Process.

Module 2 **Lectures: 8 hrs.**

Requirements: Importance of Requirement Analysis, User Needs, Software Features and Software Requirements, Classes of User Requirements: Enduring and Volatile, Sub phases of Requirement Analysis, Functional and Nonfunctional requirements, Barriers to Eliciting User requirements, The software requirements document and SRS standards, Requirements Engineering, Case Study of SRS for a Real Time System. Tools for Requirements Gathering: Document Flow Chart, Decision Table, Decision Tree, Introduction to nontraditional Requirements.

Module 3 **Lectures: 6 hrs.**

Software Design: Goals of good software design, Design strategies and methodologies, Data oriented software design, Coupling, Cohesion, Modular structure, Packaging, Structured Analysis: DFD, Data Dictionary, Structured Design: Structure chart, Object oriented design, Top-down and bottom-up approach, UML, UML Diagrams, Design patterns,.

Module 4 **Lectures: 6 hrs.**

Software Project Management: Overview of Project Manager Responsibilities & project planning, Software Measurement and Metrics: Line of Code (LOC), Function Point (FP) based measures, Various Size Oriented Measures: Halstead's software science, Project Size estimation Metrics Project Estimation, Techniques, COCOMO, Staffing Level Estimation, Scheduling, Organization & Team Structures Staffing, Risk Management.

Module 5 **Lectures: 5 hrs.**

Software Coding & Testing: Development: Selecting a language, Coding guidelines, Writing code, Code documentation. Testing process, Design of test cases, Functional Testing: Boundary value analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Structural testing, Cyclomatic Complexity Measures: Control flow graphs, Path testing, Data flow and mutation testing, Unit testing, Integration and system testing, Debugging, Alpha & beta testing, testing tools & standards.

Module 6 **Lectures: 4 hrs.**

Software Maintenance: Management of maintenance, Maintenance process, Maintenance models, Regression testing, Reverse engineering, Software reengineering, Configuration management, documentation.

Module 7 **Lectures: 3 hrs.**

Software Reliability & Quality Management**:** Introduction to reliability and metrics to reliability measure, Overview of S/W Quality management System ISO 9000, SEI CMM.

Text Book:

1. Software Engineering: A Practitioner's Approach, R. S. Pressman, McGraw Hill
2. Fundamental of Software Engg. By Rajib Mall 4th edition PHI
3. A Concise Introduction to Software Engineering By Pankaj Jalote

Reference Book:

1. Zero Defect Software, G. G. Schulmeyer, McGraw-Hill
2. Object Oriented Modeling and Design, J. Rumbaugh, Prentice Hall
3. Software Engineering, K.K. Aggarwal, Yogesh Singh, New Age International Publishers

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HSMC 501	**Professional Skill Development**	**3L:0T: 0P**	**3 credits**
Pre-requisites	HSMC 301		

Objectives of the course:

1. To learn various interpersonal skills
2. To help in developing various professionals skills.
3. To cover the facets of verbal and non-verbal languages, public speech, reading gestures and body languages, preparing for group discussion and enhancing presentations skills.
4. To enable learners to speak fluently and flawlessly in all kinds of communicative Contexts with speakers of all nationalities.

Detail contents:

Module 1 **Lecture 10 hrs.**

Communication skills: Public speaking, Group discussion, Gestures and body language & professional presentation skills

Module 2 **Lecture 10 hrs.**

Interpersonal skills: Group dynamics, Negotiation skills, Leadership, Emotional intelligence

Module 3 **Lecture 10 hrs.**

Employability and Corporate Skills: Time management and effective planning, Stress management, People skills, Team work, development of leadership qualities, Decision making and Negotiation skills, Positive attitude, Self-motivation, Professional ethics, Business etiquettes, balancing board room.

Module 4 **Lecture 10 hrs.**

Business writing skills, Resume Writing. Interview Skills, Technical Presentation, Guest Lecture, Professional Ethics, Project Management, Entrepreneurship.

Suggested reference books:

1. “Personality Development and Soft Skills”, Barun Mitra, Oxford University Press.
2. “Managing Soft Skills for Personality Development”, B.N. Ghosh, McGraw Hill.

3. "Communication Skills and Soft Skills: An Integrated Approach", E. Suresh Kumar, Pearson
4. "Communication to Win", Richard Denny, Kogan Page India Pvt. Ltd.

Course outcomes

1. Student can able to write their resume and can prepare for presentation, group discussion and interview.
2. Student can develop interpersonal skills like negotiation and leadership skills.
3. Students can develop Employability and Corporate Skills with proper time management and stress management.
4. Students learn to practice the professional ethics, project management and Entrepreneurship.

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MC 501	Constitution of India – Basic features and fundamental principles	3L : 0T : 0P	0 Credits (Mandatory non-credit course)

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized

throughout the world and it gradually made it "as one of the strongest court in the world".

Course content:

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions: National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.

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PCC CS 601	**Complier Design**	**3L:0T: 4P**	**5 Credits**
Pre-requisites	**Formal Language & Automata Theory**		

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
- To study the underlying theories in designing of a compiler
- The study especially consider the imperative languages

Detailed contents

Module 1 **Lecture: 6 hrs.**

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).

Module 2 **Lecture: 9 hrs.**

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).

Module 3 **Lecture: 10 hrs.**

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.

Module 4 **Lecture: 10 hrs.**

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.

Module 5 **Lecture: 5 hrs.**

Advanced topics: Type systems, data abstraction, compilation of Object Oriented features and non-imperative programming languages.

Suggested Books:

1. Compilers Principles Techniques And Tools by Alfred V. Aho, Ravi Sethi, Jeffery D. Ullman. Pearson Education.

Suggested Reference Book

1. Compiler Design by Santanu Chattopadhyay. PHI
2. Modern Compiler Design by Dick Grune, E. Bal. Ceriel, J. H. Jacobs, and Koen G. Langendoen, Viley Dreamtech.

Course Outcomes

After the completion of course, students can able to able to:

1. Develop the lexical analyser for a given grammar specification.
2. Design top-down and bottom-up parsers for a given parser specification
3. Develop syntax directed translation schemes
4. Develop algorithms to generate code for a target machine

PCC CS 601P	Complier Design Lab

Hands-on experiments related to the course contents of PCC CS 601.

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PCC CS 602	**Computer Networks**	**3L:0T: 4P**	**5 Credits**
Pre-requisites	**PCC CS 402 & PCC CS 403**		

Objectives of the course

- To develop an understanding of modern network architectures from a design and performance perspective.
- To introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs).
- To provide an opportunity to do network programming
- To provide a WLAN measurement ideas.

Detailed contents

Module 1 **Lecture 8 hrs.**

Data communication Components: Representation of data and its flow Networks , 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 **Lecture 8 hrs.**

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

Module 3 **Lecture 8 hrs.**

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

Module 4 **Lecture 8 hrs.**

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 5 **Lecture 8 hrs.**

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

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 Hall India.

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 of India.
3. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

Course Outcomes

After the completion of course, students can able to able to:

1. Explain the functions of the different layer of the OSI Protocol.
2. Draw the functional block diagram of wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANs) and can able to describe the function of each block.
3. Program for a given problem related TCP/IP protocol.
4. Configure DNS DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls using open source available software and tools.

PCC CS 602P	Computer Networks Lab

Hands-on experiments related to the course contents of PCC CS 602.

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PCC CS 603	Machine Learning	3L: 1T:0 P	4 Credits

Objectives of the course

- To learn the concept of how to learn patterns and concept from data.
- Design and analyze various machine learning algorithms and their applications in recent trends.
- Evaluate the various factors of machine learning to measure the performance.
- Understand basic of machine learning's application in recent trend of technology.

Detailed contents

Module 1 **Lecture 8 hrs.**

Introduction: Basic definitions, Linear Algebra, Statistical learning theory, types of learning, hypothesis space and Inductive bias, evaluation and cross validation, Optimization.

Module 2 **Lecture 8 hrs.**

Statistical Decision Theory, Bayesian Learning (ML, MAP, Bayes estimates, Conjugate priors), Linear Regression, Ridge Regression, Lasso, Principal Component Analysis, Partial Least Squares

Module 3 **Lecture 8 hrs.**

Linear Classification, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Perceptron, Support Vector Machines + Kernels, Artificial Neural Networks + Back Propagation, Decision Trees, Bayes Optimal Classifier, Naive Bayes.

Module 4 **Lecture 8 hrs.**

Hypothesis testing, Ensemble Methods, Bagging Adaboost Gradient Boosting, Clustering, K-means, K-medoids, Density-based Hierarchical, Spectral .

Module 5 **Lecture 8 hrs.**

Expectation Maximization, GMMs, Learning theory Intro to Reinforcement Learning , Bayesian Networks.

Suggested books:

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997
2. Introduction to Machine Learning Edition 2, by Ethem Alpaydin

Suggested Reference Books:

1. J. Shavlik and T. Dietterich (Ed), Readings in Machine Learning, Morgan Kaufmann, 1990.
2. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
3. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017. [SS-2017]
4. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009. [TH-2009]

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BSC 701	Biology for Engineers	2L:1T:0P	3 Credits

Module 1: Introduction **Lecture: 2 hrs.**

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry.

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18^{th} Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in

any scientific inquiry.

Module 2: Classification **Lecture: 3 hrs.**

Purpose: To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.

Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilisation -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (f) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus.

Module 3: Genetics **Lecture: 4 hrs.**

Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"

Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4: Biomolecules **Lecture: 4 hrs.**

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine.

Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Module 5: Enzymes **Lecture: 4 hrs.**

Purpose: To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyse reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6: Information Transfer **Lecture: 4 hrs.**

Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Module 7: Macromolecular analysis **Lecture: 5 hrs.**

Purpose: How to analyse biological processes at the reductionist level Proteins- structure and

function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8: Metabolism **Lecture: 4 hrs.**

Purpose: The fundamental principles of energy transactions are the same in physical and biological world.

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keqand its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge.

Module 9: Microbiology **Lecture: 3 hrs.**

Purpose: Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

Suggested Reference Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Outcomes

After studying the course, the student will be able to:

1. Describe how biological observations of 18th Century that lead to major discoveries.
2. Convey that classification per seis not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
3. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
4. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
5. Classify enzymes and distinguish between different mechanisms of enzyme action.
6. Identify DNA as a genetic material in the molecular basis of information transfer.
7. Analyse biological processes at the reductionistic level
8. Apply thermodynamic principles to biological systems.
9. Identify and classify microorganisms.

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PEC CS 601	Signals and Systems	3L:0T:0P	3 Credits

Course Outcomes:

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

1. Understand the concepts of continuous time and discrete time systems.
2. Analyse systems in complex frequency domain.
3. Understand sampling theorem and its implications.

Detailed contents

Module 1 **Lecture: 3 hrs.**

Introduction to Signals and Systems: Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity, additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Module 2 **Lecture: 8 hrs.**

Behavior of continuous and discrete-time LTI systems: Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Module 3 **Lecture: 10 hrs.**

Fourier, Laplace and z- Transforms: Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. 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's Theorem. Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 4 **Lecture: 4 hrs.**

Sampling and Reconstruction: The Sampling Theorem and its implications Spectra of sampled

signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Suggested books:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India,
1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley andSons, 2007.
5. A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2009.
6. M. J. Robert "Fundamentals of Signals and Systems", McGraw HillEducation, 2007.
7. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.

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PEC CS 602	Graph Theory	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 5 hrs .**

Introduction: What is graph, Application of graphs, Finite and infinite graphs, incidence and degree, isolated Vertex pendant Vertex, and Null graph, paths and circuits, isomorphism, sub graphs, a puzzle with multicolored cubes, walks, paths, and circuits, Connected graphs, disconnected graphs and components, Euler graphs, Operations on graphs, More on Euler graphs, Hamiltonian paths and circuits, The Traveling Salesman problem.

Module 2 **Lecture 5 hrs .**

Trees and Fundamental circuits: Trees, some properties of trees, pendant vertices in a tree, Distance and centers in a tree, Rooted and binary trees, On counting trees, Spanning trees, fundamental circuits, Finding all spanning trees of a Graph, Spanning trees in a Weighted graph.

Module 3 **Lecture 6 hrs.**

Cut set, and cut vertices: Properties of a cut set, all cut sets in a graph, Fundamental circuits and cut sets, connectivity and separability, Network flows, 1-Isomorphism, 2-Isomorphism.

Module 4 **Lecture 4 hrs.**

Planar and Dual Graphs: Combinatorial vs. Geometric Graphs, Planar graph, kuratowski's Two Graphs, Difference Representations of a planar graph, Detection of planarity, Geometric Dual, Combinatorial, Duel, More on criteria of planarity, Thickness and crossings.

Module 5 **Lecture 8 hrs.**

Matrix Representation of Graphs: Incidence Matrix Sub matrices of A(G), Circuits Matrix, Fundamental Circuit Matrix and Rank of B, An application to a switching Network, Cut-set Matrix, Relationships among Af , Bf and Cf . path Matrix, Adjacency Matrix.

Module 6 **Lecture 4 hrs.**

Coloring, Covering and partitioning: Chromatic number, Chromatic partitioning, Chromatics polynomial, Coverings, Four color problem.

Module 7 **Lecture 8 hrs.**

Directed Graphs: What's a directed Graphs, Some types of Digraphs, Digraphs and binary Relations, Directed paths and connectedness, Euler Digraphs, Trees with Directed Edges, Fundamental Circuits in Digraphs, Matrices A, B and C of Digraphs, Adjacency Matrix of a Digraph, Paired Comparisons and Tournaments, Acyclic Digraphs and Decyelization.

Text Book:

1. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India
2. Deo, N: Graph theory, PHI

Reference Books:

1. Bondy and Murthy: Graph theory and application. Addison Wesley.
2. R. Diestel, "Graph Theory", Springer-Verlag, 2nd edition, 2000.
3. John M. Aldous and Robin J. Wilson: Graphs and Applications-An Introductory Approach, Springer
4. Robin J, Wilson: Introduction to Graph Theory, Addison Wesley.
5. Frank Harary, "Graph Theory", Narosa.
6. R. Ahuja, T. Magnanti, and J. Orlin, "Network Flows: Theory, Algorithms, and Applications", Prentice-Hall

Course Outcomes

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

1. Write precise and accurate mathematical definitions of objects in graph theory;
2. Use mathematical definitions to identify and construct examples and to distinguish examples from non-examples;
3. Validate and critically assess a mathematical proof;
4. Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory;
5. Reason from definitions to construct mathematical proofs;
6. Write about graph theory in a coherent and technically accurate manner.

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PEC CS 603	Computer Graphics	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 8 hrs.**

Introduction and Line Generation: Types of computer graphics, Graphic Displays- Random scan displays, Raster scan displays, Frame buffer and video controller. RGB color model, direct coding, lookup table; storage tube graphics display, Raster scan display, 3D viewing devices, Plotters, printers, digitizers, Light pens etc.; Active & Passive graphics devices; Computer graphics software.

Module 2 **Lectures: 8 hrs.**

Points and lines, Line drawing algorithms; DDA algorithm, Bresenham's line algorithm, Circle generating algorithms, Mid-point circle generating algorithm, and parallel version of these algorithms. Ellipse generating algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm. Transformations: Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, Reflections and shearing.

Module 3 **Lectures: 10 hrs.**

Windowing and Clipping: Viewing pipeline, Viewing transformations, 2-D Clipping algorithms- Line clipping algorithms such as Cohen Sutherland line clipping algorithm, Liang Barsky algorithm, Line clipping against non-rectangular clip windows; Polygon clipping – Sutherland Hodgeman polygon clipping, Weiler and Atherton polygon clipping, Curve clipping, Text clipping

Three Dimensional: 3-D Geometric Primitives, 3-D Object representation, 3-D Transformation, 3-D viewing, projections, 3-D Clipping.

Module 4 **Lectures: 8 hrs.**

Curves and Surfaces: Quadric surfaces, Spheres, Ellipsoid, Blobby objects, introductory concepts of Spline, Bspline and Bezier curves and surfaces.

Module 5 **Lectures: 8 hrs.**

Hidden Lines and Surfaces: Back Face Detection algorithm, Depth buffer method, A- buffer method, Scan line method, basic illumination models– Ambient light, Diffuse reflection, Specular reflection and Phong model, Combined approach, Warn model, Intensity Attenuation, Color consideration, Transparency and Shadows.

Reference Books:

1. Donald Hearn and M Pauline Baker, "Computer Graphics C Version", Pearson Education
2. Foley, Vandam, Feiner, Hughes – "Computer Graphics principle", Pearson Education.
3. Rogers, " Procedural Elements of Computer Graphics", McGraw Hill
4. Donald Hearn and M Pauline Baker, "Computer Graphics with OpenGL", Pearson education

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PEC CS 604	Introduction to Java Programming Language	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 12 hrs.**

Introduction to Java: Feature to Java, Java Virtual Machine, Differences between C++ and Java, Part of Java, API Document, Starting a Java Program. Important Classes, Formatting the Output

Naming Conventions and Data Types: Naming Conventions in Java. Data types in Java, Literals.

Operators and Control Statements in Java: Arithmetic Operators, Unary Operators, Relational Operators, Logical Operators, Boolean Operators, Bitwise Operators, Ternary Operators, New Operator, Cast Operator, If … else statement, Switch statement, Break statement, Continue statement, Return statement, do … while loop, while loop, for loop.

Input and Output: Accepting Input from the keyboard, reading input in Java, Util, Scanner class, displaying output with System.out.print(), Displaying formatted output with string, Format.

Module 2 **Lectures: 8 hrs.**

Arrays and Strings: Types of Arrays, Array name, Length, Command Line Arguments, Creating Strings, String Class Methods, String Comparison, Immutability of Strings, Creating String Buffer Objects, String Buffer Class Methods, String Builder Class, String Builder Class Methods.

Wrapper Classes: Number class, Character class, Byte class, Short class, Integer class, Long class, Float class, Double class, Boolean class, Math class.

Introduction to OOPS: Problems in procedure oriented approach, Features of Object Oriented Programming System, Object creation, Initializing the instance variable, Constructors.

Module 3 **Lectures: 10 hrs.**

Methods of Java: Method Prototype, Method Body, Understanding Methods, Static Methods, Static Block, The keyword ‘this’, Instance Methods, Passing Primitive Data Types to Methods, Passing Objects to Methods, Passing Arrays to Methods, Recursion, Factory Methods.

Inheritance and Polymorphism: Inheritance, The Keyword ‘super’, The Protected Specified, Types of

Inheritance, Polymorphism with variables, Polymorphism using methods, Polymorphism with Static Methods, Polymorphism with Private Methods, Abstract Classes.

Packages: Package, Different types of Packages, Interface in a Package, Access Specifies in Java.

Module 4 **Lectures: 10 hrs.**

Exceptional handling: Errors in Java Program, Exceptions throws and throw clause, Types of exceptions, Re-throwing an exception.

Threads: Single and Multitasking, Creating and terminating the thread, Single and Multi-tasking using threads, Deadlock of threads, Thread communication.

Introduction to AWT and Applets: AWT components, Creating and closing the frame, Drawing in the frame, Displaying dots and text in the frame, Event Handling, Listeners and Listener methods, Creating and uses of Applets, An applet with swing components, Applet parameters.

Introduction on Java database connectivity: Database servers and clients, JDBC, Connecting to a Database, Stored Procedures and Callable Statement, Storing file and Image into database, retrieving a file and images from database, Types of JDBC drivers.

Text Books:

1. Core Java by R Nageswara & Kogent Solution Inc, Dreamtech.
2. The Complete Reference Java Tata McGraw Hill.
3. Java 6 Programming Black Book, w/CD by Kogent Solutions Inc,, Dreamtech .

Reference Books:

1. Professional Java, JDK 6 Ed. by Richardson Avondolio Wrox.
2. Programming with Java by E Balagurusamy Tata McGraw Hill.

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PEC CS 605	Probability and Statistical Inference	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 6 hrs.**

Probability: Properties of Probability, Methods of Enumeration, Conditional Probability, Independent Events, Bayes' Theorem.

Module 2 **Lectures: 6 hrs.**

Discrete Distributions: Random Variables of the Discrete Type, Mathematical Expectation, Special Mathematical Expectations, the Binomial Distribution, the Negative Binomial Distribution, the Poisson distribution.

Module 3 **Lectures: 6 hrs.**

Continuous Distributions: Random Variables of the Continuous Type, the Exponential, Gamma, and Chi-Square Distributions, the Normal Distribution, Additional Models.

Module 4 **Lectures: 6 hrs.**

Bivariate Distributions: Bivariate Distributions of the Discrete Type, the Correlation Coefficient, Conditional Distributions, Bivariate Distributions of the Continuous Type, the Bivariate Normal Distribution.

Module 5 **Lectures: 6 hrs.**

Distributions of Functions of Random Variables: Functions of One Random Variable, Transformations of Two Random Variables, Several Random Variables, The Moment-Generating Function Technique, Random Functions Associated with Normal Distributions, The Central Limit Theorem, Approximations for Discrete Distributions, Chebyshev's Inequality and Convergence in Probability, Limiting Moment-Generating Functions.

Module 6 **Lectures: 6 hrs.**

Point Estimation: Descriptive Statistics, Exploratory Data Analysis, Order Statistics, Maximum Likelihood Estimation, A Simple Regression Problem, Asymptotic Distributions of Maximum Likelihood Estimators, Sufficient Statistics, Bayesian Estimation, More Bayesian Concepts.

Module 7 **Lectures: 6 hrs.**

Interval Estimation: Confidence Intervals for Means, Confidence Intervals for the Difference of Two Means, Confidence Intervals For Proportions, Sample Size, Distribution-Free Confidence Intervals for Percentiles, More Regression, Resampling Methods.

Text Book:

1. "Probability and Statistical Inference", Robert V. Hogg, Elliot A. Tanis, Dale L. Zimmerman; Pearson Education, Inc. Ninth Edition-2015.

Reference Books:

1. "Statistical Inference", M. Rajagopalan, P. Dhanavanthan, PHI Learning – 2012
2. "Probability Distribution Theory and Statistical Inference", Kartick Chandra Bhuyan, NCBA Publication - 2010.

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PEC CS 606	Numerical Methods	3L:0T:0P	3 Credits

Detailed contents

Module 1: Error in numerical calculations **Lectures 10 hrs.**

Sources of errors, significant digits and numerical instability. Solutions of non-linear equations: Bisection method, Method of false position, Newton-Raphson method, Fixed-point iteration, Rates of convergence of these methods. Iteration based on second degree equation: Muller method, Chebyshev method, Graeffe's root squaring method for polynomials, Bairstow's method for extracting quadratic factor in the case of polynomial equations.

Module 2 Solution of system of linear algebraic equations **Lectures 10 hrs.**

Direct methods: Gauss and Gauss– Jordan methods. Crout's triangularization method. Iterative methods: Gauss-Jacobi and Gausss-Seidel methods, Relaxation method, Newton's method for nonlinear simultaneous equations, Power method for determination eigen values, convergence of Power method. Polynomial Interpolation: Lagrange's interpolation, Newton's divided difference interpolation polynomial, Gregory-Newton Forward and Back ward difference interpolation formulae, Piecewise and Spline interpolation.

Module 3: Numerical Differentiation **Lectures 10 hrs.**

Differentiation formulas in the case of equally spaced points. Numerical integration: Trapezoidal and Simpson rules, Gaussian integration, Errors of integration formulas. Numerical solution of ordinary differential equations: Single step methods: Taylor series method, Picard's Method, Euler

and Modified Euler methods, Runge – Kutta methods of 2nd and 4th order. Multi-step methods: Miline's PredictorCorrector formulas, Adam-Bashforth and Adam-Moulton formulas.

Module 4: Boundary value problems **Lectures 10 hrs.**

Solution of Linear difference equations with constant coefficients, Solutions of boundary value problems in ordinary differential equations, Approximate solution of eigen value problems, Finite difference methods for solving two dimensional Laplace's equation for a rectangular region, Finite difference method of solving heat equation and wave equation with given initial and boundary conditions.

References Books:

1. Froberg C. E., Introduction to Numerical Analysis 2nd edition, Addison Wesley, 1970.
2. Gerald C. F., Wheatley P.O., Applied Numerical Analysis, 6th edition, Pearson Asia,2002.
3. Jain M.K., Iyengar S. R. K., Numerical methods for Scientific and Engineering Computation, 3rd edition, New Age International (P) Ltd, 1996.
4. Phillips G.M., Taylor P.J., Theory and Applications of Numerical Analysis, 2nd edition Academic Press, 1996.

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PEC CS 607	**Information Theory and Coding**	**3L:0T: 0P**	**3 Credits**
Pre-requisites	**PCC-CS 602**		

Objectives of the course:

1. To understand information theoretic behaviour of a communication system.
2. To understand various source coding techniques for data compression
3. To understand various channel coding techniques and their capability.
4. To analyze performance of communication system with coding and modulation.

Module 1 **Lecture: 8 hrs.**

Information Theory: Introduction, measure of Information, Mutual information, Joint and conditional Entropy. Coding Theory**:** Classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Mutual information - Discrete memoryless channels

Module 2 **Lecture: 9 hrs.**

Channel capacity, Channel coding theorem, Differential entropy and mutual Information for continuous ensembles, Information Capacity theorem, Linear Block Codes: Syndrome and error detection, Error detection and correction capability, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes, Repetition codes and dual codes, Hamming code, Golay Code.

Module 3 **Lecture: 7 hrs.**

Galois field, Primitive element & Primitive polynomial, Minimal polynomial and generator

polynomial, Description of Cyclic Codes, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes

Module 4 **Lecture: 8 hrs.**

Binary BCH code, Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes, Cyclic Hamming code and Golay code, CRC code

Module 5 **Lecture: 8 hrs.**

Introduction of convolution code, State diagram, Polynomial description of convolution code, Generator matrix of convolution code, Tree diagram, Trellis diagram, Sequential decoding and Viterbi decoding, Known good convolution code

Suggested Books/Reference Books:

1. Ranjan Bose, "Information Theory coding and Cryptography", McGraw-Hill Publication
2. J C Moreira, P G Farrell, "Essentials of Error-Control Coding", Wiley Student Edition

Suggested Books/Reference Books:

1. BernadSklar, "Digital Communication Fundamentals & applications", Pearson Education. Second Edition.
2. Simon Haykin, "Communication Systems", John Wiley & Sons, Fourth Edition.
3. Shu lin and Daniel j, Cistellojr., "Error control Coding" Pearson, 2nd Edition.
4. Todd Moon, "Error Correction Coding : Mathematical Methods and Algorithms", Wiley Publication
5. Khalid Sayood, "Introduction to Data compression", Morgan Kaufmann Publishers

Course outcomes

1. Perform information theoretic analysis of communication system.
2. Design a data compression scheme using suitable source coding technique.
3. Design a channel coding scheme for a communication system.
4. Evaluate performance of a communication system.

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PEC CS 608	Soft Computing	3L:0T:0P	3 Credits

Objectives of the course

• To introduce soft computing concepts and techniques and foster their abilities in designing

appropriate technique for a given scenario.
• To implement soft computing based solutions for real-world problems
• To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
• To provide student an hand-on experience on MATLAB to implement various strategies

Detailed contents

Module 1 **Lectures 7 hrs.**

Introduction to Soft Computing: Evolution of Computing: Soft Computing Constituents, Soft vs Hard Computing, From Conventional AI to Computational Intelligence: Machine Learning Basics.

Module 2 **Lectures 10 hrs.**

Neural Networks: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks : Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks

Module 3 **Lectures 10 hrs.**

Fuzzy Systems: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Fuzzy based Back Propagation network.

Module 4 **Lectures 6 hrs.**

Genetic Algorithm: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning : Machine Learning Approach to Knowledge Acquisition, GA based Back P

Module 5 **Lectures 7 hrs.**

Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic

Suggested books:

1. Principles Of Soft Computing, 2nd Ed (With CD) Book by S. N. Deepa and S. N. Sivanandam
2. Soft Computing, D. K. Pratihar, Narosa, 2008.

Suggested Reference Books:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
2. Genetic Algorithms: Search and Optimization, E. Goldberg.
3. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI
4. Build Neural Network With MS Excel sample by Joe choong.

Course Outcomes:

After completion of course, students would be able to:

• Identify and describe soft computing techniques and their roles in building intelligent machines
• Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
• Apply genetic algorithms to combinatorial optimization problems.
• Evaluate and compare solutions by various soft computing approaches for a given problem.

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PEC CS 609	Distributed Database	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 6 hrs.**

Concept And Overview Distributed Database System: What is Distributed Database System (DDBS), Features of DDBS, promises of DDBS, Design issue in DDBS, Distributed DBMS architecture:- Client/server System, Peer-to-Peer, Multi-Database system.

Module 2 **Lectures: 6 hrs.**

Distributed Database Design: Distributed database design concept, objective of Data Distribution, Data Fragmentation, The allocation of fragment, Transparencies in Distributed Database Design.

Module 3 **Lectures: 6 hrs.**

Distributed Transaction And Concurrency Control: Basic concept of Transaction management, objective Distributed transaction management, Model for Transaction management Distributed Concurrency control:- Objective, concurrency control anomalies, Distributed Serializability, Locking based algorithm.

Module 4 **Lectures: 6 hrs.**

Distributed Deadlock and Recovery: Introduction to Deadlock, Distributed Deadlock prevention, avoidance, detection and recovery, Two-Phase and Three-Phase Commit Protocol.

Module 5 **Lectures: 6 hrs.**

Distributed Query Processing And Optimization: Concepts, objective, and phases of distributed query processing; join strategies in fragment relation, Global query optimization

Module 6 **Lectures: 6 hrs.**

Heterogeneous Database: Architecture of Heterogeneous Database, Database Integration: Schema Translation and schema Integration, Query processing issues in Heterogeneous database.

Module 7 **Lectures: 6 hrs.**

XML: XML for data integration, structure of XML, XML document schema, Querying and Transformation, storage of XML data, XML application.

Reference Books:

1. Silberschatz A, KorthHF, Sudarshan S, Database System Concepts, McGrall Hill.
2. Ceri S, Pelagatti G, Distributed Databases – Principles and Systems, McGraw Hill.

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PEC CS 610	Advanced Data Structures and Algorithms	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 4 hrs.**

Basic Algorithms: Asymptotic Notation, Recursion, Divide-and-Conquer Paradigm, Basic Data Structures; Possibly Fast Fourier Transform.

Module 2 **Lectures: 8 hrs.**

Sorting: Merge Sort, Bucket And Radix Sort; Medians and Order Statistics.

Module 3 **Lectures: 8 hrs.**

Data Structures: Priority Queues And Heaps, Dictionaries, Hash Tables, Bloom Filters, Binary Search Trees, Interval Trees. Union-Find, Range Trees, Fractional Cascading.

Module 4 **Lectures: 8 hrs.**

Algorithmic techniques: Divide-and-conquer, Dynamic Programming, Greedy Algorithms. Data Compression: Huffman's coding, BWT, LZW

Module 5 **Lectures: 8 hrs.**

Network Flow, String Algorithms, Suffix Trees, Geometric Algorithms, Linear Programming, Polynomial and the FFT.

Module 6 **Lectures: 4 hrs.**

Complexity classes and NP

Suggested Text Books:

1. Introduction to algorithms: Cormen, Leiserson, Rivest and Stein.
2. Algorithm Design, Jon Kleinberg and Eva Tardos, Pearson, ISBN-13: 978-0321295354

Suggested Reference Books:

1. Algorithms (4th Edition) by Robert Sedgewick and Kevin Wayne, ISBN-13: 978-0321573513

2. The Algorithm Design Manual: Steven Skiena
3. Algorithm Design: Kleinberg and Tardos

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PEC CS 611	Advance Java Programming Language	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 8 hrs**.

Java Beans and Web Servers: Introduction to Java Beans, Advantage, Properties, BDK, Introduction to EJB, Java Beans API Introduction to Servelets, Lifecycle, JSDK, Servlet API, Servlet Packages: HTTP package, Working with Http request and response, Security Issues. Java Script: Data types, variables, operators, conditional statements, array object, date object, string object, Dynamic Positioning and front end validation, Event Handling

Module 2 **Lectures: 8 hrs**.

JSP: Introduction to JSP, JSP processing, JSP Application Design, Tomcat Server, Implicit JSP objects, Conditional Processing, Declaring variables and methods, Error Handling and Debugging, Sharing data between JSP pages- Sharing Session and Application Data.

Module 3 **Lectures: 8 hrs**.

Database Connectivity: Database Programming using JDBC, Studying Javax.sql.*package, accessing a database from a JSP page, Application-specific Database Action, Developing Java Beans in a JSP page, introduction to Struts framework.

Module 4 **Lectures: 8 hrs**.

Java Servlet: Brief origin and advantages over CGI, J2EE Servlet 2.x Specification, Writing small Servlet Programs, Deployment Descriptor, Inter Servlet Collaboration, Session: Definition, State on web, Different ways to track sessions,

Module 5 **Lectures: 8 hrs**.

J2SE: Concepts and Prerequisites: Data Types, Arrays, Dynamic Arrays, Type Casting, Classes and Objects, Inheritance, Interfaces, Exception Handling, Multi-Threading, **J2EE** Architecture: J2EE as a framework, Client Server Traditional model, Comparison amongst 2-tier, 3-tier and N-tier architectures, Thin and Thick Clients

Text Books:

1. Elliotte Rusty Harold, " Java Network Programming", O'Reilly publishers,
2. Ed Roman, "Mastering Enterprise Java Beans", John Wiley & Sons Inc.
3. Hortsmann& Cornell, "Core Java 2 Advanced Features, Vol II", Pearson Education,

References:

1. Web reference: http://java.sun.com.
2. Patrick Naughton, "COMPLETE REFERENCE: JAVA2", Tata McGraw-Hill.

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PEC CS 612	Web and Internet Technology	3L:0T:0P	3 Credits

Objective of the course: This course is intended to teach the basics involved in publishing content on the World Wide Web. This includes the 'language of the Web' – HTML, the fundamentals of graphic production with a specific stress on creating graphics for the Web, and a general grounding introduction to more advanced topics such as programming and scripting. This will also expose students to the basic tools and applications used in Web publishing.

Detailed contents

Module 1 **Lectures: 5 hrs.**

Web Basics: Introduction, Concept of Internet- History of Internet, Protocols of Internet, World Wide Web, URL, Web Server, Web Browser. Recent Web technologies - A case study on WWW, web 2.0 etc., Client/Server Computing: C/S Computing, Middleware, Fat client VS Fat Servers, N-tiered Software Architecture; Markup-language: Markup Languages and their grammars - SGML, DTD Resources, HTML, CSS, XML, XSL, Query Languages for XML.

Module 2 **Lectures: 4 hrs.**

HTML: Introduction, History of HTML, Structure of HTML Document: Text Basics, Structure of HTML Document: Images and Multimedia, Links and webs, Document Layout, Cascading Style Sheet- HTML 4 style sheet features, Creating Forms, Frames and Tables.

Module 3 **Lectures: 3 hrs.**

Dynamic HTML: Introduction of DHTML- HTML vs. DHTML, Advantages of DHTML, CSS of DHTML, Event Handling, Data Binding, Browser Object Models.

Module 4 **Lectures: 6 hrs.**

XML Introduction and programming: Introduction of XML- Some current applications of XML, Features of XML, Anatomy of XML document, The XML Declaration, Element Tags- Nesting and structure, XML text and text formatting element, Table element, Mark-up Element and Attributes, Document Type Definition (DTD), types. XML Programming- XML Objects, Checking Validity, Understanding XLinks, XPointer, Event-driven Programming, XML Scripting.

Module 5 **Lectures: 5 hrs.**

XML Presentation Technology & XML Processor: Introduction, XML with Style Sheet Technologies- Concept of XSL, XML Schema, Importance of XML schema, Creating Element in

XML Schema, XML Schema Types, Introduction of XML Processor- Components of XML processor, Concept of DOM and SAX, Introduction of Java Script, JavaScript characteristics, Objects in Java Script, Dynamic HTML with Java Script

Module 6 **Lectures: 4 hrs.**

XMLHttpRequest: Introduction, XMLHttpRequest, The XMLHttpRequest Object, Events for the XMLHttpRequest Object, Request Object for XMLHttpRequest, Response Object for XMLHttpRequest.

Module 7 **Lectures: 3 hrs.**

AJAX Introduction: Introduction, AJAX Introduction, AJAX Components, Handling Dynamic HTML with Ajax, CSS to Define Look and Feel, Understand the XML Mark-up, XMLHttpRequest.

Module 8 **Lectures: 4 hrs.**

AJAX using XML and XML Http Request: Introduction, Ajax Using XML and XML Http Request, Accessing, Creating and Modifying XML Nodes, Loading XML Data into an HTML Page, Receiving XML Responses, Handling Response XML.

Module 9 **Lectures: 4 hrs.**

PHP Introduction & AJAX with Database: PHP Introduction, Structure of PHP, PHP Functions, AJAX with PHP, PHP Code and the Complete AJAX Example, AJAX Database, Working of AJAX with PHP, Ajax PHP Database Form, AJAX PHP MySQL Select Query.

Module 10 **Lectures: 4 hrs.**

Active Server Page & ASP Database Connectivity : Introduction, Introduction of ASP, ASP – Variables, ASP Control Structure, ASP Objects' Properties and Methods, ASP Components, ASP Database Connection, ASP Scripting Components.

Text Book:

1. Jeffrey C. Jackson, "Web Technologies: A computer science perspective", Pearson Education
2. Developing Web Applications, Ralph Moseley and M. T. Savaliya, Wiley-India
3. Web Technologies, Black Book, dreamtech Press
4. Web Design, Joel Sklar, Cengage Learning
5. Developing Web Applications in PHP and AJAX, Harwani, McGrawHill

Reference Books:

1. Eric T. Freeman, Elisabeth Robson, "Head First JavaScript Programming", O'Reilly Media
2. L. Beighley, Michael Morrison, "Head First PHP & MySQL", O-Reilly Media
3. B. Basham, Kathy Sierra, Bert Bates, "Head First Servlets and JSP", O'Reilly publication.
4. R. M. Riordan, "Head First Ajax", O'Reilly Media.
5. Web Design with HTML, CSS, JavaScript and Query Set by Jon Duckett

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PEC CS 613	Multimedia Technology and its Applications	3L:0T:0P	3 Credits

Detailed contents

Module 1: Introduction to Multimedia System **Lectures: 6 hrs**.

Architecture and components, Multimedia distributed processing model, Synchronization, Orchestration and Quality of Service (QOS) architecture.

Module 2: Audio and Speech **Lectures: 8 hrs**.

Data acquisition, Sampling and Quantization, Human Speech production mechanism, Digital model of speech production, Analysis and synthesis, Psycho-acoustics, low bit rate speech compression, MPEG audio compression.

Module 3: Images and Video **Lectures: 8 hrs**.

Image acquisition and representation, Composite video signal NTSC, PAL and SECAM video standards, Bi-level image compression standards: ITU (formerly CCITT) Group III and IV standards, JPEG image compression standards, MPEG video compression standards.

Module 4: Multimedia Communication **Lectures: 6 hrs**.

Fundamentals of data communication and networking, Bandwidth requirements of different media, Real time constraints: Audio latency, Video data rate, multimedia over LAN and WAN, Multimedia conferencing, Multimedia devices.

Module 5: Hypermedia presentation **Lectures: 6 hrs**.

Authoring and Publishing, Linear and non-linear presentation, Structuring Information, Different approaches of authoring hypermedia documents, Hyper-media data models and standards.

Module 6: Multimedia Information Systems **Lectures: 6 hrs**.

Operating system support for continuous media applications: limitations is usual OS, New OS support, Media stream protocol, file system support for continuous media, data models for multimedia and hypermedia information, content based retrieval of unstructured data.

Text Books

1. Handbook of Multimedia Computing, Borivoje Furht
2. Multimedia Systems, Standards, and Networks, A. Puri and T. Chen, Marcel Dekker
3. Multimedia : Computing Communications & Applications, Ralf Steinmetz, Klara Nahrstedtm

Reference Books

1. Multimedia Systems, Ralf Steinmetz and Klara Nahrstedt
2. Multimedia Communications: Directions and Innovations, J. D. Gibson
3. Introduction to Data Compression, Morgan-Kaufmann, K. Sayood
4. H.264 and MPEG-4 Video Compression, Iain E.G. Richardson
5. Multimedia Literacy by Fred Hoffsteller, McGraw Hill.

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PEC CS 614	Cryptography and Network Security	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 7 hrs**.

Security Services, Mechanisms and Attacks, TheOSI Security Architecture, A Model for Network Security. Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotol Machines, Steganography.

Module 2 **Lectures: 7 hrs**.

Simplified DES, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of Operation.

Module 3 **Lectures: 7 hrs**.

Finite Fields and Confidentiality: Groups, Rings, and Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields of the Form GF (p), Polynomial arithmetic, Finite Fields of the Form GF(2"), Placement of Encryption Function, Traffic Confidentially, Key Distribution, Random Number Generation.

Module 4 **Lectures: 7 hrs**.

Encryption Standard and Ciphers: Evaluation criteria for AES, AES cipher, Multiple encryption and Triple DES, Block cipher Modes of operation, Stream ciphers and RCG.

Module 5 **Lectures: 7 hrs**.

Number Theory and Public-Key Cryptography: Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms, Principles of Public-Key Cryptosystems, The RSA Algorithm,

Module 6 **Lectures: 7 hrs**.

Message Authentication, Function, Algorithms and Digital System: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs, Secure Hash Algorithm, HMAC, Digital Signatures, Authentication Protocols.

Text Book:

1. W.Stallings : Cryptography and Network Security : Principles and Practice, 4/e Pearson Education, New Delhi, 2006.

Reference Books:

1. B.A. Forouzan – Cryptography and Network Security, TMH, New Delhi, 2007
2. B. Schneier – Applied Cryptography, John Wiley, Indian Edition, 2006.

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PEC CS 615	Mobile and Wireless Computing	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 8 hrs.**

Introduction to Wireless Networks: Applications, History, Simplified Reference Model, Wireless transmission, Frequencies, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular Systems.

Module 2 **Lecture 8 hrs.**

MAC: Motivation, SDMA, FDMA, TDMA, CDMA, Telecommunication Systems: GSM, DECT, TETRA. UMTS, MT-2000.

Module 3 **Lecture 8 hrs.**

Wireless LAN, Infrared Vs Radio transmission, Infrastructure, Adhoc Network, 802.11, HIPERLAN, Bluetooth, Mobile Network Layer, Mobile IP, Dynamic Host Configuration Protocol.

Module 4 **Lecture 8 hrs.**

Adhoc Networks, Mobile Transport Layer, Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit / Fast recovery, Transmission / Time-out freezing, Selective retransmission, Transaction Oriented TCP.

Module 5 **Lecture 8 hrs.**

Support for Mobility, File Systems, WWW, Wireless Application Protocol.

Text Book:

1. Jochen Schiller, “Mobile Communications”, Pearson Education, Asia Publications, 2000.

Reference Books:

1. William Stallings, “Wireless Communication and Networks”, PHI/Pearson Education, 2002.
2. KavehPahlavan, PrasanthKrishnamoorthy, “Principles of Wireless Networks”, PHI/Pearson Education, 2003.
3. HazysztofWesolowshi, “Mobile Communication Systems”, John Wiley and Sons Ltd, 2002.

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PEC CS 701	Data Science	3L:0T:0P	3 Credits

Objectives of the course

The objective of this course is to impart necessary knowledge of the mathematical foundations needed for data science and develop programming skills required to build data science applications.

Detailed Contents

Module 1 **Lecture 4 hrs.**

1. Introduction to Data Science: Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting

Module 2 **Lecture 6 hrs.**

2. Introduction to Programming Tools for Data Science

2.1 Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK

2.2 Visualizing Data: Bar Charts, Line Charts, Scatterplots

2.3 Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction

Module 3 **Lecture 12 hrs.**

3. Mathematical Foundations

3.1 Linear Algebra: Vectors, Matrices,

3.2 Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation

3.3 Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem

3.4 Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, Phacking, Bayesian Inference

Module 4 **Lecture 16 hrs.**

4. Machine Learning

Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning And Generalization, Overview of Deep Learning.

Module 5 **Lecture 6 hrs.**

5. Case Studies of Data Science Application

Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.
6. List of Practicals
i. Write a programme in Python to predict the class of the flower based on available attributes.
ii. Write a programme in Python to predict if a loan will get approved or not.
iii. Write a programme in Python to predict the traffic on a new mode of transport.
iv. Write a programme in Python to predict the class of user.
v. Write a programme in Python to indentify the tweets which are hate tweets and which are not.
vi. Write a programme in Python to predict the age of the actors.
vii. Mini project to predict the time taken to solve a problem given the current status of the user.

Reference Books:

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media
2. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media
3. Jain V.K., "Data Sciences", Khanna Publishing House, Delhi.
4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.
5. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi.
6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press http://www.deeplearningbook.org
8. Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann Publishers

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PEC CS 702	Computational Complexity	3L:0T:0P	3 Credits

Detailed Contents

Module 1 **Lecture 8 hrs.**

Models of Computation, resources (time and space), algorithms, computability, complexity.

Module 2 **Lecture 8 hrs.**

Complexity classes, P/NP/PSPACE, reductions, hardness, completeness, hierarchy, relationships between complexity classes.

Module 3 **Lecture 8 hrs.**

Randomized computation and complexity; Logical characterizations, incompleteness; Approximability.

Module 4 **Lecture 8 hrs.**

Circuit complexity, lower bounds; Parallel computation and complexity; Counting

problems; Interactive proofs.

Module 5 **Lecture 8 hrs.**

Probabilistically checkable proofs; Communication complexity; Quantum computation.

Reference Books:

1. Christos H. Papadimitriou., Combinatorial Optimization: Algorithms and Complexity, Prentice-Hall.
2. Sanjeev Arora and Boaz Barak, Complexity Theory: A Modern Approach, Cambridge University Press
3. Steven Homer, Alan L. Selman, Computability and Complexity Theory, Springer

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PEC CS 703	Advanced Computer Architecture	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures: 8 hrs**.

Classes of computers, Trends in technology, power and costs, dependability, quantitative principles of computer design, Introduction to computing models.

Module 2 **Lectures: 10 hrs**.

Principles of scalable performance, performance metrics and measures, speedup performance laws, advanced processor technology, super scalar and VLIW processors, Verified memory, cache memory organizations, shared memory organizations. Memory hierarchy, cache performance, protection and examples of virtual memory, cache coherence.

Module 3 **Lectures: 8 hrs**.

Pipeline and superscalar techniques, linear pipeline processors, reservation and latency analysis, collision free scheduling, pipeline schedule optimization, instruction pipeline design, arithmetic pipeline design, super scalar and super pipeline design.

Module 4 **Lectures: 7 hrs**.

Multiprocessors and multi-computers, Brief overview of SIMD, MIMD, vector architectures and multi-core architectures.

Module 5 **Lectures: 7 hrs**.

Elementary theory about dependence analysis, techniques for extraction of parallelism, branch prediction, dynamic scheduling, multiple issue and speculation, limits on instruction level parallelism, Thread level parallelism

Reference Books:

1. Computer Architecture: A Quantitative Approach : Hennessy and Patterson : Morgan Kaufmann

2. Advanced Computer Architecture, Kai Hwang , McGraw Hill
3. Advanced Computer Architectures : A design space approach, Sima D, Fountain T. and Kacsuk P, Pearson Education

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PEC CS 704	Theory of Computation	3L:0T:0P	3 Credits

Detailed contents

Logic: First-order predicate calculus - syntax, semantics, validity and satisfiability, decision problems in logic, quantified Boolean formulas and their relation with the polynomial hierarchy.

Computability theory: Review of Turing machines, some other computing models and formalisms, their equivalence with Turing machines, undecidability, Post correspondence problem, Turing computability, primitive recursive functions, Cantor and Goedel numbering, Ackermann function, mu-recursive functions, recursiveness of Ackermann and Turing computable functions, lambda calculus, term rewriting, oracle machines and the arithmetic hierarchy.

Complexity theory: Time- and space-bounded Turing machines, reduction and complete problems, oracle machines and the polynomial hierarchy, randomized computation, parallel computation.

Reference Books:

1. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
2. Fred C. Hennie. Introduction to Computability. Addison-Wesley.
3. Bernard M. Moret, The Theory of Computation, Pearson Education Asia.
4. Christos H. Papadimitriou, Computational Complexity, Addison-Wesley Longman.
5. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
6. John Martin, Introduction to Languages and The Theory of Computation, Tata McGraw Hill.
7. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.

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PEC CS 705	Internet of Things	3L:0T:0P	3 Credits

Objectives of the Course:

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-life IoT based projects.

Detailed contents

Module 1 **Lectures 8 hrs.**

Introduction to IoT: Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.

Module 2 **Lectures 9 hrs.**

Elements of IoT: Hardware Components – Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication. Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

Module 3 **Lectures 18 hrs.**

IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

Module 4 **Lectures 10 hrs.**

IoT Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.

List of Suggested Books:

1. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

Learning Outcomes:

After the completion of this course, the students will be able to:

1. Understand internet of Things and its hardware and software components
2. Interface I/O devices, sensors & communication modules
3. Remotely monitor data and control devices
4. Develop real life IoT based projects

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PEC CS 706	Natural Language Processing	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 6 hrs.**

Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Module 2 **Lecture 6 hrs.**

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Module 3 **Lecture 8 hrs.**

Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

Module 4 **Lecture 6 hrs.**

Meaning: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Coreferences.

Module 5 **Lecture 8 hrs.**

Web 2.0 Applications: Sentiment Analysis; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

Reference Books:

1. Jurafsky, Dan and Martin, James, "Speech and Language Processing", 2nd Edition, Prentice Hall, 2008
2. Manning, Christopher and Heinrich, Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999
3. Allen James, "Natural Language Understanding", 2nd edition, Benjamin Cumming, 1995
4. Charniack, Eugene, "Statistical Language Learning", MIT Press, 1993

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PEC CS 707	E-Commerce and ERP	3L:0T:0P	3 Credits

Module 1 **Lecture: 10 hrs.**

Introduction to E- Commerce: Evolution of E-commerce, Advantage and Disadvantage of E Commerce, Roadmap of E-Commerce in India. Business Models of E–Commerce: Model Based On Transaction Party: B2B, B2C, C2B, C2C.

Module 2 **Lecture: 10 hrs.**

E marketing: The scope of E-Marketing, Identifying Web Presence goals, Uniqueness of the web, Meeting the need of website visitors, Website Design Issues: Factors that make People Return to Your Site, Strategies for Website Development. Site Adhesion: Content, format and access: maintaining a Website, E- Advertising, E-Branding,

Module 3 **Lecture: 10 hrs.**

E–Payment System: Digital Payment Requirement, Digital Token based E-Payment System, Electronic Cash, Smart card and Electronics payment system: Credit and Debit Card, Virtual Currency, Digital wallet, Risk of Electronics payment system, Digital Signature.

E Security: Security On the Internet: Network and Website Security Risk: Denial-of-Service attack, Viruses, Unauthorized access to computer Network. Security Standards: Firewall, Cryptography, Key Management, Password Systems, Digital certificates, Digital signatures.

Module 4 **Lecture: 10 hrs.**

Enterprise Resource Planning (ERP): Introductory Concepts, Advantages & disadvantages of ERP, ERP and Related Technologies: - Business Process Reengineering, Data Warehousing, Data Mining, Supply Chain Management. **ERP Implementation:** ERP Implementation Life Cycle – Implementation Methodology, Hidden Costs , Organizing Implementation – Contracts with Vendors, Consultants and Users , Project Management and Monitoring.

Module 5 **Lecture: 7 hrs.**

ERP Business Modules: Introduction to basic Modules of ERP System, Business Modules in an ERP Package- Finance – Manufacturing – Human Resource – Plant Maintenance – Materials Management – Quality Management – Sales and Distribution.

Case Study: Recent business issues on E-Commerce Perspective**.**

Text Books:

1. Alexis Leon, “ERP Demystified”, Tata McGraw Hill.
2. E-Commerce An Indian Perspective by P.T.Joseph, PHI

Reference Books

1. K.K. Bajaj, D. Nag “E-Commerce”, 2nd Edition, McGraw-Hill Education, New Delhi.
2. Bhaskar Bharat, “Electronic Commerce-Technology and Application”, McGraw-Hill Education, New Delhi.
3. Mary Sumner, “Enterprise Resource Planning”, 2005, PHI Learning India Pvt. Ltd. /Pearson Education, New Delhi.
4. Chan, “E-Commerce fundamentals and Applications”, Wiley India, New Delhi.
5. Vinod Kumar Garg and N.K .Venkata Krishnan, “Enterprise Resource Planning – concepts and Planning”, Prentice Hall, 1998.

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PEC CS 708	Robotics and Robot Application	3L:0T:0P	3 Credits

Objective of the Course:
The objective of this course is to impart knowledge about industrial robots for their control and design.

Detailed contents

Module 1 **Lectures 3 hrs.**

Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open loop control systems. Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

Module 2 **Lectures 7 hrs.**

Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics. Dynamic Modelling: Equations of motion: Euler-Lagrange formulation.

Module 3 **Lectures 10 hrs.**

Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc., Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean / Similarity / Affine / Projective transformations. Vision applications in robotics.

Module 4 **Lectures 12 hrs.**

Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID. Non-linear and advanced controls.

Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Module 5 **Lectures 10 hrs.**

Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications.

List of Suggested Books:

1. Saha, S. K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi, 2009
7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modelling and Control", John Wiley and Sons Inc, 2005
8. Steve Heath, "Embedded System Design", 2nd Edition, Newnes, Burlington, 2003

9. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould, "Intelligent Mechatronic System: Modeling, Control and Diagnosis", Springer.

Learning Outcomes:

After the completion of this course, the students will be able to:

1. Perform kinematic and dynamic analyses with simulation.
2. Design control laws for a robot.
3. Integrate mechanical and electrical hardware for a real prototype of robotic device.
4. Select a robotic system for given application.

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PEC CS 801	Data Mining	3L:0T:0P	3 Credits

Detailed Contents

Module 1 **Lecture 8 hrs.**

Data Warehousing and Business Analysis: - Data warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

Module 2 **Lecture 8 hrs.**

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

Module 3 **Lecture 8 hrs.**

Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

Module 4 **Lecture 8 hrs.**

Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

Module 5 **Lecture 8 hrs.**

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.

Text Book

1. Jiawei Han, MichelineKamber and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011.

Reference Books

1. Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining &OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.
2. K.P. Soman, ShyamDiwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.
3. G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

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PEC CS 802	Computational Number Theory	3L:0T:0P	3 Credits

Detailed Contents

Module 1 **Lecture 8 hrs.**

Algorithms for integer arithmetic: Divisibility, GCD Computation: Euclid's Algorithm, Extended Euclid's Algorithm, modular arithmetic, modular exponentiation, Montgomery arithmetic, congruence, Chinese remainder theorem, Hensel lifting, orders and primitive roots, quadratic residues, integer and modular square roots, prime number theorem, continued fractions and rational approximations.

Module 2 **Lecture 8 hrs.**

Representation of finite fields: Prime and extension fields, representation of extension fields, polynomial basis, primitive elements, normal basis, optimal normal basis, irreducible polynomials. **Algorithms for polynomials:** Root-finding and factorization, Lenstra-Lenstra-Lovasz algorithm, polynomials over finite fields.

Module 3 **Lecture 6 hrs.**

Elliptic curves: The elliptic curve group, elliptic curves over finite fields, Schoof's point counting algorithm.

Module 4 **Lecture 8 hrs.**

Primality testing algorithms: Fermat test, Miller-Rabin test, Solovay-Strassen test, AKS test.
Integer factoring algorithms: Trial division, Pollard rho method, *p*-1 method, CFRAC method, quadratic sieve method, elliptic curve method.

Module 5 **Lecture 8 hrs.**

Computing discrete logarithms over finite fields: Baby-step-giant-step method, Pollard rho method, Pohlig-Hellman method, index calculus methods, linear sieve method, Coppersmith's algorithm.
Applications: Algebraic coding theory, cryptography.

Reference Books:

1. V. Shoup, A computational introduction to number theory and algebra, Cambridge University Press.
2. M. Mignotte, Mathematics for computer algebra, Springer-Verlag.
3. I. Niven, H. S. Zuckerman and H. L. Montgomery, An introduction to the theory of numbers, John Wiley.
4. J. von zur Gathen and J. Gerhard, Modern computer algebra, Cambridge University Press.
5. R. Lidl and H. Niederreiter, Introduction to finite fields and their applications, Cambridge University Press.
6. A. J. Menezes, editor, Applications of finite fields, Kluwer Academic Publishers.
7. J. H. Silverman and J. Tate, Rational points on elliptic curves, Springer International Edition.
8. D. R. Hankerson, A. J. Menezes and S. A. Vanstone, Guide to elliptic curve cryptography, Springer-Verlag.
9. A. Das and C. E. Veni Madhavan, Public-key cryptography: Theory and practice, Pearson Education Asia.
10. H. Cohen, A course in computational algebraic number theory, Springer-Verlag.

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PEC CS 803	Advanced Operating Systems	3L:0T:0P	3 Credits
Pre-requisites	PCC CS 403		

Objectives of the course

The objective of this course is to impart necessary and practical knowledge to identify and solve problems in distributed, multiprocessor and database operating systems.

Detail contents

Module 1 **Lecture 6 hrs.**

Introduction to Advance Operating System: Comparative study of OS; LINUX, Linux File System + Measurements, The Log Structured File System, Server less Network File Systems, The Coda File System, AFS, Virtual Memory, Stack/Buffer Overflow, Address Space Layout Randomization (ASLR) User-Level Virtual Memory, Global Network Scheduling, Network

Optimization, Extensible Operating Systems, Issues of Security in OS, Cryptographic file systems.

Module 2 **Lecture 6 hrs.**

Distributed Operating Systems: System Architecture Types, Issues in Distributed Operating Systems: Naming, Scalability, Security, Client-Server Model, Process Synchronization, Global Knowledge, etc. RPC, Message Passing. Absence of Global Lock, Absence of Shared Memory, lamport's logical clock, Chandy Lamport's Algorithm, Termination Detection, Distributed Mutual Exclusion, Non Token Based Algorithms, Ricart Agarwala algorithm, Lamport's Algorithm, Generalized Non-Token Based Algorithm, Comparative performance Analysis

Module 3 **Lecture 6 hrs.**

Synchronization: Clock synchronization, Event ordering, Mutual exclusion, Deadlock, Election algorithms, Desirable features of good global scheduling algorithms, Task assignment approach, Load balancing approach, Load sharing approach, Process management: Process migration, Threads Distributed Deadlock Detection, Centralized/Distributed/Hierarchical control, Path Pushing Algorithm, Edge-Chasing Algorithm, Ho-Ramamoorthy Algorithms.

Module 4 **Lecture 6 hrs.**

Resource Management in Distributed Systems: Distributed File Systems: Mounting, Caching, Bulk Data Transfer, Design Issues, Cache Consistency, Scalability, Log Structured File systems; Distributed Shared Memory: Central-Server Algorithm, Full-Replication Algorithm, etc. Coherence Protocols, Granularity, Page Replacement; Distributed Scheduling: Load, Classification, Load Balancing and Load Sharing, Policies for Transfer, Selection, Location, Information, Stability, Load Balancing Algorithms, Load Sharing Case Studies.

Module 5 **Lecture 6 hrs.**

Fault Tolerance, Recovery, Protection and Security: Atomic Actions and Commit, Commit Protocols, Voting Protocols, Dynamic Voting, Classification of Failures, Backward and Forward Error Recovery, Synchronous/Asynchronous Checkpoints and Recovery, Recovery in Concurrent Systems, Access Matrix Model, Advanced Models of Protection, Cryptography.

Module 6 **Lecture 6 hrs.**

Multiprocessor and Database Operating Systems: Tightly and Loosely Coupled systems, Interconnect networks, Caching, Hypercube architectures, Threads, Process Synchronization in MP systems, Process Scheduling in MP systems, Requirements of Database OS, Transactions, Conflicts, Serializability Theory, Distributed Database Systems, Concurrency control Algorithms, Lock Based Algorithms, Timestamp Based Algorithms, 2PL.

Module 7 **Lecture 6 hrs.**

Virtualization: Introduction; Simulation, Emulation, Para-Virtualization, Full virtualization; x86 Virtualization: privileged instructions, control sensitive instructions, Trap and Emulate, Binary translation, x86 hardware virtualization vmxon/vmxoff, vmentry, vm exit;, Intel VTd, VMCS, Shadow page tables, EPT/NPT.

Suggested books:

1. Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", Wiley.
2. Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson.
3. Mukesh Singhal & Niranjan Shivaratri, "Advanced Concepts in Operating Systems", McGraw Hill Education.

Course Outcomes

Students should be able to:

1. Identify and solve problems in distributed, multiprocessor and database operating systems.
2. Explain the architectural features and solutions for implementing various virtualization features in operating systems.
3. Solve synchronization problems involving distributed and virtualized environments.

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PEC CS 804	Genetic Algorithm	3L:0T:0P	3 Credits

Detail contents

Module 1 **Lecture 8 hrs.**

Introduction to Genetic Algorithm, Genetic Algorithms, Traditional and Search Methods and their Differences, A Simple Genetic Algorithm.

Module 2 **Lecture 8 hrs.**

Genetic Algorithms Revisited: The Fundamental Theorem, Schema Processing.

Module 3 **Lecture 8 hrs.**

Two & k-Armed Bandit Problem, Hypothesis, Schemata and Revisited.

Module 4 **Lecture 8 hrs.**

Computer Implementation of A Genetic Algorithm: Data Structures, Reproduction, Crossover and Mutation, A Time to Reproduce, A Time to Cross, How Well Does It Work, Mapping Objective Functions to Fitness Form, Fitness Scaling, Coding, A Multiparameter Mapped, Fixed-Point Coding, Discretization, Constraints.

Module 5 **Lecture 8 hrs.**

Applications of Genetic Algorithms: The Rise of Genetic Algorithms, Genetic Algorithm Applications of Historical Interest, De Jong and Function Optimization, Improvements in Basic Technique, Current Applications of Genetic Algorithms. Genetics-Based Machine Learning, Whence It Came, What is Classifier System, Rule and Message, Genetic Algorithm.

Reference Books:

1. D.E. Goldberg -Genetic Algorithms in Search Optimization and Machine Learning, Pearson Education, New Delhi, 2005.
2. M. D. Vose – The Simple Genetic Algorithm, PHI, New Delhi, 2004.

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PEC CS 805	Cloud Computing	3L:0T:0P	3 Credits

Objective: This course will cover the study of various cloud services, deployment model, resource provisioning and scheduling algorithms involved in better implementing the cloud-based systems.

Detailed contents

Module 1 **Lecture 4 hrs.**

Introduction: Distributed Computing and Enabling Technologies, Cloud Fundamentals: Cloud Definition, Evolution, Architecture, Applications, deployment models, and service models.

Module 2 **Lecture 5 hrs.**

Virtualization: Issues with virtualization, virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, virtualization of data centers, and Issues with Multi-tenancy.

Module 3 **Lecture 6 hrs.**

Implementation: Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Build Private/Hybrid Cloud using open source tools, SLA management.

Module 4 **Lecture 12 hrs.**

Resource Management: Cloud resource provisioning plan (advance reservation, on demand plan, spot instances), various scheduling and load balancing techniques to improve QoS parameters, Resource Optimization algorithms, task migration and VM migration technique.

Module 5 **Lecture 7 hrs.**

Security: Vulnerability Issues and Security Threats, Application-level Security, Data level Security, and Virtual Machine level Security, Infrastructure Security, and Multi-tenancy Issues.

Module 6 **Lecture 6 hrs.**

Advances: Green Cloud, Mobile Cloud Computing, Fog Computing, Internet of Things

Suggested Books:

1. Cloud Computing Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, Wiley Publishers 2011
2. Cloud Computing Bible, Barrie Sosinsky, Wiley Publishers 2010
3. Mastering Cloud computing, Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, McGraw Hill 2013

4. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly 2010
5. Cloud Computing by Shailendra Singh 2018

Course outcomes:

1. Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
2. Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
3. Identify problems, and explain, analyze, and evaluate various cloud computing solutions
4. Provide the appropriate cloud computing solutions and recommendations according to the applications used.
5. Attempt to generate new ideas and innovations in cloud computing

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PEC CS 806	Quantum Computing	3L:0T:0P	3 Credits

Objective of the Course:

The objective of this course is to impart necessary knowledge to the learner so that he/she can develop and implement algorithm and write programs using these algorithm.

Detailed contents

Module 1 **Lectures 6 hrs.**

Introduction to Quantum Computing: Motivation for studying Quantum Computing, Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of Quantum Computing. Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bra-ket notation, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement,

Module 2 **Lectures 9 hrs.**

Math Foundation for Quantum Computing: Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.

Module 3 **Lectures 8 hrs.**

Building Blocks for Quantum Program: Architecture of a Quantum Computing platform. Details of q-bit system of information representation: Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive e.g. Bell State, Operation on qubits: Measuring and transforming using gates, Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc.
Programming model for a Quantum Computing Program: Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits.

Module 4 **Lectures 18 hrs.**

Quantum Algorithms: **Basic techniques exploited by quantum algorithms,** Amplitude amplification, Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks.

Major Algorithms: Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch - Jozsa Algorithm.

OSS Toolkits for implementing Quantum program: IBM quantum experience, Microsoft Q, Rigetti PyQuil (QPU/QVM).

List of Suggested Books:

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley
3. IBM Experience: https://quantumexperience,ng,bluemix.net
4. Microsoft Quantum Development Kit
https://www.microsoft.com/en-us/quantum/development-kit
5. Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/

Learning Outcomes:

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

1. Explain the working of a Quantum Computing program, its architecture and program Model
2. Develop quantum logic gate circuits
3. Develop quantum algorithm
4. Program quantum algorithm on major toolkits

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PEC CS 807	**Transaction Processing Systems**	**3L:0T:0P**	**3 Credits**

Detailed Contents

Module 1 **Lecture 8 hrs.**

Consistency, Atomicity, Durability, Isolation, Flat Transactions, Providing Structure within a Transaction, Structuring an Application as Multiple Transactions.

Module 2 **Lecture 8 hrs.**

Schedules and Schedule Equivalence, Recoverability, Cascaded Aborts and Strictness, Models for Concurrency Control, A Strategy for Immediate-Update Pessimistic Concurrency Controls, Design of an Immediate-Update Pessimistic Concurrency Control, Objects and Semantic Commutativity, Atomicity, Recoverability and Compensating Operations, Locking and SQL Isolation Levels, Granular Locking: Intention Locks and Index Locks, Tuning Transactions, Multi version

Concurrency Controls.

Module 3 **Lecture 8 hrs.**

Crash, Abort and Media Failure, Immediate-Update Systems and Write-Ahead Logs, Recovery in Deferred-Update Systems, Recovery from Media Failure.

Module 4 **Lecture 8 hrs.**

Transaction Processing in a Centralized System, Transaction Processing in a Distributed System, Global Atomicity and the Transaction Manager, Remote Procedure Call, Pear-to-Pear Communication, Event Communication, Storage Architectures, Transaction Processing on the Internet, Implementing the ACID Properties, Distributed Deadlock, Global Serialization.

Module 5 **Lecture 8 hrs.**

Authentication, Authorization and Encryption, Digital Signatures, Key Distribution and Authentication, Authorization, Authenticated RPC, Electronic Commerce, Certificates, Passport: SSO, SET Protocol: Dual Signatures, Goods Atomicity, Certified Delivery, and Escrow.

Text Books

1. Michael Kifer, Arthur Bernstein and Philip M. Lewis, "Database Systems: An Application-Oriented Approach", Addison Wesley, 2006

2. Philip A. Bernstein and Eric Newcomer, "Principles of Transaction Processing", 2nd Edition, Morgan Kaufmann Publishers, Elsevier, 2009

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PEC CS 808	Pattern Recognition	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 6 hrs.**

Introduction: Importance of pattern recognition, Features, Feature Vectors, and Classifiers, Supervised Versus Unsupervised Pattern Recognition

Module 2 **Lecture 6 hrs.**

Bayes Decision Theory: Discriminant Functions and Services o the Normal Distribution, Bayesian Classification, Estimating Probability Density Functions, Nearest Neighbour Rules Bayesian Networks

Module 3 **Lecture 6 hrs.**

Linear and Nonlinear Classifiers: The Perceptron Algorithm, Least-Squares Methods, Nonlinear Classifiers, Multilayer Perceptron's, Back Propagation Algorithm, Decision Trees, combinations of Classifiers, Boosting

Module 4 **Lecture 6 hrs.**

Feature Selection: Data Pre-processing, ROC Curves, Class Separability Measures, Feature Subset Selection, Bayesian Information Criterion

Module 5 **Lecture 6 hrs.**

Dimensionality Reduction: Basis Vectors , Singular Value Decomposition , Independent Component Analysis , Kernel PCA, Wavelets

Module 6 **Lecture 6 hrs.**

Additional Features And Template Matching: Texture, Shape and Size Characterization, Fractals, Features For Audio, Template Matching Using Dynamic Time Warping and Edit Distance, Context Dependent Classification

Module 7 **Lecture 6 hrs.**

Clustering: Sequential Algorithms , Hierarchical Algorithms ,Functional Optimization-Based Clustering Graph Clustering ,Learning Clustering ,Clustering High Dimensional Data ,Subspace Clustering , Cluster Validity Measure.

Text Books

1. Pattern recognition, Sergios Theodoridis
2. Pattern classification, second edition, duda, hart and stork ,wiley
3. Pattern recognition, Sergios Theodoridis Konstanti Nos Koutrou M Bas

Reference Books

1. Introduction to Statistical Pattern Recognition, Fukunaga Academic Press
2. Pattern Recognition and Machine learning, C. M. Bishop, Springer
3. Statistical Methods in Bioinformatics, Ewens & Grant, Springer
4. The Elements of Statistical Learning, Hastie, Tibshirani, Friedman, Springer

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PEC CS 809	**Deep Learning**	**3L:0T:0P**	**5 Credits**
Pre-requisites	**Artificial Intelligence**		

Objectives of the course:

This course will provide a basic understanding of deep learning and their applications to solve real world problems. Open source tools will be used to demonstrate different applications.

Detailed contents

Module 1: Introduction **Lecture 4 hrs.**

Brief introduction of big data problem. Overview of linear algebra, probability, numerical

computation. Basics of Machine learning/Feature engineering.

Module 2: Basics of Neural networks **Lecture 4 hrs.**

Neural networks, Tools for Deep learning network - Shallow vs Deep network.

Module 3: Feedforward Networks **Lecture 6 hrs.**

Multilayer Perceptron, Gradient, Loss Function, Gradient Descent, Stochastic Gradient Descent (SDD), Backpropagation algorithm, Empirical Risk Minimization, regularization, Gradient based learning - Cost function, learning rate, soft max, sigmoid function, Hidden unit - ReLU, Logistic sigmoid, hyperbolic tangent Architecture design, Heuristics for faster training.

Module 4: Unsupervised learning **Lecture 10 hrs.**

Deep Belief Network, Deep Boltzmann Machine (DBM), Factor analysis, Auto-encoders (standard, sparse, denoising, contractive, etc), Variational Auto-encoders, Adversarial Generative Networks, Auto-encoder, Regularization Optimization for training deep model.

Module 5: Advanced topics **Lecture 10 hrs.**

Convolutional Neural Network (CNN): Architectures, convolution / pooling layers. Recurrent Neural Network (RNN)/ Sequence modeling,: Long Short Term Memory networks (LSTM), GRU, Encoder Decoder architectures Reinforcement learning.

Module 6: Practical applications **Lecture 6 hrs.**

Application of Deep Learning to Computer Vision, Speech Recognition, Natural Language Processing, etc

Suggested books:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, Book in preparation for MIT Press, 2016.
2. Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie, “The elements of statistical learning”, Springer Series in Statistics, 2009.
3. Charu C Aggarwal, “Neural Networks and Deep Learning”, Springer.

Learning Outcomes

- Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
- Implement deep learning algorithms and solve real-world problems.

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PEC CS 810	Computational Geometry	3L:0T:0P	3 Credits

Objective: To introduce geometric algorithms and to give an exposure to algorithms and data structures for geometric problems.

Detail contents

Module 1 **Lecture 6 hrs.**

Polygon Triangulation: Triangulation Theory, Area of Polygon, Segment intersection, Segment-triangle intersection.

Polygon Partitioning: Monotone Partitioning, Trapezoidalization, Partition into Monotone Mountains, Linear-Time Triangulation, Convex Partitioning.

Module 2 **Lecture 5 hrs.**

Convex Hulls in Two Dimensions: Definitions of Convexity and Convex Hulls, Naive Algorithms for Extreme Points, Gift Wrapping, QuickHull, Graham's Algorithm, Lower Bound, Incremental Algorithm, Divide and Conquer.

Module 3 **Lecture 6 hrs.**

Convex Hulls in Three Dimensions: Polyhedra and data structures, Gift wrapping, Preparata-Hong algorithm, Incremental algorithm, Randomized incremental algorithm.

Module 4 **Lecture 6 hrs.**

Voronoi Diagrams: Definitions and Basic Properties, Delaunay Triangulations, Algorithms, Applications in Detail, Medial Axis, Connection to Convex Hulls, Connection to Arrangements.

Module 5 **Lecture 6 hrs.**

Arrangements: Combinatorics of Arrangements, Incremental Algorithm, Three and Higher Dimensions, Duality, Higher-Order Voronoi**,** Diagrams, Applications.

Module 6 **Lecture 8 hrs.**

Search and Intersection: Segment-Segment Intersection, Segment- Triangle Intersection, Point in Polygon, Point in Polyhedron, Intersection of Convex Polygons, Intersection of Segments, Intersection of Nonconvex Polygons, Extreme Point of Convex Polygon, Extremal Polytope, Queries, Planar Point Location.

Module 7 **Lecture 5 hrs.**

Motion Planning: Shortest Paths, Moving a Disk, Translating a Convex Polygon, Moving a Ladder, Robot Arm Motion, Separability.

Suggested Books:

1. M. de Berg, M van Kreveld, M. Overmars, O. Schwarzkopf, Computational Geometry: Algorithms and Applications (2nd Edition), Springer - Verlag 2000

2. J. O'Rourke, Computational Geometry in C, 2nd ed., Cambridge Univ. Press, 1998.
3. B. Casselman, Mathematical Illustrations: A Manual of Geometry and PostScript, Springer-Verlag,.
(http://www.math.ubc.ca/~cass/graphics/manual) 2005
4. K. Mulmuley, Computational Geometry: An Introduction Through Randomized Algorithms, Prentice Hall. 1994

Course Outcome:
Upon successful completion of this course, students will be able to:
(i) Analyze randomized algorithms for small domain problems.
(ii) Use line-point duality to develop efficient algorithms.
(iii) Apply geometric techniques to real-world problems in graphics.
(iv) Solve linear programs geometrically.

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PEC CS 811	Big Data Analytics	3L:0T:0P	3 Credits

Course Objectives:
1. To understand the competitive advantages of big data analytics
2. To understand the big data frameworks
3. To learn data analysis methods
4. To learn stream computing
5. To gain knowledge on Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

Detailed contents

Module 1 **Lecture 7 hrs.**

Introduction to Big Data: Definition, Characteristic Features, Big Data Applications, Big Data vs Traditional Data, Risks of Big Data, Structure of Big Data, Challenges of Conventional Systems, Web Data, Evolution of Analytic Scalability, Evolution of Analytic Processes, Tools and methods, Analysis vs Reporting, Modern Data Analytic Tools.

Module 2 **Lecture 9 hrs.**

HADOOP Framework: Distributed File Systems, Large-Scale File System, Organization – HDFS concepts – Map Reduce Execution, Algorithms using Map Reduce, Matrix-Vector Multiplication – Hadoop YARN

Module 3 **Lecture 10 hrs.**

Data Analysis: Statistical Methods: Regression modelling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data - Predictive Analytics – Data

analysis using R.

Module 4 **Lecture 7 hrs.**

Mining Data Streams: Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream – Mining Data Streams and Mining Time-series data - Real Time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

Module 5 **Lecture 9 hrs.**

Big Data Frameworks: Introduction to NoSQL – Aggregate Data Models – Hbase: Data Model and Implementations – Hbase Clients – Examples – .Cassandra: Data Model – Examples – Cassandra Clients – Hadoop Integration. Pig – Grunt – Pig Data Model – Pig Latin – developing and testing Pig Latin scripts. Hive – Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries

Course Outcomes:

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

1. Understand how to leverage the insights from big data analytics
2. Analyze data by utilizing various statistical and data mining approaches
3. Perform analytics on real-time streaming data
4. Understand the various NoSql alternative database models

Suggested Reference Books:

1. Bill Franks, ―Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley and SAS Business Series, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.
3. Michael Berthold, David J. Hand, ―Intelligent Data Analysis‖, Springer, Second Edition, 2007.
4. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
5. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
6. Richard Cotton, "Learning R – A Step-by-step Function Guide to Data Analysis, , O'Reilly Media, 2013.

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PEC CS 812	Real Time Systems	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 10 hrs.**

Introduction: Hard vs. Soft real time systems, A reference model of real time system. Real-time scheduling**:** Clock driven approach, Weighted Round-robin approach, Priority driven approach, Dynamic vs. static system, Effective Release Times and Deadlines, EDF and LST algorithm, Optimality and Non-Optimality of the EDF and LST algorithms, Off line vs. online Scheduling.

Module 2 **Lecture 6 hrs.**

Clock-Driven Scheduling: Static, Time-Driven scheduler, General structure of Cyclic Schedules, Cyclic Executives, Improving the Average Response Time Of Aperiodic Jobs, Scheduling Sporadic Jobs.

Module 3 **Lecture 7 hrs.**

Priority Driven Scheduling Of Periodic Tasks: Fixe-priority vs. Dynamic priority algorithms, Maximum Schedulable Utilization, Optimality of the RM and DM algorithms, A Schedulability test for fixed-priority tasks with short response times, Sufficient Schedulability conditions for the RM and DM algorithms.

Module 4 **Lecture 6 hrs.**

Scheduling Aperiodic and Sporadic Jobs in Priority-Driven Systems: Assumptions and Approaches**,** Deferrable Servers, Sporadic Servers, Constant Utilization, Total Bandwidth and Weighted Fair-Queueing Servers.

Module 5 **Lecture 8 hrs.**

Resources and Resource Access control: Resource contention, resource access control, Non-preemptive critical section, Basic Priority-Inheritance protocol, Basic Priority Ceiling Protocol, Stack based, Priority-ceiling protocol, preemption ceiling protocol.

Module 6 **Lecture 5 hrs.**

Multiprocessor scheduling, Resource Access Control, and Synchronization: Model of multiprocessor & distributed systems, task assignment, multiprocessor Priority-ceiling protocol, Elements of Scheduling Algorithms For End-to-End Periodic Tasks- IPS protocols, PM protocols, MPM protocol.

Suggested Books:

1. Real-Time system by Jane W. S. Liu, Pearson Education
2. Real-Time Systems by C. M. Krishna and K. G. Shin, McGraw Hill

Course Outcome:

After learning this subject, students will learn various types of Real Time Systems, Periodic and Aperiodic tasks, different types of scheduling algorithms in RTS(Clock Driven, Priority Driven), Priority Driven Scheduling Of Periodic Tasks, Priority Driven Scheduling of Aperiodic and Sporadic Jobs, Different protocols for resource access controls, Scheduling approach in multiprocessor Real Time Systems etc.

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PEC CS 813	Block Chain	3L:0T:0P	3 Credits

Objective of the Course:

To provide conceptual understanding of how block chain technology can be used to innovate and improve business processes. The course covers the technological underpinning of block Chain operations.

Detailed contents

Module 1 Lectures 6 hrs.

Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.

Module 2 Lectures 10 hrs.

Understanding Block chain with Crypto currency: Bitcoin and Block chain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.

Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

Module 3 Lectures 12 hrs.

Understanding Block chain for Enterprises: Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Execute contracts, State machine replication, Overview of Consensus models for permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain

Module 4 Lectures 12 hrs.

Block chain application development: Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

List of Suggested Books:

1. Melanie Swan, “Block Chain: Blueprint for a New Economy”, O’Reilly, 2015

2. Josh Thompsons, “Block Chain: The Block Chain for Beginners- Guide to Block chain Technology and Leveraging Block Chain Programming”

3. Daniel Drescher, "Block Chain Basics", Apress; 1st edition, 2017
4. Anshul Kaushik, "Block Chain and Crypto Currencies", Khanna Publishing House, Delhi.
5. Imran Bashir, "Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Packt Publishing
6. Ritesh Modi, "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Block Chain", Packt Publishing
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer", Import, 2018

Learning Outcomes:

At the end of this course, the students will be able to:
1. Understand block chain technology.
2. Develop block chain based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks.
3. Build and deploy block chain application for on premise and cloud based architecture.
4. Integrate ideas from various domains and implement them using block chain technology in different perspectives.

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PEC CS 814	Optimization Techniques	3L:0T:0P	3 Credits

Objectives of the course

• To introduce optimization techniques using both linear and non-linear programming
• After an adequate introduction to linear algebra and probability theory and optimization techniques students will learn to frame engineering minima maxima problems in the framework of optimization problems.

Detailed contents

Module 1 **Lectures 10 hrs.**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Module 2 **Lectures 8 hrs.**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Module 3 **Lectures 8 hrs.**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module 4 **Lectures 7 hrs.**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Module 5 **Lectures 8 hrs.**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Suggested Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982

Suggested Reference Books:

1. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
2. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
3. Pannerselvam, Operations Research: Prentice Hall of India 2010
4. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Course Outcomes:

After completion of course:

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

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PEC CS 815	Information Retrieval	3L:0T:0P	3 Credits

Objective of the Course:

To introduce students to Information Retrieval systems and to study theoretical aspects as well as implementation issues of classical and modern retrieval problems. Discuss mechanisms of web search along with the details of ranking algorithms. Introduce basic concepts of text categorization and recommender systems.

Detailed contents

Module 1 **Lectures 12 hrs.**

Introduction to Information Retrieval: Goals and history of IR. The impact of the web on IR, unstructured and semi-structured text. Basic IR Models Inverted index and Boolean queries. Boolean and vector-space retrieval models; ranked retrieval; text-similarity metrics; TF-IDF (term frequency/inverse document frequency) weighting; cosine similarity; Basic Tokenizing, Indexing, and Implementation of Vector-Space Retrieval: Simple tokenizing, stop-word removal, and

stemming; inverted indices; efficient processing with sparse vectors

Module 2 **Lectures 8 hrs.**

Experimental Evaluation of IR: Performance metrics: recall, precision, and F-measure; Query Operations: Relevance feedback; Query expansion; Query languages. Text Representation: Word statistics; Porter stemmer; index term selection; using thesauri. metadata and markup languages (SGML, HTML, XML)

Module 3 **Lectures 10 hrs.**

Web Search: Introduction; Spidering; Interfaces; Link Analysis Text Categorization: Categorization algorithms; Language-Model Based Retrieval; Text Clustering; Applications to web search and information organization.

Module 4 **Lectures 10 hrs.**

Recommender Systems: Collaborative filtering and content-based recommendation of documents and products. Information Extraction and Integration: Extracting data from text; semantic web; collecting and integrating specialized information on the web.

List of Suggested Books:

1. Manning, Raghavan and Schutze, "Introduction to Information Retrieval", Cambridge University Press.
2. Baeza-Yates and Ribeiro-Neto, "Modern Information Retrieval", Addison Wesley.

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PEC CS 816	Bitcoin and Crypto Currencies	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 8 hrs.**

Introduction to Cryptography, Cryptographic Hash Functions, SHA-256, Hash Pointers and Data Structures, Merkle tree.

Module 2 **Lecture 8 hrs.**

Digital Signatures, Elliptic curve group, Elliptic Curve Digital Signature Algorithm (ECDSA). Public Keys as Identities, A Simple Crypto currency.

Module 3 **Lecture 8 hrs.**

Centralization vs. Decentralization, Distributed consensus, Consensus without identity using a block chain, Incentives and proof of work. Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bitcoin network.

Module 4 **Lecture 8 hrs.**

Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

Module 5 **Lecture 8 hrs.**

Bitcoin Mining, Mining pools, Mining incentives and strategies. Bitcoin and Anonymity: Anonymity Basics, Mixing, Zerocoin and Zerocash.

Reference Book:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies, 2016.

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OEC CS 701	Soft Skills and Interpersonal Communication	3L:0T:0P	3 Credits

Detailed contents:

Module 1 **Lecture 8 hrs.**

Self-Analysis: Swot Analysis, Who am I, Attributes, Importance of Self Confidence, Self Esteem.

Module 2 **Lecture 8 hrs.**

Creativity: Out of Box Thinking, Lateral Thinking.

Module 3 **Lecture 8 hrs.**

Attitude: Factors Influencing Attitude, Challenges and Lessons from Attitude, Etiquette; Motivation: Factors of Motivation, Self-Talk, Intrinsic & Extrinsic Motivators.

Module 4 **Lecture 8 hrs.**

Goal Setting: Wish List, Smart Goals, Blue Print for Success, Short Term, Long Term, Life Time Goals; Time Management: Value of Time, Diagnosing Time Management, Weekly Planner, To Do List, Prioritizing Work.

Module 5 **Lecture 8 hrs.**

Interpersonal Skills: Gratitude - Understanding the relationship between Leadership Networking & Team work. Assessing Interpersonal Skills Situation description of Interpersonal Skill. Team Work - Necessity of Team Work Personally, Socially and Educationally.

Text Book:

1. Soft Skills, 2015, Career Development Centre, Green Pearl Publications.

Reference

1. Covey Sean, Seven Habits of Highly Effective Teens, New York, Fireside Publishers, 1998.
2. Carnegie Dale, How to win Friends and Influence People, New York: Simon & Schuster, 1998.

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OEC CS 702	History Of Science and Technology in India	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 7 hrs.**

Concepts and Perspectives

- Meaning of History
- Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history
- Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.
- Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

Module 2 **Lecture 7 hrs.**

Historiography of Science and Technology in India

- Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

Module 3 **Lecture 7 hrs.**

Science and Technology in Ancient India

- Technology in pre-historic period
- Beginning of agriculture and its impact on technology
- Science and Technology during Vedic and Later Vedic times
- Science and technology from 1st century AD to C-1200.

Module 4 **Lecture 7 hrs.**

Science and Technology in Medieval India

- Legacy of technology in Medieval India, Interactions with Arabs
- Development in medical knowledge, interaction between Unani and Ayurveda and alchemy
- Astronomy and Mathematics: interaction with Arabic Sciences
- Science and Technology on the eve of British conquest

Module 5 **Lecture 7 hrs.**

Science and Technology in Colonial India

- Science and the Empire
- Indian response to Western Science
- Growth of techno-scientific institutions

Module 6 **Lecture 7 hrs.**

Science and Technology in a Post-Independent India

- Science, Technology and Development discourse
- Shaping of the Science and Technology Policy
- Developments in the field of Science and Technology
- Science and technology in globalizing India
- Social implications of new technologies like the Information Technology and Biotechnology

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OEC CS 703	Economic Policies in India	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 10 hrs.**

Framework of Indian Economy: National Income - Trends and Structure of National Income, Demographic Features and Indicators of Economic Growth, Development Rural-Urban Migration and issues related to Urbanization, Poverty debate and Inequality, Nature, Policy and Implications, Unemployment-Nature, Central and State Government's policies, policy implications, Employment trends in Organized and Unorganized Sector

Module 2 **Lecture 10 hrs.**

Development Strategies in India: Agricultural- Pricing, Marketing and Financing of Primary Sector, Economic Reforms- Rationale of Economic Reforms, Liberalization, Privatization and Globalization of the Economy, Changing structure of India's Foreign Trade, Role of Public Sector- Redefining the role of Public Sector, Government Policy towards Public Sector, problems associated with Privatization, issues regarding Deregulation-Disinvestment and future of Economic Reforms

Module 3 **Lecture 10 hrs.**

The Economic Policy and Infrastructure Development: Energy and Transport, Social Infrastructure- Education, Health and Gender related issues, Social Inclusion, Issues and policies in Financing Infrastructure Development, Indian Financial System- issues of Financial Inclusion, Financial Sector Reforms-review of Monetary Policy of R.B.I. Capital Market in India.

Module 4 **Lecture 10 hrs.**

The Economic Policy and Industrial Sector: Industrial Sector in Pre-reforms period, Growth and Pattern of Industrialization, Industrial Sector in Post-reform period- growth and pattern of Micro, Small, Medium Enterprises s, problems of India's Industrial Exports, Labor Market- issues in Labor Market Reforms and approaches to Employment Generation.

Text Books

1. Dhingra, Ishwar C. [2006],'Indian Economy,' Sultan Chand and Sons, New Delhi.
2. Datt, Ruddar and Sundaram, K.P.M. [Latest edition] ,'Indian Economy,' S. Chand and Co, New Delhi.

Reference Books

1. Brahmananda, P.R. and V.A. Panchmukhi. [2001], Ed. 'Development Experience in Indian Economy, Inter-state Perspective,' Bookwell, New Delhi.
2. Gupta,S.P. [1989],'Planning and Development in India: A Critique,' Allied Publishers Private Limited, New Delhi.
3. Bhagwati, Jagdish. [2004],'In Defense of Globalization,' Oxford University Press, U.K.

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OEC CS 704	Cyber Law and Ethics	3L:0T: 0P	3 credits

Objectives of the course:

1. Discuss the structure of the legal system and how it enforces laws governing the Internet.
2. Evaluate the ethical responsibilities of Internet users, service providers, and content providers.
3. Examine the constitutional considerations concerning free speech and content controls in Cyber Space.
4. Investigate a security breach and the legally required responses to a breach.

Detail contents

Module 1 **Lecture 8 hrs.**

Introduction: Computers and its Impact in Society, Overview of Computer and Web Technology, the Internet and online resources, Security of information, Introduction to ethical theory and its application to the Internet, Definition of Cyber Security. Search Engines, E – mails and WWW, E – commerce & M – commerce System Security, Government Regulation of the Internet.

Module 2 **Lecture 10 hrs.**

Cyber Crimes & Legal Framework: Distinction between Cyber Crime and Conventional Crime, Cyber Criminals and their Objectives, Kinds of Cyber Crime: Hacking, Digital Forgery, Cyber Stalking/Harassment, Identity Theft & Fraud, Cyber terrorism, Cyber Defamation, Computer Vandalism etc. Cyber Crimes against Individuals, Institution and State, Issues in Data and Software Privacy, Cyber Forensics.

Module 3 **Lecture 12 hrs.**

Introduction to Indian Cyber Law: Overview of General Laws and Procedures in India, Different offences under IT Act, Overview of Information Technology Act, 2000 and

Information Technology (Amendment) Act, 2008. National Cyber Security Policy 2013, Offences in Cyber Space under the Indian Penal Code, 1860, Intellectual Property Issues in Cyber Space, Interface with Copyright Law, Interface with Patent Law, Trademarks & Domain Names Related issues.

Module 4 **Lecture 10 hrs.**

Constitutional & Human Rights Issues in Cyberspace: Freedom of Speech and Expression in Cyberspace, Right to Access Cyberspace, Access to Internet, Right to Privacy, Right to Data Protection, Issues with cybercrime using social networking sites. Electronic Commerce, Digital Signatures - technical and legal issues. Electronic Contracts, Law relating to Hardware and Software Layout & Design.

Suggested reference books:

1. Jonathan Rosenoer, "Cyberlaw: the Law of the Internet" Springer-Verlag New York Inc.
2. Pavan Duggal, "Cyber Law - An exhaustive section wise Commentary on the Information Technology Act along with Rules, Regulations, Policies, Notifications etc.", Universal Law Publishing.
3. Deborah E. Bouchoux, "Intellectual Property: The Law Of Trademarks, Copyrights, Patents, And Trade Secrets", Cenage Learning.
4. M. K. Bhandari, "Law Relating to Intellectual Property Rights", Central Law Publications.
5. Vivek Sood, "Cyber Law Simplified", McGraw Hill Education.
6. Prashant Mali, "Cyber Law & Cyber Crimes Simplified", Cyber Infomedia.

Course outcomes

After the completion of course, students can able to able to demonstrate a critical understanding of the Cyber law and Cyber-crime with respect to IT Act.

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OEC CS 705	Cyber Security	3L:0T:0P	3 Credits

Objective of the Course:

The course has been designed to give students an extensive overview of cyber security issues, tools and techniques that are critical in solving problems in cyber security domains. The course aims at providing students with concepts of computer security, cryptography, digital money, secure protocols, detection and other security techniques. The course will help students to gauge understanding in essential techniques in protecting Information Systems, IT infrastructure, analysing and monitoring potential threats and attacks, devising security architecture and implementing security solutions. The students will also have a wider perspective to information security from national security perspective from both technology and legal perspective.

Detailed contents

Module 1 **Lectures 2 hrs.**

Cyber Security Concepts: Essential Terminologies: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.

Module 2 **Lectures 4 hrs.**

Cryptography and Cryptanalysis: Introduction to Cryptography, Symmetric key Cryptography, Asymmetric key Cryptography, Message Authentication, Digital Signatures, Applications of Cryptography. Overview of Firewalls- Types of Firewalls, User Management, VPN Security, Security Protocols: - security at the Application Layer- PGP and S/MIME, Security at Transport Layer- SSL and TLS, Security at Network Layer-IPSec.

Open Source/ Free/ Trial Tools: Implementation of Cryptographic techniques, OpenSSL, Hash Values Calculations MD5, SHA1, SHA256, SHA 512, Steganography (Stools)

Module 3 **Lectures 6 hrs.**

Infrastructure and Network Security: Introduction to System Security, Server Security, OS Security, Physical Security, Introduction to Networks, Network packet Sniffing, Network Design Simulation. DOS/ DDOS attacks. Asset Management and Audits, Vulnerabilities and Attacks. Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Security Information Management, Network Session Analysis, System Integrity Validation.

Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain & abel, iptables/ Windows Firewall, snort, suricata, fail2ban.

Module 4 **Lectures 8 hrs.**

Cyber Security Vulnerabilities& Safe Guards: Internet Security, Cloud Computing &Security, Social Network sites security, Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration, Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, Authorization, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment. Open Source/ Free/ Trial Tools: WinAudit, Zap proxy (OWASP), burp suite, DVWA kit.

Module 5 **Lectures 8 hrs.**

Malware: Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis.

Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.

Module 6 **Lectures 8 hrs.**

Security in Evolving Technology: Biometrics, Mobile Computing and Hardening on android and ios, IOT Security, Web server configuration and Security. Introduction, Basic security for

HTTP Applications and Services, Basic Security for Web Services like SOAP, REST etc., Identity Management and Web Services, Authorization Patterns, Security Considerations, Challenges.
Open Source/ Free/ Trial Tools: adb for android, xcode for ios, Implementation of REST/ SOAP web services and Security implementations.

Module 7 Lectures 9 hrs.

Cyber Laws and Forensics: Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyber space, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013. Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations.
Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools like dd, md5sum, sha1sum, Ram dump analysis, USB device.

List of Suggested Books:

1. William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.
2. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
3. Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
4. Atul Kahate, "Cryptography and Network Security", McGraw Hill.
5. V.K. Pachghare, "Cryptography and Information Security", PHI Learning
6. Nina Godbole, "Information System Security", Wiley
7. Bothra Harsh, "Hacking", Khanna Publishing House, Delhi.

Learning Outcomes:

After completion of this course, the students should be able to:
1. Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information.
2. Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios
3. Identify common trade-offs and compromises that are made in the design and development process of Information Systems
4. Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection.

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OEC CS 706	**Virtual Reality**	**3L:0T:0P**	**3 Credits**

Objective of the Course:

The objective of this course is to provide a detailed understanding of the concepts of Virtual Reality and its applications..

Detailed contents

Module 1 **Lectures 6 hrs.**

Introduction to Virtual Reality: Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.

3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Module 2 **Lectures 10 hrs.**

Geometric Modelling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

Module 3 **Lectures 10 hrs.**

Virtual Environment: Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in betweening, free from deformation, particle system.
Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Module 4 **Lectures 10 hrs.**

VR Hardware and Software: Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML

Module 5 **Lectures 4 hrs.**

VR Applications: Introduction, Engineering, Entertainment, Science, Training. The Future: Virtual environment, modes of interaction

List of Suggested Books:

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
2. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
3. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
4. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.
5. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

Learning Outcomes:

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

1. Understand geometric modelling and Virtual environment.
2. Study about Virtual Hardware and Software.
3. Develop Virtual Reality applications.

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OEC CS 707	3D Printing and Design	3L:0T:0P	3 Credits

Objective of the Course:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry 4.0 environment.

Detailed contents

Module 1 **Lectures 3 hrs.**

3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

Module 2 **Lectures 3 hrs.**

CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format.

Module 3 **Lectures 12 hrs.**

Additive Manufacturing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology; Process, Process parameter, Process Selection for various applications; Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools.

Module 4 **Lectures 8 hrs.**

Materials: Polymers, Metals, Non-Metals, Ceramics; Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties; Support Materials

Module 5 **Lectures 8 hrs.**

Additive Manufacturing Equipment: Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design.

Module 6 **Lectures 6 hrs.**

Post Processing: Requirement and Techniques.

Product Quality: Inspection and testing, Defects and their causes.

List of Suggested Books:

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
4. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
5. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
6. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
7. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

Learning Outcomes:

After completion of this course, the students will be able to:
1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate .stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM).

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OEC CS 708	**Simulation and Modelling**	**3L:0T:0P**	**3 Credits**

Detailed contents

Module 1 **Lectures 4 hrs.**

Introduction: System, environment, input and output variables, State variables; Static and Dynamic systems; Hierarchy of knowledge about a system and Modelling Strategy.

Module 2 **Lectures 4 hrs.**

Physical Modelling: Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models.

Module 3 **Lectures 7 hrs.**

Modeling of System with Known Structure: Review of conservation laws and the governing equation for heat, mass and momentum transfer, Deterministic model-(a) distributed parameter models in terms of partial identification and their solutions and (b) lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modelling for control

Module 4 **Lectures 7 hrs.**

Optimizations and Design of Systems: Summary of gradient based techniques: Nontraditional Optimizations techniques (i) genetic Algorithm (GA) - coding, GA operations elitism, Application using MATLAB: (ii) Simulated Annealing

Module 5 **Lectures 8 hrs.**

Neural Network Modelling of Systems only with Input-output Database: Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm, Application to complex engineering systems and strategy for optimum output.

Module 6 **Lectures 8 hrs.**

Modelling Based on Expert Knowledge: Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers

Module 7 **Lectures 4 hrs.**

Simulation of Engineering Systems: Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems.

Text Books:

1. Theory of modeling and simulation, Zeigler B. P. Praehofer. H. and Kim I.G.
2. System Simulation: the Art and Science, Shannon, R. E.

Reference Books:

1. Modern control Engineering, Ogata K
2. Neuro-Fuzzy and soft Computing ", Jang J.S.R. sun C.T and Mizutani E

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OEC CS 801	**VLSI System Design**	**3L:0T:0P**	**3 Credits**

Detailed contents

Module 1 **Lectures 6 hrs.**

Introduction to VLSI design: Moore's Law; Scale of Integration; Types of VLSI Chips; Design principles (Digital VLSI); Design Domains(Y-Chart), Challenges of VLSI design- power, timing area, noise, testability reliability, and yield; CAD tools for VLSI design

Module 2 **Lectures 7 hrs.**

Introduction to VLSI Technology: VLSI Technology - An Overview - Wafer Processing, Oxidation, Epitaxial Deposition, Ion-implantation and Diffusion; The Silicon Gate Process- Basic CMOS Technology; basic n-well CMOS process, p-well CMOS process; Twin tub process, Silicon on insulator; CMOS process enhancement-Interconnect; circuit elements; 3-D CMOS

Module 3 **Lectures 7 hrs.**

Analysis of CMOS logic Circuits: MOSFET as Switch; Recapitulation of MOS; CMOS Inverter, CMOS logic circuits; NAND gate and NOR Gate; Complex logic circuits; Pass transistor logic; CMOS Transmission gate; CMOS full adder

Module 4 **Lectures 4 hrs.**

Advanced Techniques in CMOS logic circuit: Pseudo nMOS; Tri-state; Clocked CMOS; Dynamic CMOS logic- Domino, NORA, Zipper, etc.; Dual rail logic networks

Module 5 **Lectures 2 hrs.**

Memories: Static RAM; SRAM arrays; Dynamic RAMs; ROM arrays; Logic arrays

Module 6 **Lectures 8 hrs.**

Timing issues in VLSI system design: Timing classification- synchronous timing basics, skew and jitter, latch based clocking, self-timed circuit design; self-timed logic; completion signal generation; self-timed signaling–synchronizers and arbiters

Module 7 **Lectures 6 hrs.**

Verilog Hardware Description language: Overview of digital design with Verilog HDL; Hierarchical modeling concepts; Modules and port definitions; Gate level modeling; Data flow modeling; Behavioral modeling; Task & functions; Test bench

Text Books:

1. Neil H. E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI Design”, 2nd edition, Pearson Education Asia, 2000.
2. John P. Uyemura, “Introduction to VLSI Circuits and Systems”, John Wiley and Sons, Inc., 2002.
3. Samir Palnitkar, “Verilog HDL”, 2nd Edition, Pearson Education, 2004.

Reference Books:

1. Eugene D. Fabricius, “Introduction to VLSI Design”, TMH International Editions, 1990.
2. Bhasker J., “A Verilog HDL Primer”, 2nd Edition, B. S. Publications, 2001.
3. Pucknell, “Basic VLSI Design”, Prentice Hall of India Publication, 1995.
4. Wayne Wolf, “Modern VLSI Design System on chip”, Pearson Education, 2002.

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OEC CS 802	Embedded Systems	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 10 hrs.**

Embedded Computing: Introduction, Complex systems and Microprocessors, The embedded system design process, Formalization for system design.

Module 2 **Lecture 10 hrs.**

Instruction Sets CPUs: Instruction and preliminaries ARM and SHARC Processors, Programming I/O CPU performance and Power consumption.

Module 3 **Lecture 10 hrs.**

The embedded Computing Platform and program design: Introduction, the CPU bus, Component interfacing, designing with microprocessors, development and debugging.

Module 4 **Lecture 10 hrs.**

Program Design and Analysis: Introduction program design, Assembly, Linking, Basic compilation techniques, and Analysis optimization of executive time.

Text Book:

1. Wayner Wolf., "Computers as components – Principle of Embedded Computing System Design", Morgan Kaufmann/ Hercourt India Pvt. Ltd.

Reference Books:

1. Raj Kamal - Embedded Systems, TMH, New Delhi 2004.
2. F. Vahid& T. givargis- Embedded system Design, John wiley, India Edition, 2005.

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OEC CS 803	**Digital Image Processing**	**3L:0T:0P**	**3 Credits**

Detailed contents

Module 1 **Lecture 8 hrs.**

Introduction: Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System.

Digital Image Fundamentals: Elements of Visual Perception, a Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry.

Module 2 **Lecture 8 hrs.**

Image Transforms: Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform, Other Separable Image Transforms.

Module 3 **Lecture 8 hrs.**

Image Enhancement: Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background, Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications.

Module 4 **Lecture 8 hrs.**

Image Restoring: Degradations Model - Definitions, Degradation Model for Continuous Functions, Diagonalization of Circulant and Block-Circulant Matrices, Circulant Matrices, Block Circulant Matrices, Effects of Diagonalization on the Degradation Model, Algebraic Approach to Restoration, Unconstrained Restoration, Constrained Restoration, Inverse Filtering – Formulation, Removal of Blur Caused by Uniform Linear Motion, Restoration in the Spatial Domain, Geometric Transformation.

Module 5 **Lecture 8 hrs.**

Image Compression: Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria. Image Compression Models – The Source Encoder and Decoder, The Channel Encoder and Decoder. Elements of Information Theory – Measuring Information, The Information Channel, Fundamental Coding Theorems, Using Information Theory. Error-Free Compression – Variable-Length Coding, Bit-Plane Coding, Lossless Predictive Coding. Lossy Compression – Lossy Predictive Coding, Transform Coding.

Text Book:

1. Rafael. C. Gonzalez & Richard E.Woods.- Digital Image Processing, 2/e Pearson Education, New Delhi - 2006

Reference Books:

1. W.K.Pratt.-Digital Image Processing, 3/e Edn., John Wiley & sons, Inc. 2006
2. M. Sonka et.al Image Processing, Analysis and Machine Vision, 2/e, Thomson, Learning, India Edition, 2007

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OEC CS 804	**Digital Signal Processing**	**3L:0T:0P**	**3 Credits**

Detailed contents

Module 1 **Lecture 8 hrs.**

Introduction: Characterization and classification of signals, typical signal processing operations, Review of discrete-time signal and system analysis; Advantages and typical applications of DSP.

Module 2 **Lecture 8 hrs.**

Sampling and Quantization: Sampling and discrete-time processing of continuous time signals, Sampling of low-pass and band-pass signals; Uniform and non-uniform quantization, Lloyd-Max algorithm, Log-companding, A-law, μ-law; Adaptive quantization and prediction

Module 3 **Lecture 8 hrs.**

Orthogonal transforms: Properties and applications of DFT, implementing linear time invariant systems using DFT, circular convolution, linear convolution using DFT; Fast Fourier Transform, FFT algorithms: Decimation in time, decimation in frequency; Goertzel algorithm; Application of transform in speech, audio, image and video coding, Karhunen-Loeve Transform, DCT, JPEG and MPEG coding standards

Module 4 **Lecture 8 hrs.**

Digital Filter design techniques: IIR and FIR filters, filter design specifications; Design of digital IIR filters: Impulse invariant, and bilinear transformation techniques for Butterworth and Chebyshev filters; Design of FIR filters: Windowing, frequency sampling filter design, optimum approximations of FIR filters

Module 5 **Lecture 6 hrs.**

Multi-rate Signal Processing: Fundamentals of multirate systems, Decimation and interpolation, application of Multirate DSP in sampling rate conversion; Filter banks; Polyphase structures; Quadrature-mirror filter bank; Wavelet transform and its relation to multi-rate filter banks; applications to speech and audio coding.

Module 6 **Lecture 4 hrs.**

Basic concept of Adaptive Digital Signal Processing: Adaptive Wiener filter and LMS algorithm; Applications of adaptive filtering to echo cancellation and equalization.

Text Books:

1. Digital Signal Processing-A Computer Based Approach, Mitra, S.K.,
2. Discrete Time Signal Processing, Oppenheim, A.V. and Schafer, R.W. with Buck, J.R
3. Digital Signal Processing: A Practical Approach, Ifeachor, E.C. and Jervis, B.W

Reference Books:

1. Digital Signal Processing: Principles, Algorithm and Applications, Proakis, J.G. and Manolakis, D.G
2. Multirate Systems and Filter Banks ,Vaidyanathan, P.P

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OEC CS 805	High Speed Networks	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lecture 8 hrs.**

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications, requirements – Architecture of 802.11.

Module 2 **Lecture 8 hrs.**

Queuing Analysis- Queuing Models – Single Server Queues – Effects of Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

Module 3 **Lecture 8 hrs.**

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management - Exponential RTObackoff – KARN's Algorithm – Window management – Performance of TCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes –Traffic Management Frame work, Traffic Control – ABR traffic Management.

Module 4 **Lecture 8 hrs.**

Integrated Services Architecture – Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ – Random Early Detection, Differentiated Services.

Module 5 **Lecture 8 hrs.**

RSVP – Goals & Characteristics, Data Flow, RSVP operations, Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP –Protocol Architecture.

Text Books:

1. William Stallings, "High Speed Networks and Internet", Pearson Education, 2 nd Edition, 2002
2. Warland, Pravin Varaiya, "High performance communication networks", 2 nd Edition, Jean Harcourt Asia Pvt. Ltd., 2001

Reference Books:

1. IrvanPepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", CiscoPress, Volume 1 and 2, 2003
2. Abhijit S. Pandya and Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2004

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OEC CS 806	High Performance Computing	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures 10 hrs.**

Introduction to parallel computing. Parallel processing terminology, Pipelining Vs Data parallelism, Control parallelism, Scalability, Control parallel approach, Data parallel approach, Data parallel approach with I/O Parallel reduction, Prefix sums, List ranking, Preorder tree traversal, Merging two sorted lists, Graph coloring, Reducing the number of processors, Problems defying fast solutions on PRAMS

Module 2 **Lectures 10 hrs.**

Thread and process level parallel architectures: MIMD, multi-threaded architectures. Distributed and shared memory MIMD architectures.

Module 3 **Lectures 8 hrs.**

Dynamic interconnection networks.

Mapping and scheduling: Mapping data to processors on processor arrays and multicomputers, Dynamic Load Balancing on multicomputers, Static scheduling on UMA multiprocessors, Deadlock.

Module 5 **Lectures 12 hrs.**

Parallel programming and parallel algorithms: Programming models, parallel programming on multiprocessors and multicomputers. Parallel algorithm structure, analyzing parallel algorithm. Elementary parallel algorithms, Matrix algorithms, sorting, Graph algorithms.

Text Book:

1. Quinn, Parallel computing – theory and practice, Tata McGraw Hill.

Reference Books:

1. Selim G. Akl, The Design and Analysis of Parallel Algorithms, PH International
2. Ghosh, Moona and Gupta, Foundations of parallel processing, Narosa
3. Mehdi R. Zargham, Computer Architectures single and parallel systems, PHI. publishing.
4. Ed. Afonso Ferreira and Jose' D. P. Rolin, Parallel Algorithms for irregular problems - State of the art, Kluwer Academic Publishers.

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OEC CS 807	Introduction to Communication Systems	3L:0T:0P	3 Credits

Detailed contents

Module 1 **Lectures 8 hrs.**

Introduction: Communication model, Transmission line, Data Communication Concepts, Data Transmission: Parallel Transmission, Serial Transmission, Asynchronous Transmission, Synchronous Transmission, Data Encoding, Non-Return to Zero (NRZ), Return to Zero (RZ), Modem Concept, Modem Operation

Module 2 **Lectures 6 hrs.**

Basic signal processing operations in Digital communication: Analog Pulse Modulation: Sampling theorem for base-band and pass-band signals, quadrature sampling of band pass signal Reconstruction of message from its samples, signal distortion in sampling

Module 3 **Lectures 8 hrs.**

Pulse Amplitude modulation: Modulation generation and demodulation, PAM/TDM system.
Digital Pulse modulation: Quantization, PCM, DPCM, Delta modulation, Adaptive delta modulation-Design of typical systems and performance analysis.
Signal space concepts: Geometric structure of the signal space, vector representation, distance, norm and inner product, orthogonality, Gram-Schmidt orthogonalization procedure.

Module 4 **Lectures 8 hrs.**

Filtering and receivers: Matched filter receiver, Inter symbol interference, Pulse Shaping, Nyquist criterion for zero ISI, Eye diagram, Equalizer, Scrambling and descrambling, Review of Gaussian random process, Optimum threshold detection, Optimum Receiver for AWGN channel, Matched filter and Correlation receivers

Module 5 **Lectures 10 hrs.**

Decision Procedure: Maximum aposteriori probability detector- Maximum likelihood detector, Error probability performance of binary signaling.
Digital Band Pass Modulation Schemes: ASK, FSK, PSK, MSK – Digital M-ary modulation schemes – signal space representation.
Error in Communication: Detection of signals in Gaussian noise - Coherent & non-coherent detection – Differential modulation schemes – Error performance of binary and M-ary modulation schemes – Probability of error of binary DPSK. Performance of M-ary signaling schemes in AWGN channels - Power spectra of digitally modulated signals, Performance comparison of digital modulation schemes

Text Books:

1. Digital Communications, Simon Haykin John Wiley & Sons, Indian edition
2. Modern Digital and Analog Communication Systems, fourth edition by B.P. Lathi and Zhi Ding, Oxford University Press
3. Introduction to data communications and networking, Behrouz Forouzan

Reference Books:

1. Fundamentals of Communication Systems by J Proakis and M Salehi
2. Signals and Systems, second edition, by A. Oppenheim and A. Willsky

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OEC CS 808	Ad-hoc and Sensor Networks	3L:0T:0P	3 Credits

Objectives:

- Understand the design issues in Ad Hoc and Sensor Networks.
- Learn the different types of MAC protocols.
- Be familiar with different types of Ad-hoc routing protocols.
- Be expose to the TCP issues in Ad-hoc networks.
- Learn the architecture and protocols of wireless sensor networks.

Detailed contents

Module 1: Introduction **Lectures 8 hrs.**

Fundamentals of wireless communication technology – the electromagnetic spectrum – radio propagation mechanisms – characteristics of the wireless channel – Mobile Ad-hoc Networks (MANETS) and Wireless Sensor Networks (WSNs): concepts and architectures. Applications of Ad-hoc and sensor networks. Design challenges in Ad-hoc and sensor networks.

Module 2: Mac Protocols for Ad-hoc Wireless Networks **Lectures 8 hrs.**

Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols Contention based protocols with Reservation Mechanisms- Contention based protocols with Scheduling Mechanisms – Multi channel MAC-IEEE 802.11

Module 3: Routing Protocols and Transport Layer in Ad-hoc Networks **Lectures 8 hrs.**

Issues in designing a routing and Transport Layer protocol for Ad hoc networks- proactive routing, reactive routing (on-demand), hybrid routing- Classification of Transport Layer solutions-TCP over Ad hoc wireless Networks.

Module 4: Wireless Sensor Networks (WSNs) And MAC Protocols **Lectures 8 hrs.**

Single node architecture: hardware and software components of a sensor node - WSN Network architecture: typical network architectures-data relaying and aggregation strategies -MAC layer protocols: self-organizing, Hybrid TDMA/FDMA and CSMA based MAC- IEEE 802.15.4

Module 5: Security in Ad Hoc and Sensor Networks **Lectures 8 hrs.**

Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Anti-tamper techniques – Water marking techniques – Defense against routing attacks – Secure Ad hoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network

Security Protocols – SPINS

Text Book:

1. C. Siva Ram Murthy and B.S.Manoj, ―Ad Hoc Wireless Networks – Architectures and Protocols, Pearson Education, 2006.
2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", Wiley, 2005

References Book:

1. Carlos De Morais Cordeiro, Dharma Prakash Agrawal "Ad Hoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2006.
2. Feng Zhao and Leonides Guibas, "Wireless Sensor Networks", Elsevier Publication - 2002.

Course Outcomes:

Upon completion of the course, the student should be able to:

1. Identify different issues in wireless ad hoc and sensor networks.
2. Analyze protocols developed for ad hoc and sensor networks.
3. Identify and understand security issues in ad hoc and sensor networks.

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OEC CS 809	**Human Computer Interaction**	**3L:0T:0P**	**3 Credits**

Detailed contents

Module 1 **Lectures 8 hrs.**

Foundations: Introduction, Historical evolution of the field, Input-Output channels, Human memory, Thinking, Emotion, Psychology and design of interactive systems, Text entry devices, Display Devices, Devices for virtual reality and 3D interactions, models of interaction, ergonomics, interaction styles, HCI paradigms.

Module 2 **Lectures 8 hrs.**

Design Process: Interaction design basics, HCI in the software process, The software life cycle, Usability engineering, Iterative design and prototyping, Design rules: Principles to support usability, Standards and guidelines, golden rules and heuristics, HCI patterns.

Module 3 **Lectures 8 hrs.**

Design Process: Implementation support, evaluation techniques, universal design, user support.

Module 4 **Lectures 8 hrs.**

Models and Theories: Cognitive models, Socio organizational issues and stake holder requirements. Communication and Collaboration Models: Face-to-face communication, conversation, text based

communication, group working. Module

Module 5 **Lectures 8 hrs.**

Groupware systems, ubiquitous computing and augmented realities, hypertext, multimedia and World Wide Web.

Text Book:

Human Computer Interaction by Alan Dix, Janet Finley, Gregory Abowd, Russell Beale, Pearson India.

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