ERODE SENGUNTHAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University)

PERUNDURAI, ERODE - 638 057

PG Curriculum and Syllabus

(1 to 4 Semesters)

M.E – COMPUTER SCIENCE AND ENGINEERING

Choice Based Credit System (CBCS)

REGULATION 2019

ERODE SENGUNTHAR ENGINEERING COLLEGE,ERODE

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

I TO IV SEMESTERS CURRICULUM

M.E. COMPUTER SCIENCE AND ENGINEERING Minimum credits to be earned :70													
SEMESTER I													
Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Tot.	
19MCS11	Mathematical Modeling	I,II,III	2,4,12	1	3	1	0	4	40	60	100	BS
19MCS12	Advanced Data Structures and Algorithms	I,II,III	2,3,4,5, 12	1,2	3	0	0	3	40	60	100	PC
19MCS13	Advanced Database Technology	I,II,III	2,3,4,5, 12	1,2	3	0	0	3	40	60	100	PC
19MCS14	Embedded Systems and Real Time Operating Systems	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PC
19MCS15	Computer Networks and Management	I,II,III	2,3,4,12	1,2	3	0	0	3	40	60	100	PC
PRACTICAL												
19MCS16	Advanced Data Structures Laboratory	I,II,III	2,3,4,5, 9,12	1,2	0	0	4	2	60	40	100	PC
19MCS17	Advanced Database Laboratory	I,II,III	2,3,4,12	1,2	0	0	4	2	60	40	100	PC
				TOTAL	15	1	4	20	320	380	700	-

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SEMESTER II												
Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Tot.	
19MCS21	High Performance Computing	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PC
19MCS22	Web Programming	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PC
19MCS23	Data Science and Analytics	I,II,III	2,3,4,5, 12	1,2	3	0	0	3	40	60	100	PC
	Professional Elective I	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
	Professional Elective II	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
PRACTICAL												
19MCS24	Web Technology Laboratory	I, II ,III	2,3,4,5, 9, 12	1,2	0	0	4	2	60	40	100	PC
19MCS25	Data Analytics Laboratory	I,II,III	2,3,4,5, 9,12	1,2	0	0	4	2	60	40	100	PC
				TOTAL	18	0	8	19	320	380	700	-

SEMESTER III												
Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19MCS31	Machine Learning	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PC
	Professional Elective III	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
	Professional Elective IV	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
PRACTICAL												
19MCS32	Project Work Phase – I	I ,II ,III	1,2,3,4,5,6,7,8,9,10,11,12	1,2,3	0	0	12	6	60	40	100	EEC
				TOTAL	9	0	12	15	180	220	400	-

SEMESTERIV												
Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Tot.	
19MCS41	Project Work Phase – II	I ,II ,III	1,2,3,4,5,6,7,8,9 ,10,11,12	1,2,3	0	0	32	16	60	40	100	EEC
				TOTAL	0	0	32	16	60	40	100	-

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LIST OF PROFESSIONAL ELECTIVES

PROFESSIONAL ELECTIVE I

Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CSX01	Software Project Management	I, II, III	2,3,4,5,10,12	1,2	3	0	0	3	40	60	100	PE
19CSX02	Software Requirements Engineering	I,II, III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX03	Software Quality Assurance and Testing	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX04	Software Product Development and Management	I, II, III	2,3,4,5, 10,12	1,2	3	0	0	3	40	60	100	PE
19CSX05	Internet of Things	I, II, III	2,3,7,8,12	1,2	3	0	0	3	40	60	100	PE
19CSX06	Research Methodology	II, III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE

PROFESSIONAL ELECTIVE -II

Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CSX07	Graph Theory and Optimization Techniques	II, III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX08	Stochastic Processes and Queuing Theory	II, III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX09	Operations Research	II, III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX10	Network and Information Security	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX11	Block chain technology	I, II, III	2,3,4,12	2	3	0	0	3	40	60	100	PE
19CSX12	Compiler Optimization Techniques	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE

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PROFESSIONAL ELECTIVE III

Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CSX13	Green Computing	I, II, III	2,3,4,12	2	3	0	0	3	40	60	100	PE
19CSX14	Reconfigurable Computing	I, II, III	2,3,4,12	2	3	0	0	3	40	60	100	PE
19CSX15	Performance Metrics and Advanced Computing	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX16	Data Visualization Techniques	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX17	Cloud Computing	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX18	XML and Web Services	I, II, III	2,3,4,12	1, 2	3	0	0	3	40	60	100	PE

PROFESSIONAL ELECTIVE IV

Course Code	Course Title	Course Objectives			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19CSX19	Image Processing and Analysis	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX20	Speech Processing and Synthesis	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX21	Bio Informatics	II, III	2,3,4,12	1, 2	3	0	0	3	40	60	100	PE
19CSX22	Information Storage Management	I, II, III	2,3,4,12	2	3	0	0	3	40	60	100	PE
19CSX23	Computer Vision	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE
19CSX24	Data Mining Techniques	I, II ,III	2,3,4, 12	1,2	3	0	0	3	40	60	100	PE

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS11	MATHEMATICAL MODELLING	3	1	0	4	60	100	

Course Objective (s): The purpose of learning this course is

- To study about the random variables and distribution
- To learn about correlation and regression
- To know about the sampling and testing hypothesis
- To do analysis on time series data
- To analyze using one way and two way classifications

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

- Do curve fitting, conversion to known model and perform regression for any data
- Apply the theory of sampling and testing the hypothesis
- Critically do time series analysis
- Apply ANOVA
- Test for reliability of a system

Unit I	CURVE FITTING	12

Correlation –Multiple Correlation-Regression –Multiple Regression –Linear fit-Quadratic fit-Cubic Splines

Unit II	THEORY OF SAMPLING AND TEST OF HYPOTHESIS	12

Introduction to hypothesis, Large and small samples test -mean and variance (single and double), test, Independent of attributes and contingency table.

Unit III	TIME SERIES ANALYSIS	12

Introduction to Stochastic process, Time series as a discrete stochastic process. Stationarity, Main characteristics of stochastic process (mean, auto covariation and auto correlation function). Autoregressive models AR (p), Yull-Worker equation Auto regressive moving average models ARMA. Seasonality in Box –Jenkins model.

Unit IV	DESIGN OF EXPERIMENTS	12

Analysis of variance (one way & two ways) classification – completely randomized design – randomized block design – Latin square design.

Unit V	REALIABILITY	

Concepts of reliability-hazard rate-Entropy-Reliability of series system- parallel systems- Mean time to Failure-Mean time Between Failure.

REFERENCE BOOKS:

1.K.S.Trivedi.John , "Probability and statistics with reliability, Queuing and computer Science Application", Second edition, Wiley&Son, 2016

2. Levin Richard and Rubin Davids, "Statistics for Management ", Pearson Publications,2016

3. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS12	ADVANCED DATA STRUCTURES AND ALGORITHMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Learn about analyzing and designing algorithms to solve a problem and learn to find the asymptotic efficiency of an algorithm
- Be familiar with various data structure concepts like Heaps
- Learn advanced data structures such as balanced search trees
- Study various graph processing algorithms and Algorithm Design techniques
- Study about parallel algorithm

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

- Estimate time and space complexities for a given algorithm.
- Describe the heap property and the use of heaps as an implementation of priority queues.
- Illustrate the various self- balanced trees and their operations.
- Apply an appropriate algorithmic approach to a given problem
- Illustrate parallel algorithm models.

Unit I	INTRODUCTION	9

Abstract Data Types - Time and Space Analysis of Algorithms - Big Oh and Theta Notations - Average, best and worst case analysis - Simple recurrence relations – Mappings.

Unit II	HEAP STRUCTURES	9

Min-max heaps - Heaps - Leftist heaps -Binomial heaps - Fibonacci heaps - Skew heaps - Lazy-binomial heaps.

Unit III	SEARCH STRUCTURES	9

Binary search trees - AVL trees - 2-3 trees - 2-3-4 trees - Red-black trees - B-trees - splay trees – k-d trees,Tries.

Unit IV	ALGORITHM DESIGN TECHIQUES	9

Divide and Conquer and Greedy : Quick sort - Strassen's matrix multiplication - Convex hull - Tree-vertex splitting - Job sequencing with deadlines - Optimal storage on tapes Dynamic Programming and Backtracking: Multistage graphs - 0/1 knapsack - 8- queens problem - graph coloring, Palindrome partitioning

Unit V	ADVANCED ALGORITHMS	9

Parallel Algorithms: Basic Techniques- Work & Efficiency - Distributed Computation - Heuristic & Approximation Approaches.

REFERENCE BOOKS

1. Thomas H.Coremen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein , "Introduction to algorithms", Third edition, MIT press,2013
2. E. Horowitz, S.Sahni and Dinesh Mehta, Fundamentals of Data structures in C++, University Press, 2009.
3. E. Horowitz, S. Sahni and S. Rajasekaran, Computer Algorithms/C++, Second Edition, University Press, 2007.
4. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Third Edition, Pearson Education, Asia.2007.
5. AnanthGrama, Anshul Gupta, George Karypis, VipinKuma, "Introduction to Parallel Computing ", Second Edition, Addison Wesley, 2003

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS13	ADVANCED DATABASE TECHNOLOGY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Know about the parallelism and distributed databases
- Learn about the object oriented databases
- Study about the intelligent databases
- Know about the advanced data models
- Know the emerging trends in database technology

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

- Implement parallel and distributed databases
- Implement object and object relational databases.
- Deal with Intelligent Databases
- Learn advanced data models
- Learn emerging databases

UNIT I	PARALLEL AND DISTRIBUTED DATABASES	9

Database System Architectures: Centralized and Client-Server Architectures –Server System Architectures – Parallel Systems-Distributed Systems –Parallel Databases: I/O Parallelism –Inter and Intra Query Parallelism – Inter and Intra operation Parallelism –Design of Parallel Systems-Distributed Database Concepts -Distributed Data Storage –Distributed Transactions –Commit Protocols –Concurrency Control –Distributed Query Processing –Case Studies

UNIT II	OBJECT AND OBJECT RELATIONAL DATABASES	9

Concepts for Object Databases: Object Identity –Object structure –Type Constructors –Encapsulation of Operations –Methods –Persistence –Type and Class Hierarchies –Inheritance –Complex Objects –Object Database Standards, Languages and Design: ODMG Model –ODL –OQL –Object Relational and Extended – Relational Systems: Object Relational features in SQL/Oracle –Case Studies.

UNIT III	INTELLIGENT DATABASES	9

Active Databases: Syntax and Semantics (Starburst, Oracle, DB2)-Taxonomy-Applications-Design Principles for Active Rules-Temporal Databases: Overview of Temporal Databases-TSQL2-Deductive Databases: Logic of Query Languages –Datalog-Recursive Rules-Syntax and Semantics of Datalog Languages-Implementation of Rules and Recursion-Recursive Queries in SQL-Spatial Databases-Spatial Data Types-Spatial Relationships- Spatial Data Structures-Spatial Access Methods-Spatial DB Implementation.

UNIT IV	ADVANCED DATA MODELS	9

Mobile Databases: Location and Handoff Management -Effect of Mobility on Data Management -Location Dependent Data Distribution -Mobile Transaction Models -Concurrency Control -Transaction Commit Protocols-Multimedia Databases-Information Retrieval-Data Warehousing-Data Mining-Text Mining.

UNIT V	EMERGING TECHNOLOGIES	9

XML Databases: XML-Related Technologies-XML Schema-XML Query Languages-Storing XML in Databases-XML and SQL-Native XML Databases-Web Databases-Geographic Information Systems-Biological Data Management-Cloud Based Databases: Data Storage Systems on the Cloud-Cloud Storage Architectures-Cloud Data Models-Query Languages-Introduction to Big Data-Storage-Analysis.

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REFERENCE BOOKS

1. Approach to Design, Implementation, and Management", Sixth Edition ,Pearson Education, 2015.
2. RamezElmasri&ShamkantB.Navathe, "Fundamentals of Database Systems", Seventh Edition , Pearson Education , 2016.
3. Tamer Ozsu M., Patrick Ualduriel, "Principles of Distributed Database Systems", Second Edition, Pearson Education, 2003.
4. Prabhu C.S.R., "Object Oriented Database Systems", PHI, 2003.
5. Peter Rob and Corlos Coronel, "Database Systems –Design, Implementation and Management", Thompson Learning, Course Technology, 9th Edition, 2011.
6. Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2010.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS14	EMBEDDED SYSTEMS AND REAL TIME OPERATING SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the aspects of Real Time Embedded concepts
- Learn the Essentials of Open Source RTOS and their usage
- Select the proper technique to design a Real-Time System
- Understand VxWorks RTOS and real time application programming with it
- Build the device driver and kernel internal for Embedded OS and RTOSearn and apply the knowledge of memory systems

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

- Know the scheduling models
- Work with open source tools
- Understand the graph based models
- Understand real time OS
- Find solution to real time issues

Unit I	EMBEDDED OS INTERNALS	9

Linux internals: Process Management, File Management, Memory Management, I/O Management. Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication – Semaphore, Pipes, FIFO, Shared Memory Kernel: Structure, Kernel Module Programming Schedulers and types of scheduling. Interfacing: Serial, Parallel Interrupt Handling Linux Device Drivers: Character, USB, Block& Network.

Unit II	OPEN SOURCE RTOS	9

Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management, File systems, I/O Systems, Advantage and disadvantage of RTOS. POSIX standards, RTOS Issues – Selecting a Real-Time Operating System, RTOS comparative study.

Unit III	REAL TIME KERNEL BASICS	9

Converting a normal Linux kernel to real time kernel, Xenomai basics. Overview of Open source RTOS for Embedded systems (Free RTOS/ ChibiosRT) and application development. Real Time Operating Systems: Event based, process based and graph based models, Petrinet models. Real time languages, real time kernel, OS tasks, task states, task scheduling, interrupt processing, clocking, communication and Synchronization. Control blocks, memory requirements and control, kernel services, basic design using RTOS.

Unit IV	VXWORKS / FREE RTOS	9

VxWorks/ Free RTOS Scheduling and Task Management – Realtime scheduling, Task Creation, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts I/O Systems – General Architecture, Device Driver Studies, Driver Module explanation, Implementation of Device Driver for a peripheral.

Unit V	CASE STUDY	9

Software Development and Tools: Simulators, debuggers, cross compilers, in circuit emulators for the microcontrollers. Interface Issues Related to Embedded Systems: A/D, D/A converters, FPGA, ASIC, diagnostic port. Cross compilers, debugging Techniques, Creation of binaries & porting stages for Embedded Development board (Beagle Bone Black, Rpi or similar), Porting an Embedded OS/ RTOS to a target board ().Testing a real-time application on the board.

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REFERENCE BOOKS

1. Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
2. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.
3. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.
4. Raymond J.A. Buhr, Donald L.Bailey, "An Introduction to Real-Time Systems- From Design to Networking with C/C++", Prentice Hall, 1999.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS15	COMPUTER NETWORKS AND MANAGEMENT	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Study IPV4 and IPV6 protocols routing
- Learn Frame relay and ATM congestion control management
- Know Network security and Integrated and Differentiated Services
- Study Network management and its protocols

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

- Compare different network architectures
- Implement ATM protocol architecture and services.
- Design techniques to control the congestion in the network.
- Apply the different routing protocols to find the shortest path.
- Design theISA with the associated protocols.

UNIT I	HIGH SPEED NETWORKS	9

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL. High Speed LAN's: Fast Ethernet, Gigabit Ethernet, Fibre Channel – Wireless LAN's.

UNIT II	CONGESTION AND TRAFFIC MANAGEMENT	9

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

UNIT III	TCP AND ATM CONGESTION CONTROL	9

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO back-off – 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 – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.

UNIT IV	INTEGRATED AND DIFFERENTIATED SERVICES	9

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

UNIT V	PROTOCOLS FOR QOS SUPPORT	9

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

REFERENCE BOOKS

1. William Stallings, "High Speed Networks and Internet", Pearson Education, Second Edition, 2012.
2. Prakash.C.Guptha, "Data Communication and Computer Networks", PHI , 6thprinting 2012.
3. Larry L. Peterson and Bruce S Davis , "Computer Network A System Approach", Elsevier,5th edition 2010.
4. IrvanPepelnjk, Jim Guichard and Jeff Apcar, "MPLS and VPN Architecture", Cisco Press, Volume 1 and 2, 2003.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS16	ADVANCED DATA STRUCTURES LAB	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Learn to implement iterative and recursive algorithms.
- Learn to design and implement algorithms using hill climbing and dynamic programming techniques.
- Learn to implement shared and concurrent objects.
- Learn to implement concurrent data structures.

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

- Implement tree concepts
- Implement stack applications
- Implement Hashing concepts
- Implement dynamic programming and backtracking concepts
- Implement network flow and advanced algorithm techniques

LIST OF EXPERIMENTS

1. Beginning with an empty binary search tree, Construct binary search tree by inserting the values in the order given. After constructing a binary tree –
   i. Insert new node
   ii. Find number of nodes in longest path
   iii. Minimum data value found in the tree
   iv. Change a tree so that the roles of the left and right pointers are swapped at every node v. Search a value
2. For given expression eg. a-b*c-d/e+f construct inorder sequence and traverse it using postorder traversal(non recursive).
3. Write a function to get the number of vertices in an undirected graph and its edges. You may assume that no edge is input twice. i. Use adjacency list representation of the graph and find runtime of the function ii. Use adjacency matrix representation of the graph and find runtime of the function
4. Implement all the functions of a dictionary (ADT) using hashing. Data: Set of (key, value) pairs, Keys are mapped to values, Keys must be comparable, Keys must be unique Standard Operations: Insert(key, value), Find(key), Delete(key)
5. Read the marks obtained by students of second year in an online examination of particular subject. Find out maximum and minimum marks obtained in that subject. Use heap data structure. Analyze the algorithm
6. Implementation of graph search algorithms.
7. Implementation and application of network flow and linear programming problems.
8. Implementation of algorithms using the hill climbing and dynamic programming design techniques.
9. Implementation of recursive backtracking algorithms.
10. Implementation of randomized algorithms.
11. Implementation of various locking and synchronization mechanisms for concurrent linked lists, concurrent queues, and concurrent stacks.
12. Developing applications involving concurrency.

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LIST OF EQUIPMENTS
Systems with Linux Operating System with C/C++ Compiler – 18 Nos.
REFERENCE BOOKS
1. E. Horowitz, S.Sahni and Dinesh Mehta, Fundamentals of Data structures in C++, University Press, 2009. 2. E. Horowitz, S. Sahni and S. Rajasekaran, Computer Algorithms/C++, Second Edition, University Press, 2007. 3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Third Edition, Pearson Education, Asia.2007. 4. AnanthGrama, Anshul Gupta, George Karypis, VipinKuma, "Introduction to Parallel Computing ", Second Edition, Addison Wesley, 2003

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester I	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS17	ADVANCED DATABASE LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is

- Familiarize MySQL Database
- Analyze ER Model
- Develop Data Flow Diagram
- Develop project

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

- Manipulate tables in MySQL
- Analyze ER Model
- Implement Normalization
- Use Database in Serverside pages
- Use constrains in tables

- Familiarization of the MySQL database – creation and manipulation of tables.
- Analyze a given situation, develop an ER model and convert the ER model to Relational model.
- Implement the database using MySQL and manipulate the tables using SQL commands.
- Lab Course Project : Course project topic selection , developing an ER model and converting ER model to a Scheme diagram
- Developing a data flow diagram for the problem specification.
- Implementation of front end pages.
- Implementation of server side pages and verifying the normalization
- Testing the constraints and project
- Submission and evaluation of project

LIST OF EQUIPMENTS

Systems with Linux Operating System with MySQL / Oracle Database, XAMPP Framework – 18 Nos

REFERENCE BOOKS :

1. Elmasr, Navathe, 'Fundamentals of Database Systems', 4 th ed., Pearson Education

2. ReghuRamakrishnan, Database Management Systems, McGrawHill

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS21	HIGH PERFORMANCE COMPUTING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

1. Provide systematic and comprehensive treatment of the hardware and the software high performance techniques invovled in current day computing.
2. Introduce the fundamentals of high performance computing with the graphics processing units and many integrated cores using their architectures and corresponding programming environments.
3. Introduce the learner to fundamental and advanced parallel algorithms through the GPU and MIC programming environments
4. Provide systematic and comprehensive treatment of the components in the pipeline that extract instruction level parallelism.
5. Provide a strong foundation on memory hierarchy design and tradeoffs in both uniprocessor and multiprocessors.
6. Illustrate the cache coherence and consistency problems in multiprocessors, and their existing solutions

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

1. Design, formulate, solve and implement high performance versions of standard single threaded algorithms
2. Demonstrate the architectural features in the GPU and MIC hardware accelerators.
3. Design programs to extract maximum performance in a multi-core, shared memory execution environment processor.
4. Design and implement one, two and three dimensional operations using XEON PHI programming
5. Design and deploy large scale parallel programs on tightly coupled parallel systems using the message passing paradigm

Unit I	GRAPHICS PROCESSING UNITS	9

Introduction to Heterogeneous Parallel Computing. GPU architecture. Thread hierarchy. GPU Memory Hierarchy.

Unit II	GPGPU PROGRAMMING	9

Vector Addition, Matrix Multiplication algorithms. 1D, 2D, and 3D Stencil Operations. Image Processing algorithms – Image Blur, Grayscaling. Histogramming, Convolution, Scan, Reduction techniques

Unit III	MANY INTEGRATED CORES	9

Introduction to Many Integrated Cores. MIC, Xeon Phi architecture. Thread hierarchy. Memory Hierarchy. Memory Bandwidth and performance considerations.

Unit IV	XEON PHI PROGRAMMING	9

Vector Addition, Matrix Multiplication algorithms. 1D, 2D, and 3D Stencil Operations. Image Processing algorithms – Image Blur, Grayscaling. Histogramming, Convolution, Scan, Reduction techniques.

Unit V	SHARED MEMORY PARALLEL PROGRAMMING	9

Symmetric and Distributed architectures. OpenMP Introduction. Thread creation, Parallel regions. Worksharing, Synchronization

REFERENCE BOOKS

1. Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors A Hands-on Approach, Morgann Kaufmann, 3e.
2. Rezaur Rahman, Intel Xeon Phi Coprocessor Architecture and Tools, Apress Open, 2013.
3. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP, MIT Press, 2008.
4. Gropp, Lusk, Skjellum, Using MPI, Using MPI, 2014.
5. Recent publications in IPDPS, PACT, and similar.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS22	WEB PROGRAMMING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Learn about HTML tags
- Know about the Cascading Style Sheets
- Learn object model and java script
- Know the concepts of server side scripts
- Study PHP and SQL database

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

- Apply HTML concepts to develop Webpages
- Build Web applicationsusing Cascading Style Sheets.
- ChooseJavaScript to develop Webpages.
- Design Web application usingJSP and Servlet.
- Develop PHP program to manipulation a database.

Unit I	PROGRAMMING HTML	9

Overview of HTML-Using the HTML Canvas API-Working with HTML Audio and Video-Using the HTML Geolocation API-Using the Communication APIs-Using the HTML Forms API-Using the HTML Web Storage API

Unit II	CASCADING STYLE SHEETS (CSS)	9

Properties Table: Using the style Attribute, Creating Classes and IDs, Generating External Style Sheets, Typography, Consistency, Types of styles, specifying class within HTML document, Style placement: Inline style, Span & div tags, header styles, Text and font attributes: FontVs CSS, changing fonts, text attributes, Advance CSS properties: Backgrounds, Box properties and Positioning.

Unit III	JAVASCRIPT	9

Client-Side Programming: Introduction to JavaScript –Functions –Objects –Arrays –Built -in Objects -JavaScript Debuggers.Host Objects: Browsers and the DOM -Introduction to the Document Object Model DOM History and Levels -Intrinsic Event Handling -Modifying Element Style -The Document Tree -DOM Event Handling

Unit IV	JSP and SERVLETS	9

JSP application Basics: Introducing Java Server Pages-HTTP and Servlet Basics-JSP Overview-Setting up the JSP Environment. JSP Application Development: Generating Dynamic Content-Using JavaBean Components in JSP Pages-Using Custom Tag Libraries and the JSP Standard Tag Library-Processing Input and Output-Error Handling and Debugging-Sharing Data between JSP Pages, Request, and Users-Accessing a Database

Unit V	PHP	9

PHP: Introduction –Programming in Web Environment –Variables –Constants –Data; Types –Operators – Statements –Functions –Arrays –OOP –String Manipulation and Regular Expression –File Handling and Data Storage –PHP and SQL Database –PHP and LDAP –PHP Connectivity –Sending and Receiving E-mails – Debugging and Error Handling –Security –Templates

REFERENCE BOOKS

1. Peter Lubbers, Brian Albers, Frank Salim-Pro HTML5 Programming Powerful APIs for Richer Internet Application Development-Apress (2010)
2. Jeffrey C.Jackson, "Web Technologies-A Computer Science Perspective", Pearson Education, 2013. (Unit 2 &3).
3. Hans Bergsten, "JavaServerPages", Second Edition, O'Reilly Publication, 2002.
4. Steven Holzner, "PHP: The Complete Reference", Second edition, Tata McGraw-Hill, Indian Reprint, 2009.5.Rasmus Lerdorf and Levin Tatroe, "Programming PHP", O'Reilly, 2002.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS23	DATA SCIENCE AND ANALYTICS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Know about the basics of Data Science
- Learn about various models in data science
- Study the basics of R Language
- Set up Hadoop environment and work with Mapreduce
- Visualize the results

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

- Understand roles and stages of data science project and manage the size of data
- Explain various machine learning algorithm for analytics project
- Identify and design and write functions in R and implement simple iterative algorithms
- Demonstrate map reduce framework for simple dataset
- Explain various delivering method for analysis process

UNIT I	INTRODUCTION TO DATA SCIENCE	9

What is data sciences-The rising and importance of data sciences -Big data analytics in industry verticals -Data science process –roles, stages in data science project –working with data from files –working with relational databases –exploring data –managing data –cleaning and sampling for modeling and validation

UNIT II	MODELING METHODS	9

Choosing and evaluating models –mapping problems to machine learning, evaluating clustering models, validating models –cluster analysis –K-means algorithm, Naïve Bayes –Memorization Methods –Linear and logistic regression –unsupervised methods.

UNIT III	INTRODUCTION TO R	9

Reading and getting data into R –ordered and unordered factors –arrays and matrices –lists and data frames –reading data from files –probability distributions –statistical models in R -manipulating objects –data distribution

UNIT IV	MAP REDUCE	9

Introduction –distributed file system –algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce –Hadoop -Understanding the Map Reduce architecture -Writing HadoopMapReduce Programs -Loading data into HDFS -Executing the Map phase -Shuffling and sorting -Reducing phase execution.

UNIT V	DELIVERING RESULTS	9

Documentation and deployment –producing effective presentations –Introduction to graphical analysis –plot() function -Histograms and Density Charts-Starting Layer Tips-Using Facets-Coordinates-Perfecting By Adding Themes –displaying multivariate data –matrix plots –multiple plots in one window -exporting graph -using graphics parameters-Time Series Analysis -Additive & Multiplicative models -Exponential smoothing techniques-Case studies.

REFERENCE BOOKS

1. Nina Zumel, John Mount, "Practical Data Science with R", Manning Publications, 2014.
2. Jure Leskovec, AnandRajaraman, Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014.
3. Mark Gardener, "Beginning R -The Statistical Programming Language", John Wiley & Sons, Inc., 2012. 4. Nathan Yau, "Visualize This: TheFlowingData Guide to Design, Visualization, and Statistics", Wiley, 2011.
4. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
5. Eric Siegel, Thomas H. Davenport, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", Wiley, 2013

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS24	WEB TECHNOLOGY LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Familiar with Web page design using HTML/XML and style sheets
- Exposed to creation of user interfaces using Java frames and applets.
- Learn to create dynamic web pages using server side scripting.
- Learn to write Client Server applications.
- Familiar with the PHP programming.
- Exposed to creating applications with AJAX

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

- Construct Web pages using HTML/XML and style sheets.
- Build dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms.
- Develop dynamic web pages using server side scripting.
- Use PHP programming to develop web applications.
- Construct web applications using AJAX and web services.

LIST OF EXPERIMENTS

1. Create a HTML webpage to play/Pause a video and if the video is paused, resize it by small, normal and big.
2. Create a HTML webpage that contains a button to retrieve Latitude and Longitude.
3. Develop a webpage that consists of three types of CSS implementation
4. Develop a webpage that contains form validation using JavaScript.
5. Develop a webpage to perform mouse event handling.
6. Develop a webpage to add two numbers using JSP and servlet.
7. Develop a JSP program to use Java Bean component.
8. Develop a webpage to retrieve the database table using JSP
9. Develop a webpage to perform CRUD operation using PHP
10. Develop a PHP program to use the send mail configuration.

LIST OF EQIUPMENTS

Systems with Windows 7 or Linux, - 18 Nos.
Softwares : Java,JSP,ISP Webserver- Apache Tomcat, MySQL, XAMPP

REFERENCE BOOKS

1. Peter Lubbers, Brian Albers, Frank Salim-Pro HTML5 Programming Powerful APIs for Richer Internet Application Development-Apress (2010)
2. Jeffrey C.Jackson, "Web Technologies-A Computer Science Perspective", Pearson Education, 2013.
3. Hans Bergsten, “JavaServerPages”, Second Edition, O’Reilly Publication, 2002.
4. Steven Holzner, “PHP: The Complete Reference”, Second edition, Tata McGraw-Hill, Indian Reprint, 2009.
5. RasmusLerdorf and Levin Tatroe, “Programming PHP”, O’Reilly, 2002.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS25	DATA ANALYTICS LABORATORY	0	0	4	2	60	100	

Course Objective (s): The purpose of learning this course is to

- Optimize business decisions and create competitive advantage with Big Data analytics
- Imparting the architectural concepts of Hadoop and introducing map reduce paradigm
- Introducing Java concepts required for developing map reduce programs
- Derive business benefit from unstructured data
- Introduce programming tools PIG & HIVE in Hadoop echo system.
- Developing Big Data applications for streaming data using Apache Spark.

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

- Prepare for data summarization, query, and analysis.
- Apply data modelling techniques to large data sets
- Create applications for Big Data analytics
- Build a complete business data analytic solution

LIST OF EXPERIMENTS

1. Install, configure and run Hadoop Framework
2. Running Map Reduce Programming in Hadoop (Word count, Weather forecast etc)
3. Implement Linear and logistic Regression using R
4. Implement various Clustering Techniques using R
5. Visualize data using any plotting framework using R/Python
6. Implement an application that stores big data in Hbase / MongoDB / Pig using Hadoop / R.

LIST OF EQUIPMENTS

Machines – Windows 7/8 , RStudo, Hadoop / HDFC, Map Reduce, Big data tools – 18 Nos.

REFERENCES

1. Nina Zumel, John Mount, "Practical Data Science with R", Manning Publications, 2014.
2. Jure Leskovec, AnandRajaraman, Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014.
3. Mark Gardener, "Beginning R -The Statistical Programming Language", John Wiley & Sons, Inc., 2012. 4. Nathan Yau, "Visualize This: TheFlowingData Guide to Design, Visualization, and Statistics", Wiley, 2011.
4. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
5. Eric Siegel, Thomas H. Davenport, "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die", Wiley, 2013

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MCS31	MACHINE LEARNING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Introduce the basic concepts and techniques of Machine Learning.
- Be familiar with a set of well-known supervised, semi-supervised andunsupervised learning algorithms
- Compare and Contrast various about analysis models
- Illustrate various optimization techniques.
- Develop the skills in using recent machine learning software for solvingpractical problems.

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

- Apply multilayer perceptron using simple machine learning techniques.
- Use decision trees and statistics models
- Use data analysis for machine learning
- Use Genetic algorithm and reinforced learning for appropriate applications
- Use the Python programming for machine learning.

Unit I	INTRODUCTION	9

Learning - Types of machine learning - Supervised learning - The brain and the neurons, Linear Discriminants - Perceptron - Linear Separability -Linear Regression - Multilayer perceptron - Examples of using MLP - Back propagation of error.

Unit II	CLASSIFICATION ALGORITHMS	9

Decision trees - Constructing decision trees - Classification of regression trees - Regression example - Probability and Learning: Turning data into probabilities - Some basic statistics - Gaussian mixture models - Nearest Neighbor methods.

Unit III	ANALYSIS	9

The k-Means algorithm - Vector Quantization's - Linear Discriminant Analysis - Principal component analysis - Factor Analysis - Independent component analysis - Locally Linear embedding – Isomap - Least squares optimization - Simulated annealing.

Unit IV	OPTIMIZATION TECHNIQUES	9

The Genetic algorithm - Genetic operators - Genetic programming - Combining sampling with genetic programming - Markov Decision Process - Markov Chain Monte Carlo methods: sampling - Monte carlo - Proposal distribution

Unit V	PYTHON FOR MACHINE LEARNING	9

Baysean Networks - Markov Random moFields - Hidden Markov Models -Tracking methods. Python: Installation - Python for MATLAB AND R users - Code Basics - Using NumPy and MatPolitB.

REFERENCE BOOKS

1. EthemAlpaydin, "Machine Learning: The New AI", MIT Press, 2016.
2. ShaiShalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
3. Sebastian Raschka, "Python Machine Learning", Packt Publishing Ltd, 2015.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX07	GRAPH THEORY AND OPTIMIZATION TECHNIQUES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Develop analytical capability and to impart knowledge in graphs, linear programming problem and statistical methods and their applications in Engineering & Technology and to apply their concepts in engineering problems they would come across
- Understand graphs ,linear programming problems and statistical concepts.
- Apply the concepts in solving the Engineering problems

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

- Write precise and accurate mathematical definitions of objects in graph theory.
- Use mathematical definitions to identify and construct examples and to distinguish examples from non-examples.
- Validate and critically assess a mathematical proof.
- Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory.
- Reason from definitions to construct mathematical proofs.

Unit I	BASICS OF GRAPH THEORY	9

Graphs - Data structures for graphs - Subgraphs - Operations on Graphs Connectivity– Networks and the maximum flow - Minimum cut theorem - Trees - Spanning trees - Rooted trees – Matrix representation of graphs.

Unit II	CLASSES OF GRAPHS	9

Eulerian graphs and Hamiltonian graphs - Standard theorems - Planar graphs - Euler's formula - Five colour theorem - Coloring of graphs - Chromatic number (vertex and edge) properties and examples - Directed graphs

Unit III	GRAPH ALGORITHM	9

Computer Representation of graphs - Basic graph algorithms - Minimal spanning tree algorithm - Kruskal and Prim's algorithm - Shortest path algorithms - Dijsktra's algorithm - DFS and BFS algorithms.

Unit IV	OPTIMIZATION TECHNIQUES	9

Linear programming – Graphical methods – Simplex method (Artificial variables not included) – Transportation and assignment problems

Unit V	STATISTICS	9

Tchebyshev's inequality – Maximum likelihood estimation – Correlation – Partial correlation – Multiple correlations.

REFERENCE BOOKS

1. NarsinghDeo, "Graph Theory with Applications to Engineering and ComputerScience", PHI 1974.
2. Rao S.S., "Engineering Optimization: Theory and Practice", New Age International Pvt. Ltd., 3rd Edition 1998

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX08	STOCHASTIC PROCESSES AND QUEUEING THEORY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Compute the characteristics of the random variable given the probabilities
- Understand and apply various distribution
- Solve cases of different Stochastic processes along with their properties.
- Use discrete time finite state Markov chains
- Gain sufficient knowledge in principles of queueing theory

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

- Understand random variables and its properties
- Know about theoretical distributions
- Know the classification of stochastic processes
- Know the discrete parameters
- Learn the queueing models

Unit I	RANDOM VARIABLES	9

One dimensional and two dimensional Random Variables – Characteristics of Random Variables : Expectation, Moments

Unit II	THEORETICAL DISTRIBUTIONS	9

Continuous: Uniform, Exponential, Erlang and Gamma, Weibull Distributions

Unit III	STOCHASTIC PROCESSES	9

Classification of Stochastic Processes – Bernoulli process – Poisson process – Pure birth process – Birth and Death process.

Unit IV	MARKOV CHAINS	9

Introduction – Discrete-Parameter Markov Chains – Transition Probability Matrix – Chapman Kolmogorov Theorem – State classification and limiting distributions.

Unit V	QUEUING THEORY	9

Introduction – Characteristics of Markovian Single server and Multi server queuing models [(M/M/1) : (∞ / FIFO), (M/M/1) : (N / FIFO), (M/M/s) : (∞ /FIFO)] – M/G/1 Queuing System – PollaczekKhinchin formula.

REFERENCE BOOKS

1. Kishore.S.Trivedi, "Probability & Statistics with Reliability, Queuing andComputer Science Applications", PHI, New Delhi, 1995.
2. Veerajan T, "Probability, Statistics and Random Processes", 3rd Edition Tata McGraw Hill, New Delhi, 2002.
3. Gupta S.C and Kapoor V.K, "Fundamentals of Mathematical Statistics", 9th revised edition, Sultan Chand & Co., New Delhi 2003.
4. Gross.D and Harris.C.M. "Fundementals of Queuing theory", John Wiley and Sons, 1985.
5. Allen.A.O., "Probability, Statistics and Queuing Theory", Academic Press, 1981

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX02	SOFTWARE REQUIREMENTS ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basics of requirements engineering
- Learn different techniques used for requirements elicitation
- Know the role played by requirements analysis in requirement integration
- Appreciate the use of various methodologies for requirements development
- Study the current trends in requirements prioritization and validation.

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

- Prepare SRS including the details of requirements engineering
- Able to work with elicitation models
- Analyze software requirements gathering
- Describe the stages of requirements analysis
- Able to validate the requirements

Unit I	REQUIREMENTS ENGINEERING OVERVIEW	9

Software Requirement Overview – Software Development Roles –Software Development Process Kernels – Commercial Life Cycle Model – Vision Development – Stakeholders Needs & Analysis – Stakeholder needs – Stakeholder activities.

Unit II	REQUIREMENTS ELICITATION	9

The Process of Requirements Elicitation – Requirements Elicitation Problems – Problems of Scope – Problems of Understanding – Problems of Volatility – Current Elicitation Techniques – Information Gathering – Requirements Expression and Analysis – Validation – An Elicitation Methodology Framework – A Requirements Elicitation Process Model – Methodology over Method – Integration of Techniques – Fact-Finding – Requirements Gathering – Evaluation and Rationalization – Prioritization – Integration and Validation.

Unit III	REQUIREMENTS ANALYSIS	9

Identification of Functional and Non Functional Requirements – Identification of Performance Requirements – Identification of safety Requirements – Analysis – Feasibility and Internal Compatibility of System Requirements – Definition of Human Requirements Baseline.

Unit IV	REQUIREMENTS DEVELOPMENT	9

Requirements analysis – Requirements Documentation – Requirements Development Workflow – Fundamentals of Requirements Development – Requirements Attributes Guidelines Document – Supplementary Specification Document – Use Case Specification Document – Methods for Software Prototyping – Evolutionary prototyping – Throwaway prototyping.

Unit V	REQUIREMENTS VALIDATION	9

Validation objectives – Analysis of requirements validation – Activities – Properties – Requirement reviews – Requirements testing – Case tools for requirements engineering.

REFERENCE BOOKS

1. Dean Leffingwe, Don Widrig, —Managing Software Requirements A Use Case Approach‖, Second Addition, Addison Wesley, 2003
2. Ian Graham, —Requirements Engineering and Rapid Development‖, Addison Wesley, 1998
3. Ian Sommerville, Pete Sawyer, —Requirements Engineering: A Good Practice Guide‖, Sixth Edition, Pearson Education, 2004
4. Karl Eugene Wiegers, —Software Requirements‖, Word Power Publishers, 2000
5. Wiegers, Karl, Joy Beatty, ‖Software requirements‖, Pearson Education, 2013

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX06	RESEARCH METHODOLOGY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Develop understanding of the basic framework of research process
- Identify various sources of information for data collection.
- Identify the different sampling methods.
- Recognize the concepts of hypothesis testing.
- Appreciate the components of scholarly writing and evaluate its quality.

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

- Able to find errors in research problem
- Able to classify various data collection methods
- Able to make use of sampling methods
- To test the collected data using various testing methods
- Able to write reports effectively.

Unit I	RESEARCH METHODOLOGY	9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Unit II	DATA COLLECTION METHODS	9

Data collection methods-Primary data –observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data-internal sources of data, external sources of data.

Unit III	SAMPLING METHODS	9

Scales –measurement, Types of scale –Thurstone's Case V scale model, Osgood's SemanticDifferential scale, Likert scale, Q-sort scale.Sampling methods-Probability sampling methods –simple random sampling with replacement, simple random sampling without replacement, stratified sampling, cluster sampling. Non-probability sampling method –convenience sampling, judgment sampling, quota sampling.

Unit IV	HYPOTHESES TESTING	9

Testing of hypotheses concerning means -One mean and difference between two means -One tailed and Two tailed tests, concerning variance –One Tailed Chi-square test.

Unit V	REPORT WRITING&IPR	9

Report writing-Types of Report, Guidelines to review report, typing instructions, Oral Presentation-Layout of research Paper-Ethical issues related to publishing, Plagiarism and Self Plagiarism. Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs

TEXT BOOKS / REFERENCE BOOKS

1. Kothari.C.R.,"Research Methodology -Methods and Techniques", NewAgePublications,New Delhi,2009.
2. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2004.
3. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs andgeographical indications.
4. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: theTRIPS agreement and policy options. Zed Books, New York
5. Donald Cooper, Pamela Schindler, Business Research Methods, Mc-Graw Hill HigherEducation, 12th Edition,2010

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX09	OPERATIONS RESEARCH	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.
- Learn linear models, transportation models, network models, inventory models and Queueing models

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

- Apply various linear models to a problem
- Develop networked models for the problem
- Apply inventory model for real-time applications
- Implement Queuing Models
- Apply Decision Models

Unit I	LINEAR MODELS	9

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

Unit II	TRANSPORTATION MODELS AND NETWORK MODELS	9

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

Unit III	INVENTORY MODELS	9

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

Unit IV	QUEUEING MODELS	9

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

Unit V	DECISION MODELS	9

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.

TEXT BOOKS / REFERENCE BOOKS

1. Taha H.A., "Operations Research", Sixth Edition, Prentice Hall of India, 2003.
2. Shennoy G.V. and Srivastava U.K., "Operation Research for Management", Wiley Eastern, 1994.
3. Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley, 1990.
4. Philip D.T. and Ravindran A., "Operations Research", John Wiley, 1992.
5. Hillier and Libeberman, "Operations Research", Holden Day, 1986
6. Budnick F.S., "Principles of Operations Research for Management", Richard D Irwin, 1990.
7. Tulsian and Pasdey V., "Quantitative Techniques", Pearson Asia, 2002.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX12	COMPILER OPTIMIZATION TECHNIQUES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the optimization techniques used in compiler design.
- Be aware of the various computer architectures that support parallelism.
- Become familiar with the theoretical background needed for code optimization.
- Understand the techniques used for identifying parallelism in a sequential program.
- Learn the various optimization algorithms.

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

- Know the basics of processing a language
- Find difference among scheduling process
- Understand the parallelism concepts
- Learn the loops
- Analyze the flow of program

Unit I	INTRODUCTION	9

Language Processors - The Structure of a Compiler – The Evolution of Programming LanguagesThe Science of Building a Compiler – Applications of Compiler Technology Programming Language Basics - The Lexical Analyzer Generator -Parser Generator - Overview of Basic Blocks and Flow Graphs - Optimization of Basic Blocks - Principle Sources of Optimization.

Unit II	INSTRUCTION-LEVEL PARALLELISM	9

Processor Architectures – Code-Scheduling Constraints – Basic-Block Scheduling –Global Code Scheduling – Software Pipelining.

Unit III	OPTIMIZING FOR PARALLELISM AND LOCALITY-THEORY	9

Basic Concepts – Matrix-Multiply: An Example - Iteration Spaces - Affine Array Indexes – Data Reuse Array data dependence Analysis

Unit IV	OPTIMIZING FOR PARALLELISM AND LOCALITY – APPLICATION	9

Finding Synchronization - Free Parallelism – Synchronization Between Parallel Loops – Pipelining – Locality Optimizations – Other Uses of Affine Transforms.

Unit V	INTERPROCEDURAL ANALYSIS	9

Basic Concepts – Need for Interprocedural Analysis – A Logical Representation of Data Flow – A Simple Pointer-Analysis Algorithm – Context Insensitive Interprocedural Analysis – ContextSensitive Pointer-Analysis - Datalog Implementation by Binary Decision Diagrams

REFERENCE BOOKS

1. Alfred V. Aho, Monica S.Lam, Ravi Sethi, Jeffrey D.Ullman, "Compilers:Principles, Techniques and Tools", Second Edition, Pearson Education,2008.
2. Randy Allen, Ken Kennedy, "Optimizing Compilers for Modern Architectures: A Dependence-based Approach", Morgan Kaufmann Publishers, 2002.
3. Steven S. Muchnick, "Advanced Compiler Design and Implementation",Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint 2003.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX16	DATA VISUALIZATON TECHNIQUES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Develop skills to both design and critique visualizations.
- Introduce visual perception and core skills for visual analysis and for time-series analysis.
- Understand visualization for ranking and deviation analysis.
- Understand visualization for distribution analysis and multivariate analysis.
- Understand issues and best practices in information dashboard design

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

- Explain principles of visual perception
- Apply core skills for visual analysis
- Apply visualization techniques for various data analysis tasks
- Design information dashboard

Unit I	CORE SKILLS FOR VISUAL ANALYSIS	9

Information visualization – effective data analysis – traits of meaningful data – visual perception –making abstract data visible – building blocks of information visualization – analytical interaction – analytical navigation – optimal quantitative scales – reference lines and regions – trellises and crosstabs – multiple concurrent views – focus and context – details on demand – over-plotting reduction – analytical patterns – pattern examples.

Unit II	TIME-SERIES, RANKING, AND DEVIATION ANALYSIS	9

Time-series analysis – time-series patterns – time-series displays – time-series best practices – part-to-whole and ranking patterns – part-to-whole and ranking displays – best practices – deviation analysis – deviation analysis displays – deviation analysis best practices.

Unit III	DISTRIBUTION, CORRELATION, AND MULTIVARIATE ANALYSIS	9

Distribution analysis – describing distributions – distribution patterns – distribution displays – distribution analysis best practices – correlation analysis – describing correlations – correlation patterns – correlation displays – correlation analysis techniques and best practices – multivariate analysis – multivariate patterns – multivariate displays – multivariate analysis techniques and best practices.

Unit IV	INFORMATION DASHBOARD DESIGN	9

Information dashboard – Introduction– dashboard design issues and assessment of needs – Considerations for designing dashboard-visual perception – Achieving eloquence.

Unit V	INFORMATION DASHBOARD DESIGN	9

Advantages of Graphics _Library of Graphs – Designing Bullet Graphs – Designing Sparklines – Dashboard Display Media –Critical Design Practices – Putting it all togetherUnveiling the dashboard.

REFERENCE BOOKS

1. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
2. Edward R. Tufte, "The visual display of quantitative information", Second Edition, Graphics Press, 2001.
3. Evan Stubbs, "The value of business analytics: Identifying the path to profitability", Wiley, 2011.
4. Gert H. N. Laursen and JesperThorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley, 2010.
5. Nathan Yau, "Data Points: Visualization that means something", Wiley, 2013.
6. Stephen Few, "Information dashboard design: Displaying data for at-a-glance monitoring", second edition, Analytics Press, 2013.
7. Stephen Few, "Now you see it: Simple Visualization techniques for quantitative analysis", Analytics Press, 2009.
8. Tamara Munzner, Visualization Analysis and Design, AK Peters Visualization Series, CRC Press, Nov. 2014

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX23	COMPUTER VISION	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Review image processing techniques for computer vision.
- Understand shape and region analysis.
- Understand segmentation and alignement..
- Understand three-dimensional image analysis techniques.
- Understand motion analysis.
- Study some applications of computer vision algorithms.

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

- Explain the fundamentals of image formation, transformation and analysis.
- Explain the feature detection and tracking techniques.
- Demonstrate various segmentation and alignment techniques
- Explain Structure from Motion and Dense Motion Analysis methodologies
- Implement various recognition techniques.

Unit I	IMAGE FORMATION AND IMAGE PROCESSING	9

Introduction to computer vision-Geometric primitives-2D and 3D transformations-3D to 2D projections- Image formation- Lighting- Reflective and Shading. Histogram Equalization-Linear filtering- Non-Linear Filtering-Morphology-Distance transforms- Interpolation- Decimation.

Unit II	FEATURE DETECTION AND TRACKING	9

Invariance-key points and 3D flow vectors- RANSAC-SIFT, SURF, ORB- Feature evaluation. Tracking and feature updation-Lucas-Kanade tracker-Kalman filter.

Unit III	SEGMENTATION AND ALIGNMENT	9

Segmentation- Active contours, Graph based segmentation- Mean shift- Normalized cut. 2D feature based alignment-Least squares-Iterative algorithms-3D alignment -Pose estimation- Geometric intrinsic calibration

Unit IV	STRUCTURE FROM MOTION AND DENSE MOTION ANALYSIS	9

Structure from motion (sfm)-Triangulation- Two frame sfm - Bundle adjustment. 3D motion and 2D optical flow -The Horn Schunck algorithm-Lucas-Kanade Algorithm-Performance evaluation of optical flow results.

Unit V	RECOGNITION	9

Object detection- Face detection -Pedestrian detection- Face recognition- Eigenfaces- Active appearance and 3D shape models. Category recognition- Bag of words- Part-based models, Recognition with segmentation- Context and scene understanding.

REFERENCE BOOKS

Computer Vision: Algorithms and Applications, Richard Szeliski, Springer International, 2011.
Concise Computer Vision: An introduction into theory and Algorithms, Reinhard Klette,2014, Springer-Verlag London.
R. Hartley and A. Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2003.
Computer vision – A modern Approach , David A forsyth& Jean ponce , Prentice Hall ,2002.
"Computer vision and Applications" , Bernd Jahne and Horst HauBecker Academic press ,2000

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester II	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX10	NETWORK AND INFORMATION SECURITY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the fundamentals of Cryptography
- Acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.
- Understand the various key distribution and management schemes.
- Understand how to deploy encryption techniques to secure data in transit across data networks
- Design security applications in the field of Information technology

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

- Implement basic security algorithms required by any computing system.
- Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
- Analyze the possible security attacks in complex real time systems and their effective countermeasures
- Identify the security issues in the network and resolve it.
- Evaluate security mechanisms using rigorous approaches, including theoretical derivation, modeling, and simulations

Unit I	INTRODUCTION	9

An Overview of Computer Security-Security Services-Security Mechanisms-Security Attacks, Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies.

Unit II	CRYPTOSYSTEMS & AUTHENTICATION	9

Classical Cryptography-Substitution Ciphers-permutation Ciphers-Block Ciphers-DES- Modes of Operation-AES-Linear Cryptanalysis, Differential Cryptanalysis- Hash Function - SHA 512- Message Authentication Codes-HMAC - Authentication Protocols

Unit III	PUBLIC KEY CRYPTOSYSTEMS	9

Introduction to Public key Cryptography- Number theory- The RSA Cryptosystem and Factoring Integer-Attacks on RSA-The ELGamal Cryptosystem- Digital Signature Algorithm-Finite FieldsElliptic Curves Cryptography- Key management – Session and Interchange keys, Key exchange and generation-PKI

Unit IV	SYSTEM IMPLEMENTATION	9

Design Principles, Representing Identity, Access Control Mechanisms, Information Flow and Confinement Problem Secure Software Development: Secured Coding - OWASP/SANS Top Vulnerabilities - Buffer Overflows - Incomplete mediation - XSS - Anti Cross Site Scripting Libraries - Canonical Data Format - Command Injection - Redirection - Inference – Application Controls

Unit V	NETWORK SECURITY	9

Secret Sharing Schemes-Kerberos- Pretty Good Privacy (PGP)-Secure Socket Layer (SSL)- Intruders – HIDS-NIDS - Firewalls - Viruses

REFERENCE BOOKS

1. William Stalling, "Cryptography and Network Security: Principles and Practices", Third Edition, Pearson Education, 2006.
2. Matt Bishop ,"Computer Security art and science ", Second Edition, Pearson Education, 2002
3. Wade Trappe and Lawrence C. Washington, "Introduction to Cryptography with Coding Theory" Second Edition, Pearson Education, 2007
4. Jonathan Katz, and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press, 2007
5. Douglas R. Stinson, "Cryptography Theory and Practice", Third Edition, Chapman & Hall/CRC, 2006
6. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, First Edition, 2006.
7. Network Security and Cryptography, Menezes Bernard, Cengage Learning, New Delhi, 2011
8. Man Young Rhee, Internet Security, Wiley, 2003

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX24	DATA MINING TECHNIQUES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the concepts of Data Mining
- Perform different data mining tasks
- Learn visualization methods
- Study about various clustering techniques
- Study the applications of Data mining

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

- Understand data mining principles and techniques
- Gather and analyze large sets of data to gain useful business understanding.
- Produce a quantitative analysis report/memo with the necessary information to make decisions.
- Describe and demonstrating basic data mining algorithms, methods, and tools 6. Identifying business applications of data mining
- Overview of the developing areas - web mining, text mining, and ethical aspects of data mining

Unit I	INTRODUCTION	9

Introduction to Data Mining – Data Mining Tasks – Components of Data Mining Algorithms – Data Mining supporting Techniques – Major Issues in Data Mining – Measurement and Data – Data Preprocessing – Data sets

Unit II	OVERVIEW OF DATA MINING ALGORITHMS	9

Overview of Data Mining Algorithms – Models and Patterns – Introduction – The Reductionist viewpoint on Data Mining Algorithms – Score function for Data Mining Algorithms- Introduction – Fundamentals of Modeling – Model Structures for Prediction – Models for probability Distributions and Density functions – The Curve of Dimensionality – Models for Structured Data – Scoring Patterns – Predictive versus Descriptive score functions – Scoring Models with Different Complexities – Evaluation of Models and Patterns – Robust Methods.

Unit III	CLASSIFICATIONS	9

Classifications – Basic Concepts – Decision Tree induction – Bayes Classification Methods – Rule Based Classification – Model Evaluation and Selection – Techniques to Improve Classification Accuracy – Classification: Advanced concepts – Bayesian Belief Networks- Classification by Back Propagation – Support Vector Machine – Classification using frequent patterns.

Unit IV	CLUSTER ANALYSIS	9

Cluster Analysis: Basic concepts and Methods – Cluster Analysis – Partitioning methods – Hierarchical methods – Density Based Methods – Grid Based Methods – Evaluation of Clustering – Advanced Cluster Analysis: Probabilistic model based clustering – Clustering High – Dimensional Data – Clustering Graph and Network Data – Clustering with Constraints.

Unit V	ASSOCIATION RULE MINING AND VISUALIZATION	9

Association Rule Mining – Introduction – Large Item sets – Basic Algorithms – Parallel and Distributed Algorithms – Comparing Approaches – Incremental Rules – Advanced Association Rule Techniques – Measuringthe Quality of Rules – Visualization of Multidimensional Data – Diagrams for Multidimensional visualization – Visual Data Mining – Data Mining Applications – Case Study: WEKA.

REFERENCE BOOKS

1. Jiawei Han, MichelineKamber ,Jian Pei, "Data Mining: Concepts and Techniques", Third Edition (The Morgan Kaufmann Series in Data Management Systems), 2012.
2. David J. Hand, HeikkiMannila and Padhraic Smyth "Principles of Data Mining" (Adaptive Computation and Machine Learning), 2005
3. Margaret H Dunham, "Data Mining: Introductory and Advanced Topics", 2003
4. Soman, K. P., DiwakarShyam and Ajay V. "Insight Into Data Mining: Theory And Practice", PHI, 2009.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX15	PERFORMANCE METRICS AND ADVANCED COMPUTING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the memory organization and hierarchy
- Learn performance metrics
- Know mathematical representation of performance metrics
- Simulate the results in real time systems
- Know the metrics for information systems

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

- Apply basic performance metrics to measure the performance of a computer systems.
- Use Principles of Experimentation for simulations
- Use performance metrics and Non Performance metrics for computing
- Measuring Performance of Real time Applications
- Measuring Performance of Advanced Computing Applications

Unit I	PERFORMANCE OF COMPUTER SYSTEMS	9

Performance of Computer Systems, Technology -Circuit speed (clock, MHz), Processor technology (how many transistors on a chip), Organization -Type of processor (ILP), Configuration of the memory hierarchy, type of I/O devices, Number of processors in the system, Software -Quality of the compilers, Organization & quality of OS, databases, etc.

Unit II	PRINCIPLES OF EXPERIMENTATION	9

Principles of Experimentation -Meaningful metrics, Reproducibility, Real programs, Simulation Metrics.

Unit III	METRICS THAT MEASURE PERFORMANCE	9

Metrics that Measure Performance -Execution time, Throughput, Raw speed, Clock Speed, Component metrics,Metrics Not to Performance Use –MIPS, MFLOPS, Variation of Means –arithmetic, harmonic, weighted means, Speedup, Scalability

Unit IV	CASE STUDY	9

Challenges of Measuring Performance with Real Applications –HPC, Cloud, Kernels.

Unit V	ADVANCED METRICS	9

Advanced Computing Metric System -Consistent Representation of Information, Explicit Relationships Repository of Definitions, Comparability, Flexibility and Adaptability, Composability

REFERENCE BOOKS

1. Brendan Gregg, "Systems Performance: Enterprise and the Cloud", 1st Edition, Holdings Private Limited, 2016.
2. Randal S, "Python Machine Learning, PACKT Publishing, 2016
3. Cloud Computing Service Metrics Description, NIST, 2017
4. Grid Computing Performance Metrics Framework, NIST, 2013
5. Nasir Abbas, Yan Zhang, Amir Taherkordi, Tor Skeie, "Mobile Edge Computing: A Survey", Internet of Things Journal IEEE, vol. 5, no. 1, pp. 450-465, 2018

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX20	SPEECH PROCESSING AND SYNTHESIS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Introduce speech production and related parameters of speech.
- Show the computation and use of techniques such as short time Fourier transform, linear predictive coefficients and other coefficients in the analysis of speech.
- Understand different speech modeling procedures such as Markov and their implementation issues

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

- Model speech production system and describe the fundamentals of speech.
- Extract and compare different speech parameters.
- Choose an appropriate statistical speech model for a given application.
- Design a speech recognition system.
- Use different speech synthesis techniques.

Unit I	BASIC CONCEPTS	9

Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

Unit II	SPEECH ANALYSIS	9

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

Unit III	SPEECH MODELING	9

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

Unit IV	SPEECH RECOGNITION	9

Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.

Unit V	SPEECH SYNTHESIS	9

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

REFERENCE BOOKS

1. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2002.
3. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.
4. Steven W. Smith, "The Scientist and Engineer"s Guide to Digital Signal Processing", California Technical Publishing, 1997.
5. Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education, 2004.
6. Claudio Becchetti and LucioPrinaRicotti, "Speech Recognition", John Wiley and Sons, 1999.
7. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006..

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX03	SOFTWARE QUALIFY ASSURANCE AND TESTING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basics of testing, test planning &design and test team organization
- Study the various types of test in the life cycle of the software product.
- Build design concepts for system testing and execution
- Learn the software quality assurance ,metrics, defect prevention techniques
- Learn the techniques for quality assurance and applying for applications.

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

- Perform functional and nonfunctional tests in the life cycle of the software product.
- Understand system testing and test execution process.
- Identify defect prevention techniques and software quality assurance metrics.
- Apply techniques of quality assurance for typical applications.
- Effectively manage a testing and quality assurance in software project.

Unit I	SOFTWARE TESTING - CONCEPTS, ISSUES, AND TECHNIQUES	9

Quality Revolution, Verification and Validation, Failure, Error, Fault, and Defect, Objectives of Testing, Testing Activities, Test Case Selection White-Box and Black ,test Planning and design, Test Tools and Automation, . Power of Test. Test Team Organization and Management-Test Groups, Software Quality Assurance Group ,System Test Team Hierarchy, Team Building.

Unit II	SYSTEM TESTING	9

System Testing - System Integration Techniques-Incremental, Top Down Bottom Up Sandwich and Big Bang, Software and Hardware Integration, Hardware Design Verification Tests, Hardware and Software Compatibility Matrix Test Plan for System Integration. Built- in Testing. functional testing - Testinga Function in Context. Boundary Value Analysis, Decision Tables. acceptance testing - Selectionof Acceptance Criteria, Acceptance Test Plan, Test Execution Test. software reliability - Fault and Failure, Factors Influencing Software, Reliability Models

Unit III	SYSTEM TEST CATEGORIES	9

System test categories Taxonomy of System Tests, Interface Tests Functionality Tests. GUI Tests, Security Tests Feature Tests, Robustness Tests, Boundary Value Tests Power Cycling Tests Interoperability Tests, Scalability Tests, Stress Tests, Load and Stability Tests, Reliability Tests, Regression Tests, Regulatory Tests. Test Generation from FSM models- State-Oriented Model. Finite-State Machine Transition Tour Method, Testingwith State Verification. Test Architectures-Local, distributed, Coordinated, Remote. system test design- Test Design Factors Requirement Identification, modeling a Test Design Process Test Design Preparedness, Metrics, Test Case Design Effectiveness. system test execution- Modeling Defects, Metrics for Monitoring Test Execution .Defect Reports, Defect Causal Analysis, Beta testing, measuring Test Effectiveness.

Unit IV	SOFTWARE QUALITY	9

Software quality - People's Quality Expectations, Frameworks and ISO-9126, McCall's Quality Factors and Criteria – Relationship. Quality Metrics. Quality Characteristics ISO 9000:2000 Software Quality Standard. Maturity models- Test Process Improvement ,Testing Maturity Model.

Unit V	SOFTWARE QUALITY ASSURANCE	9

Quality Assurance - Root Cause Analysis, modeling, technologies, standards and methodologies for defect prevention. Fault Tolerance and Failure Containment - Safety Assurance and Damage Control, Hazard analysis using fault-trees and event-trees. Comparing Quality Assurance Techniques and Activities. QA Monitoring and Measurement, Risk Identification for Quantifiable Quality Improvement. Case Study: FSM-Based Testing of Web-Based Applications.

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REFERENCE BOOKS

1. Software Testing And Quality Assurance-Theory and Practice, KshirasagarNakPriyadarshiTripathy, John Wiley & Sons Inc,2008
2. Software Quality Engineering: Testing, Quality Assurance, and Quantifiable Improvement, Jeff Tian, John Wiley & Sons, Inc., Hoboken, New Jersey. 2005.
3. Software Quality Assurance - From Theory to Implementation, Daniel Galin, Pearson Education Ltd UK, 2004
4. Software Quality Assurance, MilindLimaye, TMH ,New Delhi, 2011

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX19	IMAGE PROCESSING AND ANALYSIS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basics of digital images and to understand noise models
- Understand spatial domain filters and frequency domain filters
- Learn basic image analysis --- segmentation, edge detection, and corner detection
- Learn morphological operations and texture analysis and processing of color images
- Understand image compression techniques

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

- Explain image modalities, sensing, acquisition, sampling, and quantization and image noise models
- Implement spatial filter operations and frequency domain transformations
- Implement frequency domain filters and apply segmentation algorithms
- Apply edge detection techniques and apply corner and interest point detection algorithms
- Apply morphological operations and perform texture analysis
- Analyze color images and implement image compression algorithms

Unit I	SPATIAL DOMAIN PROCESSING	9

Introduction to image processing – imaging modalities – image file formats – image sensing and acquisition – image sampling and quantization – noise models – spatial filtering operations – histograms – smoothing filters – sharpening filters – fuzzy techniques for spatial filtering – spatial filters for noise removal.

Unit II	FREQUENCY DOMAIN PROCESSING	9

Frequency domain – Review of Fourier Transform (FT), Discrete Fourier Transform (DFT), and Fast Fourier Transform (FFT) – filtering in frequency domain – image smoothing – image sharpening – selective filtering – frequency domain noise filters – wavelets – Haar Transform – multiresolution expansions – wavelet transforms – wavelets based image processing

Unit III	SEGMENTATION AND EDGE DETECTION	9

Thresholding techniques – region growing methods – region splitting and merging – adaptive thresholding – threshold selection – global valley – histogram concavity – edge detection –template matching – gradient operators – circular operators – differential edge operators –hysteresis thresholding – Canny operator – Laplacian operator – active contours – object segmentation

Unit IV	INTEREST POINTS, MORPHOLOGY, AND TEXTURE	9

Corner and interest point detection – template matching – second order derivatives – median filter based detection – Harris interest point operator – corner orientation – local invariant feature detectors and descriptors – morphology – dilation and erosion – morphological operators –grayscale morphology – noise and morphology – texture – texture analysis – co-occurrence matrices – Laws' texture energy approach – Ade's eigen filter approach

Unit V	COLOR IMAGES AND IMAGE COMPRESSION	9

Color models – pseudo colors – full-color image processing – color transformations – smoothing and sharpening of color images – image segmentation based on color – noise in color images.Image Compression – redundancy in images – coding redundancy – irrelevant information in images – image compression models – basic compression methods – digital image watermarking.

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REFERENCE BOOKS

1. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012.
2. W. Burger and M. Burge, "Digital Image Processing: An Algorithmic Introduction using Java", Springer, 2008.
3. John C. Russ, "The Image Processing Handbook", Sixth Edition, CRC Press, 2011.
4. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", Third Edition, Pearson, 2008.
5. Mark Nixon and Alberto S. Aquado, "Feature Extraction & Image Processing for Computer Vision", Third Edition, Academic Press, 2012.
6. D. L. Baggio et al., "Mastering OpenCV with Practical Computer Vision Projects", Packt Publishing, 2012.
7. Jan Erik Solem, "Programming Computer Vision with Python: Tools and algorithms for analyzing images", O'Reilly Media, 2012.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX17	CLOUD COMPUTING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand cloud services and solutions
- Know about cloud virtualization technologies and cloud management
- Understand the relevance of Cloud, SOA and benchmarks
- Introduce the broad perceptive of cloud architecture and model
- Learn to design the trusted cloud Computing system

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

- Compare the strengths and limitations of cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Apply suitable virtualization concept.
- Choose the appropriate Programming Models and approach.
- Address the core issues in cloud computing such as security,privacy and interoperability and set a private cloud

Unit I	INTRODUCTION	9

Introduction - Essentials - Benefits - Business and IT Perspective - Cloud and Virtualization -Cloud Services Requirements - Cloud and Dynamic Infrastructure - Cloud Computing Characteristics - Cloud Adoption. Cloud Models - Cloud Characteristics - Measured Service - Cloud Models - Security in a Public Cloud - Public versus Private Clouds - Cloud Infrastructure Self Service.

Unit II	CLOUD SERVICES AND SOLUTIONS	9

Gamut of Cloud Solutions - Principal Technologies - Cloud Strategy - Cloud Design and Implementation using SOA - Conceptual Cloud Model - Cloud Service Defined. Cloud Solutions - Introduction - Cloud Ecosystem - Cloud Business Process Management - Cloud Service Management - Cloud Stack - Computing on Demand (CoD) – Cloudsourcing.

Unit III	CLOUD OFFERINGS AND CLOUD MANAGEMENT	9

Cloud Offerings - Information Storage, Retrieval, Archive and Protection - Cloud Analytics - Testing under Cloud - Information Security - Virtual Desktop Infrastructure - Storage Cloud.Cloud Management - Resiliency - Provisioning - Asset Management - Cloud Governance - High Availability and Disaster Recovery - Charging Models, Usage Reporting, Billing and Metering

Unit IV	CLOUD VIRTUALIZATION TECHNOLOGY	9

Virtualization Defined - Virtualization Benefits - Server Virtualization - Virtualization for x86 Architecture - Hypervisor Management Software - Logical Partitioning (LPAR) - VIO Server - Virtual Infrastructure Requirements - Storage virtualization - Storage Area Networks - Network-Attached storage - Cloud Server Virtualization - Virtualized Data Center

Unit V	CLOUD, SOA AND INFRASTRUCTURE BENCHMARKING	9

SOA and Cloud - SOA Defined - SOA and IaaS - SOA-based Cloud Infrastructure Steps - SOA Business and IT Services. OLTP Benchmark - Business Intelligence Benchmark - e-Business Benchmark - ISV Benchmarks Cloud Performance Data Collection and Performance Monitoring Commands Benchmark Tools.

REFERENCE BOOKS

1. Kumar Saurabh, "Cloud Computing: Insights into New-Era Infrastructure", Wiley India, 2011.
2. John Rhoton, "Cloud Computing Explained: Implementation Handbook for Enterprises", Recursive Press, 2013.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud (Theory in Practice)", O'Reilly, 2009

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	MaximumMarks	
		L	T	P	C			
19CSX05	INTERNET OF THINGS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand IoT Technologies, Architecture and Protocols
- Build real world application using IoT

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

- Understand the basics of Internet of Things
- Demonstrate knowledge on IoT Architecture
- Understand the various protocols used in IoT
- Develop IoT based application
- Understand the various real world applications

Unit I	INTRODUCTION TO IoT	9

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.

Unit II	IoT ARCHITECTURE	9

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture.

Unit III	IoT PROTOCOLS	9

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security.

Unit IV	BUILDING IoT WITH ARDUINO	9

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks - Other IoT Platforms - Arduino.

Unit V	REAL-WORLD APPLICATIONS	9

Real world design constraints - Applications - Asset management, Industrial automation, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

REFERENCE BOOKS

1. Arshdeep Bahga and Vijai Madisetti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3. Samuel Greengard, "The Internet of Things", The MIT press, 2015
4. Adrian McEwen and Hakim Cassimally "Designing the Internet of Things "Wiley, 2014.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX04	SOFTWARE PRODUCT DEVELOPMENT AND MANAGEMENT	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the fundamentals of product design, practical management concepts like leadership and motivation.
- Induce entrepreneurial intent as well as understand the practical issues faced by entrepreneurs.
- Practice software product management techniques in software development process.
- Induce the qualities of software product manager in the software management process.

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

- Relate software product management to better software products
- Recognize the role of a software product manager
- Reflect on how management the principles will improve software projects
- Demonstrate various software design techniques in software
- Gauge the applicability of process models for a software development project

Unit I	SOFTWARE PRODUCT	9

Terms and Characterstics–External and Internal views – Software Product as type – Attributes of software products –Elements of Software Product Management –Role of software product manager – Framework – Marketanalysis – Product analysis – Product Strategy – Product planning – development

Unit II	SOFTWARE PRICING	9

Elements of product pricing – Product Pricing in corporate structure.Product Design – Importance – Objectives – Factors influencing product design – Characteristics of a good product design

Unit III	PRODUCT DEVELOPMENT PROCESS	9

Sources of Ideas for designing new products – Stages in Product Design – Effect of Products Design on Product Cost. - Characteristics of Management – Managerial Skills – Contribution of F.W.Taylor and Henry Fayol – Industrial Ownership

Unit IV	LEADERSHIP STYLES	9

Qualities of Leadership – Morale – Motivation Theories (Maslow, Herzberg and ERG theory

Unit V	AGILITY AND QUALITY ASSURANCE	9

Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance – Test Driven Development – Agile Approach in Global Software Development.

TEXT BOOKS / REFERENCE BOOKS

1. Software Product Management and Pricing: Key Success Factors for Software Organization, Hans-Bernd
2. Kittlaus, Peter N. Clough, 2011, Springer Science & Business Media. 2 Text book of production management, ShridharaBhat.K, 1st Edition, Himalaya Publishing House,2012.
3. Industrial Engineering and Management, Khanna.O.P, 2nd Edition, DhanpatRai Publications, 2013.
4. Entrepreneurial Development, Jayshree Suresh, 5th Edition, Margham Publications,2010.
5. Entrepreneurship, Robert D. Hisrich, 6th Edition, Tata McGraw Hill Publications.,2014.
6. David J. Anderson and Eli Schragenheim, —Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, 2003.
7. Hazza and Dubinsky, —Agile Software Engineering, Series: Undergraduate Topics in Computer Science, Springer, 2009

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX11	BLOCK CHAIN TECHNOLOGY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Explain how bitcoin works, from when a transaction is created to when it is considered part of the blockchain Thoroughly explain private and public keys as well as addresses and how exactly they are constructed and used
- Expose the students to the Bitcoin Script language including developing different type of scripts using the provided API.
- Explain to students both fundamental and implied differences between Ethereum and Bitcoin protocol by covering historical, conceptual and architectural distinctions
- Provide a detailed covering of the most prominent smart contract platform Ethereum and expose students to its main programming language Solidity

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

- Understand the concept of cryptocurrency and blockchain
- Discover the secure and efficient transactions with crypto-currencies
- Experiment with cryptocurrency trading and crypto exchanges
- Develop private blockchain environment and develop a smart contract on ethereum
- Build the hyperledger architecture and the consensus mechanism applied in the Hyperledger

Unit I	CRYPTOCURRENCY AND BLOCKCHAIN-INTRODUCTION	9

Blockchain-An Introduction, Distinction between databases and blockchain, Distributed ledger. Blockchain ecosystem -Consensus Algorithms & Types, Blockchain structure,Distributed networks-Distributed Applications (DApps) –Web 3.0 -DApps Ecosystems.Working -Permissioned and permission-less Blockchain –Cross Chain Technologies. –IOT &Blockchain -Digital Disruption in Industries –Banking, Insurance, Supply Chain, Governments, IP rights, Creationof trustless Ecosystems –Block chain as a Service –Open Source Block chains

Unit II	CRYPTO CURRENCIES	9

Crypto Currencies -Anonymity and Pseudonymity in Cryptocurrencies -Digital Signatures -Cryptocurrency Hash Codes -Need for CryptoCurrencies –Crypto Markets –Explore Crypto Currency Ecosystems -ICOs –Crypto Tokens -Atomic Swaps –CryptoCurrency Exchanges –Centralised and Decentralized Crypto exchanges – Regulations on Crypto Currencies & exchanges –Downside of non-regulated currencies –crypto Scams – Exchange hacks

Unit III	BITCOIN	9

Bitcoin –history-Bitcoin-usage, storage, selling, transactions, working-Invalid Transactions-Parameters that invalidate the transactions-Scripting language in Bitcoin-Applications of Bitcoin script-Nodes and network of Bitcoin-Bitcoin ecosystem

Unit IV	ETHEREUM	9

The Ethereum ecosystem, DApps and DAOs -Ethereum working-Solidity-Contract classes, functions, and conditionals-Inheritance & abstract contracts-Libraries-Types & optimization of Ether-Global variables-Debugging-Future of Ethereum-Smart Contracts on Ethereum-different stages of a contract deployment-Viewing Information about blocks in Blockchain-Developing smart contract on private Blockchain-Deploying contract from web and console

Unit V	HYPERLEDGER	9

Hyperledger Architecture-Consensus-Consensus & its interaction with architectural layers-Application programming interface-Application model -Hyperledger frameworks-Hyperledger Fabric -Various ways to create Hyperledger Fabric Blockchain network-Creating and Deploying a business network on Hyperledger Composer Playground-Testing the business network definition-Transferring the commodity between the participants

REFERENCE BOOKS

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas M Antonopoulos 20182.
2. Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations-2016

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX14	RECONFIGURABLE COMPUTING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the need for reconfigurable computing
- Expose the students to various device architectures and to examine the various reconfigurable computing systems
- Understand the different types of computer models for programming reconfigurable architectures
- Expose the students to HDL programming and familiarize with the development environment
- Expose the students to the various placement and routing protocols and to develop applications with FPGAs

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

- Identify the need for reconfigurable architectures
- Discuss the architecture of FPGAs
- Point out the salient features of different reconfigurable architectures
- Develop applications using any HDL and appropriate tools
- Design and build an SoPC for a particular application

Unit I	DEVICE ARCHITECTURE	9

General Purpose Computing Vs Reconfigurable Computing – Simple Programmable Logic Devices – Complex Programmable Logic Devices – FPGAs – Device Architecture - Case Studies

Unit II	RECONFIGURABLE COMPUTING ARCHITECTURES AND SYSTEMS	9

Reconfigurable Processing Fabric Architectures – RPF Integration into Traditional Computing Systems – Reconfigurable Computing Systems – Case Studies – Reconfiguration Management.

Unit III	BITCOIN	9

Compute Models - Programming FPGA Applications in HDL – Compiling C for Spatial Computing – Operating System Support for Reconfigurable Computing.

Unit IV	MAPPING DESIGNS TO RECONFIGURABLE PLATFORMS	9

The Design Flow - Technology Mapping – FPGA Placement and Routing – Configuration Bitstream Generation – Case Studies with Appropriate Tools.

Unit V	APPLICATION DEVELOPMENT WITH FPGAS	9

Case Studies of FPGA Applications – System on a Programmable Chip (SoPC) Designs.

REFERENCE BOOKS

1. Maya B. Gokhale and Paul S. Graham, "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays", Springer, 2005.
2. Scott Hauck and Andre Dehon (Eds.), "Reconfigurable Computing – The Theory and Practice of FPGA-Based Computation", Elsevier / Morgan Kaufmann, 2008.
3. Christophe Bobda, "Introduction to Reconfigurable Computing – Architectures, Algorithms and Applications", Springer, 2010.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX13	GREEN COMPUTING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Acquire knowledge to adopt green computing practices to minimize negative impacts on the environment
- Infuse skill in energy saving practices in their use of hardware, examine technology tools that can reduce paper waste and carbon footprint by user.
- Understand how to minimize equipment disposal requirements

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

- **Understand the basis of green computing**
- Demonstrate the benefits and policies of energy efficient computing.
- Able to understand the grid frame work for grren computing
- Understand the change in processes and products to make them green safe and economically acceptable.
- Apply the strategies of going Green for energy aware applications [AP] CO4 Devise energy efficient computing application

Unit I	FUNDAMENTALS	9

Green IT Fundamentals: Business, IT, and the Environment – Green computing: carbon foot print, scoop on power – Green IT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics

Unit II	GREEN ASSETS AND MODELING	9

Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration – Green Enterprise Architecture – Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models.

Unit III	GRID FRAMEWORK	9

Virtualizing of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework.

Unit IV	GREEN COMPLIANCE	9

Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies an Future.

Unit V	CASE STUDIES	9

The Environmentally Responsible Business Strategies (ERBS) – Case Study Scenarios for Trial Runs – Case Studies – Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector.

REFERENCE BOOKS

1. BhuvanUnhelkar, "Green IT Strategies and Applications-Using Environmental Intelligence", CRC Press, June 2016.
2. Woody Leonhard, Katherrine Murray, "Green Home computing for dummies", August 2009
3. Alin Gales, Michael Schaefer, Mike Ebbers, "Green Data Center: steps for the Journey", Shoff/IBM rebook, 2011.
4. John Lamb, "The Greening of IT", Pearson Education, 2009.
5. Jason Harris, "Green Computing and Green IT- Best Practices on regulations & industry", Lulu.com, 2008.
6. Carl speshocky, "Empowering Green Initiatives with IT", John Wiley & Sons, 2010. Wu Chun Feng (editor), "Green computing: Large Scale energy efficiency", CRC Press, 2012.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSY06	NATURAL LANGUAGE UNDERSTANDING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Learn basics of Speech technology, parsing
- Understand the semantic analysis of speech
- Study the machine translation principles
- Recognize the speech pattern

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

- To tag a given text with basic Language features
- To learn phonology methods for computations.
- To implement a system to recognize language
- To design a tag for parsing the given text of a language
- To compare and contrast different translation methods for language processing.

Unit I	INTRODUCTION	9

Regular Expressions and Finite State Automata – Morphology and Finite State Transducers

Unit II	COMPUTATIONAL PHONOLOGY	9

Computational Phonology and Text to speech - N-grams: Counting words in Corpora – Simple N- grams – Smoothing – Entropy

Unit III	HMMS AND SPEECH RECOGNITION	9

HMMS and Speech Recognition: Speech Recognition Architecture – Overview of HMM – Advanced Methods for decoding – Training a speech Recognizer – Human Speech Recognition - Part of Speech Tagging: Rule Based, Stochastic Part-of-Speech Tagging – Transformation Based Tagging-Context Free Grammars for English – Context Free Rules and Trees – Sentence Level Constructions- Coordination – Agreement – Grammars and Human Processing

Unit IV	PARSING	9

Parsing with Context Free Grammars – Top down Parser – Problems with Basic Top Down Parser – Finite State Parsing Methods - Representing Meaning: Computational Desiderata for Representations – Meaning Structure of Language – First Order Predicate Calculus- Semantic Analysis: Syntax driven Semantic Analysis – Attached for a Fragment of English- Integrating Semantic Analysis into the Earley Parser, Robust Semantic Analysis

Unit V	MACHINE TRANSLATION	9

Dialogue and Machine Translation - Dialogue Acts – Automatic, Plan inferential, Cue based Interpretation of Dialogue Acts – Dialogue Structure and coherences – Dialogue Managers - Language Similarities and differences – The Transfer Metaphor – The Interlingua Idea- Direct Translation – Using Statistical Techniques – Usability and System Development

REFERENCE BOOKS

1. D. Jurafsky and J. Martin , "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2004
2. C. Manning and H. Schutze , "Foundations of Statistical Natural Language Processing", Massachusetts Institute of Technology, 2003.
3. James Allen "Natural Language Understanding" ,The Benajmins/Cummings Publishing Company Inc. 1994.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX18	XML AND WEB SERVICES	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Provide an in-depth knowledge of XML and Web Services.
- Gain knowledge about SOAP, UDDI and XML to create Web Services.
- Design Web service Architecture.
- Study Building Blocks of Web services.
- Understand XML security issues.
- Develop and deploy Web Service Applications.

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

- Understand the fundamental elements in Web Technology and XML services.
- Understand Web Services and its Infrastructure.
- Building a Web Service.
- Deploying and Publishing Web Services.

Unit I	INTRODUCTION TO XML TECHNOLOGY	9

XML – benefits – Advantages of XML over HTML – EDL –Databases – XML based standards – DTD – XML Schemas – X- Files – XML processing – DOM –SAX.

Unit II	PRESENTATION TECHNOLOGIES	9

Presentation technologies – XSL – XFORMS – XHTML – voice XML – Transformation – XSLT – XLINK – XPATH –XQ

Unit III	WEB SERVICES BUILDING BLOCK	9

Transport protocols for web services – messaging with web services – protocols – SOAP – describing web services – WSDL – Anatomy of WSDL – manipulating WSDL – web service policy – Discovering web services – UDDI – Anatomy of UDDI- Web service inspection – Ad-Hoc Discovery – Securing web services.

Unit IV	IMPLEMENTING XML IN E-BUSINESS	9

B2B - B2C Applications – Different types of B2B interaction – Components of e-business XML systems – ebXML – Rosetta Net Applied XML in vertical industry – Web services for mobile devices.

Unit V	DEPLOY WEBSERVICES USING .NET/JAVA	9

Develop and Deploy Web Services – Global Weather Forecast - Current weather and weather conditions for major cities around the world. Translate Service - Convert text from one language to another language. ISBN Information Retrieval - Book Information web services by ISBN. Country Details - Get Currency, Currency code,International Dialing code, ISO country code for all countries.

REFERENCE BOOKS

1. Ron schmelzer et al, "XML and Web Services", Pearson Education, 2002.
2. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services: An Architect's Guide", Prentice Hall, 2004.
3. Frank P. Coyle, "XML, Web Services and the Data Revolution", Pearson Education, 2002.
4. Keith Ballinger, ".NET Web Services Architecture and Implementation", Pearson Education,2003.
5. Henry Bequet and MeerajKunnumpurath, "Beginning Java Web Services", Apress, 2004.
6. Russ Basiura and Mike Batongbacal, "Professional ASP.NET Web Services", Apress,2.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX01	SOFTWARE PROJECT MANAGEMENT	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the Software Project Planning and Evaluation techniques.
- Plan and cost at each stage of the software development life cycle (SDLC).
- Learn about the activity planning and quality management.
- Manage software projects and software metrics.
- Develop skills to manage the various phases involved in project management and people management.

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

- Understand Software Project Models and Software Management Concepts.
- Apply thevarious methods of Cost Estimation
- Study about Software Quality Management.
- Study about Software Metrics.
- Apply the project Evaluation methods.

Unit I	PROJECT CONCEPTS AND ITS MANAGEMENT	9

Project life cycle models-ISO 9001 model-Capability Maturity Model-Project Planning-Project tracking-Project closure. Evolution of Software Economics –Software Management Process Framework: Phases, Artifacts, Workflows, Checkpoints –Software Management Disciplines: Planning / Project Organization and Responsibilities / Automation / Project Control –Modern Project Profiles.

Unit II	COST ESTIMATION	9

Problems in Software Estimation –Algorithmic Cost Estimation Process, Function Points, SLIM (Software Life cycle Management), COCOMO II (Constructive Cost Model) –Estimating Web Application Development – Concepts of Finance, Activity Based Costing and Economic Value Added (EVA) –Balanced Score Card.

Unit III	SOFTWARE QUALITY MANAGEMENT	9

Software Quality Factors –Software Quality Components –Software Quality Plan –Software Quality Metrics – Software Quality Costs –Software Quality Assurance Standard –Certification –Assessment.

Unit IV	SOFTWARE MANAGEMENT AND METRICS	9

Software Configuration Management –Risk Management: Risk Assessment: Identification / Analysis / Prioritization –Risk Control: Planning / Resolution / Monitoring –Failure Mode and Effects Analysis (FMEA) – Defect Management –Cost Management.Software Metrics –Classification of Software Metrics: Product Metrics: Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality Metrics, and Process metrics.

Unit V	PROJECT EVALUATION AND EMERGING TRENDS	9

Strategic Assessment–Technical Assessment–Cost Benefit Analysis–Cash Flow Forecasting–Cost Benefit Evaluation Technique–Risk Evaluation–Software Effort Estimation. Emerging Trends: Import of the internet on project Management –people Focused Process Models.

REFERENCE BOOKS

1. Ramesh Gopalaswamy , "Managing and global Software Projects", Tata McGraw Hill Tenth Reprint, 2011
2. Roger S.Pressman, "Software Engineering-A Practitioner's Approach", 7th Edition ,McGraw Hill, 2018
3. Daniel Galin, "Software Quality Assurance: from Theory to Implementation", Pearson Addison-Wesley, 2008.
4. Bob hughes and Mike Cotterell, "Software Project Management" 5thedition,2018
5. Royce, W. "Software Project Management: A Unified Framework", AddisonWesley,6thprint2000.

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX21	BIO INFORMATICS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Get exposed to the domain of bioinformatics
- Understand the role of data warehousing and data mining for bioinformatics
- Learn to model bioinformatics based applications
- Understand how to deploy the pattern matching and visualization techniques in bioinformatics
- Study the Microarray technologies for genome expression

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

- Deploy the data warehousing and data mining techniques in Bioinformatics
- Model bioinformatics based applications
- Deploy the pattern matching and visualization techniques in bioinformatics
- Work on the protein sequences
- Use the Microarray technologies for genome expression

Unit I	INTRODUCTION	9

Need for Bioinformatics technologies – Overview of Bioinformatics technologies – Structural bioinformatics – Data format and processing – secondary resources- Applications – Role of Structural bioinformatics - Biological Data Integration System

Unit II	DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS	9

Bioinformatics data – Data ware housing architecture – data quality – Biomedical data analysis –DNA data analysis – Protein data analysis – Machine learning – Neural network architecture Applications in bioinformatics

Unit III	MODELING FOR BIOINFORMATICS	9

Hidden markov modeling for biological data analysis – Sequence identification – Sequence classification – multiple alignment generation – Comparative modeling – Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks – Molecular modeling – Computer programs for molecular modeling.

Unit IV	PATTERN MATCHING AND VISUALIZATION	9

Gene regulation – motif recognition and motif detection – strategies for motif detection – Visualization – Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension – Game representation of Biological sequences – DNA, Protein, Amino acid sequences

Unit V	MICROARRAY ANALYSIS	9

Microarray technology for genome expression study – image analysis for data extraction – preprocessing – segmentation – gridding , spot extraction , normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model ,Benchmark , Tradeoffs.

REFERENCE BOOKS

1. Yi-Ping Phoebe Chen (Ed), "Bio Informatics Technologies", First Indian Reprint, Springer Verlag, 2007.
2. N.J. Chikhale and VirendraGomase, "Bioinformatics- Theory and Practice", Himalaya Publication House, India, 2007
3. Zoe lacroix and Terence Critchlow, "Bio Informatics – Managing Scientific data", First Indian Reprint, Elsevier, 2004
4. Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2003.
5. Arthur M Lesk, "Introduction to Bioinformatics", Second Edition, Oxford University Press, 2005
6. Burton. E. Tropp, "Molecular Biology: Genes to Proteins ", 4th edition, Jones and Bartlett Publishers, 2011
7. Dan Gusfield, "Algorithms on Strings Trees and Sequences", Cambridge University Press, 1997.
8. P. Baldi, S Brunak , Bioinformatics, "A Machine Learning Approach ", MIT Press, 1998

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Department	COMPUTER SCIENCE AND ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19CSX22	INFORMATION STORAGE MANAGEMENT	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the storage architecture and available technologies.
- Learn about the storage systems
- Learn to establish & manage datacenter.
- Learn security aspects of storage & data center
- Understand data virtualization

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

- Select from various storage technologies to suit for required application.
- Apply security measures to safeguard storage & farm.
- Able to connect storage systems
- AnalysisQoS on Storage.
- Able to identify the threads to the storage

Unit I	INTRODUCTION TO STORAGE TECHNOLOGY	9

Review data creation and the amount of data being created and understand the value of data to a business, challenges in data storage and data management, Solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities

Unit II	STORAGE SYSTEMS ARCHITECTURE	9

Hardware and software components of the host environment, Key protocols and concepts used by each component ,Physical and logical components of a connectivity environment ,Major physical components of a diskdrive and their function, logical constructs of a physical disk, access characteristics, and performance Implications, Concept of RAID and its components, Different RAID levels and their suitability for different application environments: RAID 0, RAID 1, RAID 3, RAID 4, RAID 5, RAID 0+1, RAID 1+0, RAID 6, Compare and contrast integrated and modular storage systems ,High-level architecture and working of intelligent storage system.

Unit III	INTRODUCTION TO NETWORKED STORAGE	9

Evolution of networked storage, Architecture, components, and topologies of FC-SAN, NAS, and IP-SAN, Benefits of the different networked storage options, understand the need for long-term archiving solutions and describe how CAS full fill the need, understand the appropriateness of the different networked storage options for different application environments.

Unit IV	INFORMATION AVAILABILITY, MONITORING & MANAGING DATA CENTER	9

List reasons for planned/unplanned outages and the impact of downtime, Impact of downtime - Differentiate between business continuity (BC) and disaster recovery (DR) ,RTO and RPO, Identify single points of failure in a storage infrastructure and list solutions to mitigate these failures, Architecture of backup/recovery and thedifferent backup/ recovery topologies, replication technologies and their role in ensuring information availability and business continuity, Remote replication technologies and their role in providing disaster recovery and business continuity capabilities. Identify key areas to monitor in a data center, Industry standards for data center monitoring and management, Key metrics to monitor for different components in a storage infrastructure, Key management tasks in a data center.

Unit V	SECURING STORAGE AND STORAGE VIRTUALIZATION	9

Information security, Critical security attributes for information systems, Storage security domains, List and analyzes the common threats in each domain, Virtualization technologies, block-level and file-level virtualization technologies and processes

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REFERENCE BOOKS

1. EMC Corporation, Information Storage and Management, Wiley, India.
2. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill , Osborne, 2003.
3. Marc Farley, "Building Storage Networks", Tata McGraw Hill ,Osborne, 2001.
4. Additional resource material on www.emc.com/resource-library/resource-library.esp

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