**SCHEME OF INSTRUCTION**
**M.TECH (COMPUTER SCIENCE AND ENGINEERING)**
**Proposed from the Academic year 2019-20**
**SEMESTER - I**

| S.No | Course Code | Course Title | Scheme of Instruction | | Contact Hrs/Wk | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | L/T | P | | CIE | SEE | |
| 1. | CS 101 | Program Core I- Mathematical foundations of Computer Science | 3 | -- | 3 | 30 | 70 | 3 |
| 2. | CS 102 | Program Core II-Advanced Data Structures | 3 | -- | 3 | 30 | 70 | 3 |
| 3. | CS 121 | Program Elective I- Cloud Computing | 3 | -- | 3 | 30 | 70 | 3 |
| 4. | CS 125 | Program Elective II- Image Processing | 3 | -- | 3 | 30 | 70 | 3 |
| 5. | CS 100 | Research Methodology in Computer Science | 3 | -- | 3 | 30 | 70 | 3 |
| 6. | AC 101 | Audit Course I | 2 | -- | 2 | 30 | 70 | 0 |
| | | | | | | | | |
| 7. | CS 151 | Laboratory I (Advanced Data Structures Lab) | -- | 3 | 3 | 50 | - | 1.5 |
| 8. | CS 152 | Laboratory II (Cloud Computing Lab) | -- | 3 | 3 | 50 | - | 1.5 |
| **Total** | | | **17** | **6** | **23** | **280** | **420** | **18** |

**SEMESTER - II**

| S.No | Course Code | Course Title | Scheme of Instruction | | Contact Hrs/Wk | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | L/T | P | | CIE | SEE | |
| 1. | CS 103 | Program Core III- Advanced Algorithms | 3 | -- | 3 | 30 | 70 | 3 |
| 2. | CS 104 | Program Core IV- Artificial Intelligence | 3 | -- | 3 | 30 | 70 | 3 |
| 3. | Elective III | Elective III | 3 | -- | 3 | 30 | 70 | 3 |
| 4. | Elective IV | Elective IV | 3 | -- | 3 | 30 | 70 | 3 |
| 5. | AC 107 | Audit Course II | 2 | -- | 2 | 30 | 70 | 0 |
| 6. | CS 171 | Mini Project with Seminar | | 6 | 6 | 50 * | - | 3 |
| | | | | | | | | |
| 7. | CS 153 | Laboratory III - Advanced Algorithms Lab | -- | 3 | 3 | 50 | - | 1.5 |
| 8. | CS 154 | Laboratory IV | -- | 3 | 3 | 50 | - | 1.5 |
| **Total** | | | **14** | **12** | **26** | **300** | **350** | **18** |

***Mini Project with Seminar Evaluation:** 25 marks to be awarded by Supervisor and 25 marks to be awarded by Viva-Voce committee comprising Head, Supervisor and an Examiner.*

L: Lecture T: Tutorial P: Practical
CIE: Continuous Internal Evaluation SEE: Semester End Examination

**SCHEME OF INSTRUCTION**
**M.TECH (COMPUTER SCIENCE AND ENGINEERING)**
**Proposed from the Academic year 2019-20**

## SEMESTER III

| S.No | Course Code | Course Title | Scheme of Instruction | | Contact Hrs/Wk | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | L/T | P | | CIE | SEE | |
| 1. | Elective V | Elective V | 3 | - | 3 | 30 | 70 | 3 |
| 2. | Open Elective | Open Elective | 3 | - | 3 | 30 | 70 | 3 |
| 3. | CS 181 | Major Project Phase I | -- | 20 | 20 | 100 ** | | 10 |
| | | **Total** | **6** | **20** | **26** | **160** | **140** | **16** |

** ***Major Project Phase I Evaluation:*** *50 marks to be awarded by Supervisor and 50 marks to be awarded by Viva-Voce committee comprising Head, Supervisor and an Examiner.*

**SEMESTER – IV**

| S.No | Course Code | Course Title | Scheme of Instruction | | Contact Hrs/Wk | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | L/T | P | | CIE | SEE | |
| 1. | CS 182 | Major Project Phase II | -- | 32 | 32 | --- | 200 | 16 |
| | | **Total** | **--** | **32** | **32** | **---** | **200** | **16** |

**Audit course 1 & 2**

AC 101 : English for Research Paper Writing
AC 102 : Disaster Management
AC 103 : Sanskrit for Technical Knowledge
AC 104: Value Education
AC 105: Constitution of India
AC 106 : Pedagogy Studies
AC 107 : Stress Management by Yoga
AC 108: Personality Development through Life Enlightenment Skills.

**Open Elective**

CS 901 : Business Analytics

CS 902 : Industrial Safety

CS 903 : Operations Research

CS 904 : Cost Management of Engineering Projects

CS 905 : Composite Materials

CS 906 : Waste to Energy

**List of Core Subjects:**

| S.No | Course Code | Course Title |
|---|---|---|
| 1 | CS 101 | Mathematical Foundation of Computer Science |
| 2 | CS 102 | Advanced Data Structures |
| 3 | CS 103 | Advanced Algorithms |
| 4 | CS 104 | Artificial Intelligence |

**Mandatory Course :**

| S.No | Course Code | Course Title |
|---|---|---|
| 1 | CS 100 | Research Methodology in Computer Science |

**List of Labs:**

| S.No | Course Code | Course Title |
|---|---|---|
| 1 | CS 151 | Advanced Data Structures Lab |
| 2 | CS 152 | Cloud Computing Lab |
| 3 | CS 153 | Advanced Algorithms Lab |
| 4 | CS 154 | Laboratory IV |

**List of Elective Subjects:**

| S.No | Course Code | Course Title |
|---|---|---|
| 1 | CS 111 | Mobile Computing |
| 2 | CS 112 | Real Time Systems |
| 3 | CS 113 | Web Engineering |
| 4 | CS 114 | Multimedia Technologies |
| 5 | CS 115 | Data Mining |
| 6 | CS 116 | Network Security |
| 7 | CS 117 | Machine Learning |
| 8 | CS 118 | Information Retrieval System |
| 9 | CS 119 | Natural Language processing |
| 10 | CS 120 | Software Quality and Testing |
| 11 | CS 121 | Cloud Computing |
| 12 | CS 122 | Soft Computing |
| 13 | CS 123 | Artificial Neural Networks |
| 14 | CS 124 | Software Project Management |
| 15 | CS 125 | Image Processing |
| 16 | CS 126 | Software Reuse Techniques |
| 17 | CS 127 | Reliability and Fault Tolerance |
| 18 | CS 128 | Web Mining |
| 19 | CS 129 | Human Computer Interaction |
| 20 | CS 130 | Advanced Computer Graphics |
| 21 | CS 131 | Software Engineering for RTS |
| 22 | CS 132 | Simulation and Modelling |
| 23 | CS 133 | Advanced Operating Systems |
| 24 | CS 134 | Object Oriented Software Engineering |
| 25 | CS 135 | Distributed Computing |

| | | |
|---|---|---|
| 26 | CS 136 | Advanced Databases |
| 27 | CS 211 | Parallel Algorithms |
| 28 | CS 212 | Grid Computing |
| 29 | CS 213 | Real Time Operating Systems |
| 30 | CS 214 | Scripting Languages For Design Automation |
| 31 | CS 215 | Storage Management |
| 32 | CS 216 | Performance Evaluation of Computing |
| 33 | CS 217 | Parallel and Distributed Databases |
| 34 | CS 201 | Parallel Computer Architecture |
| 35 | CS 202 | Parallel Programming |
| 36 | CS 301 | Embedded System Design |
| 37 | CS 302 | Hardware and Software Co-design |

**CS 101** **Mathematical foundations of Computer Science**

*Credits: 3*

*Instruction: (3L) hrs per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*

**COURSE OBJECTIVE:**

- To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
- To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
- To study various sampling and classification problems.

**COURSE OUTCOMES :**

At the end of the Course, Student would be :

- Able to apply the understanding of probability and distribution functions to solve various applications of Computer science .
- Able to solve sampling and classification problems
- Able to Infer and apply the various statistical models with suitable assessment based on various samples relevant in Computer Science
- Able to use Concepts of Graph theory and Solve combinatorial enumeration problems
- Able to create solutions by applying the mathematical techniques for solving engineering applications in computer science

**Unit 1**

Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains.

**Unit 2**

Random samples, sampling distributions of estimators**,** Methods of Moments and Maximum Likelihood**.**

**Unit 3**

Statistical inference**,** Introduction to multivariate statistical models: regression and classification problems, principal components analysis**,** The problem of over fitting model assessment.

**Unit 4**

Graph Theory: Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems.

**Unit 5**

**Computer science and engineering applications**

Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

Recent trends in various distribution functions in mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision.

**References**

1. John Vince, Foundation Mathematics for Computer Science, Springer.

2. K. Trivedi.Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.

3. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.

4. Alan Tucker, Applied Combinatorics, Wiley

**CS 102** # Advanced Data Structures

*Credits: 3*

*Instruction: (3L) hrs per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*

**COURSE OBJECTIVE:**

- The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
- Students should be able to understand the necessary mathematical abstraction to solve problems.
- To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
- Student should be able to come up with analysis of efficiency and proofs of correctness.

**COURSE OUTCOMES :**

After completion of course, students would be able to:

- Understand the implementation of symbol table using hashing techniques.
- Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
- Develop algorithms for text processing applications.
- Identify suitable data structures and develop algorithms for computational geometry problems.

**Unit 1**

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

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

**Unit 2**

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

**Unit 3**

**Trees:** Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees

**Unit 4**

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

**Unit 5**

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

Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem

**References:**

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

**CS 103** **ADVANCED ALGORITHMS**

*Credits: 3*

*Instruction: (3L) hrs per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*

**COURSE OBJECTIVE**

- Introduce students to the advanced methods of designing and analyzing algorithms.
- The student should be able to choose appropriate algorithms and use it for a specific problem.
- To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
- Students should be able to understand different classes of problems concerning their computation difficulties.
- To introduce the students to recent developments in the area of algorithmic design.

**COURSE OUTCOMES**

- After completion of course, students would be able to:
- Analyze the complexity/performance of different algorithms.
- Determine the appropriate data structure for solving a particular set of problems.
- Categorize the different problems in various classes according to their complexity.
- Students should have an insight of recent activities in the field of the advanced data structure.

**Unit1**

Sorting: Review of various sorting algorithms, topological sorting,

Graph: Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

**Unit 2**

Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.

Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

**Unit 3**

Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm.

Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

**Unit 4**

Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming.

Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.

Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm

**Unit 5**

Linear Programming: Geometry of the feasibility region and Simplex algorithm

NP-completeness: Examples, proof of NP-hardness and NP-completeness.

Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm. Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures

**Suggested Reading:**

1. "Introduction to Algorithms" byCormen, Leiserson, Rivest, Stein, 4th edition, McGraw Hill,
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3. "Algorithm Design" by Kleinberg and Tardos.

**CS 104** **ARTIFICIAL INTELLIGENCE**

*Credits: 3*

*Instruction: (3L) hrs per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*

**UNIT - 1**

**Introduction:** History Intelligent Systems, Foundations of Artificial Intelligence, Sub areas of Al, Applications.

**Problem Solving - State - Space Search and Control Strategies:** Introduction, General Problem Solving Characteristics of problem, Exhaustive Searches, Heuristic Search Techniques, Iterative - Deepening A*, Constraint Satisfaction.

Game Playing, Bounded Look - ahead Strategy and use of Evaluation Functions, Alpha Beta Pruning.

**UNIT – II**

**Logic Concepts and Logic Programming:** Introduction, Propositional Calculus Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Table, A System in Propositional Logic, Resolution, Refutation in Propositional Logic, Predicate Logic, Logic Programming.

**Knowledge Representation:** Introduction, Approaches to knowledge Representation, Knowledge Representation using Semantic Network, Extended Semantic Networks for KR, Knowledge Representation using Frames.

**UNIT - III**

**Expert System and Applications:** Introduction, Phases in Building Expert Systems Expert System Architecture, Expert Systems Vs Traditional Systems, Truth Maintenance Systems, Application of Expert Systems, List of Shells and tools.

**Uncertainity Measure - Probability Theory:** Introduction, Probability Theory, Bayesian Belief Networks, Certainity Factor Theory, Dempster - Shafer Theory.

**UNIT - IV**

**Machine - Learning Paradigms:** Introduction, Machine learning System, Supervised and Unsupervised Learning, Inductive Learning, Learning Decision Trees, Deductive Learning, Clustering, Support Vector Machines.

**Artificial Neural Networks:** Introduction Artificial Neural Networks, Single - Layer Feed Forward Networks, Multi - Layer Feed Forward Networks, Radial - Basis Function Networks, Design Issues of Artificial Neural Networks, Recurrent Networks

**UNIT - V**

**Advanced Knowledge Representation Techniques:** Case Grammars, Semantic Web.

**Natural Language Processing:** Introduction, Sentence Analysis Phases, Grammars and Parsers, Types of Parsers, Semantic Analysis, Universal Networking Knowledge.

**Suggested Reading:**

1. Saroj Kaushik, *Artificial Intelligence*, Cengage Learning India, First Edition, 2011.
2. Russell, Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education, 2nd Edition, 2004.
3. Rich, Knight, Nair , *Artificial Intelligence*, Tata McGraw Hill, 3rd Edition 2009.

**CS 100** **Research Methodology In Computer Science**

*Credits: 3*

*Instruction: (3L) hrs per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*

**Objectives:**
The main aim is to enable the students
1. To understand the research process
2. To solve unfamiliar problems using scientific procedures
3. To pursue ethical research
4. To use appropriate tools for documentation and analysis of data

**Course Outcomes:**
At the end of this course, students will be able to
- understand research problem formulation
- design experiments
- analyze research related information
- write papers and thesis
- follow research ethics
- use tools for analysis and thesis writing

**UNIT-I**

**Research Process:** Meaning of Research, Objectives and Motivation of Research, Technological Innovation, Types of Research, Research Vs Scientific method, Research Methodology vs Research Methods, Research process.

**Research Problem Formulation:** Problem solving in Engineering, Identification of Research Topic, Problem Definition, Literature Survey, Literature Review.

**Research Design:** Research Design: What it is?, Why we need Research Design? Terminology and Basic Concepts, Different Research Designs, Experimental Designs, Important Experimental Designs, Design of Experimental Setup, Use of Standards and Codes.

**UNIT-II**

**Mathematical Modeling:** Models in General, Mathematical Model, Model Classification, Modeling of Engineering Systems.

**Probability and Distributions:** Importance of Statistics to Researchers, Probability Concepts, Probability Distributions, Popular Probability Distributions, Sampling Distributions.

**Sample Design And Sampling:** Sample design, Types of sample designs, The Standard Error, Sample Size for Experiments, Prior Determination Approach, Use of Automatic Stopping Rule.

**Hypothesis Testing And ANOVA:** Formulation of Hypothesis, Testing of Hypothesis, Analysis of Variance.

**UNIT-III**

**Design of Experiments and Regression Analysis:** Design of Experiments, Planning of Experiments, Multivariate Analysis, Simple Regression and Correlation, Multiple Regression and Correlation

**Analysis and Interpretation of Data:** Introduction, Data Checking, Data Analysis, Interpretation of Results, Guidelines in Interpretations.

**Accuracy, Precision and Error Analysis:** Introduction, Repeatability and Reproducibility, Error Definition and Classification, Analysis of Errors, Statistical Analysis of Errors, Identification of Limitations

**UNIT-IV**

**Writing of Papers and Synopsis:** Introduction, Audience Analysis,, Preparing Papers for Journals, Preparation of Synopsis of Research Work

**Thesis Writing Mechanics:** Introduction, Audience for Thesis Report, Steps in Writing the report, Mechanics of Writing, Presentation of graphs, figures and tables.

**Structure of Thesis Report:** Suggested Framework of the Report, Preliminary Pages, Main Body of Thesis, Summary, Appendices, References, Glossary.

**UNIT-V :**

**Ethics in Research:** Importance of Ethics in Research, Integrity in Research, Scientific Misconduct and Consequences.

**Spreadsheet tool**: Introduction, Quantitative Data Analysis Tools, Entering and preparing your data, Using statistical functions, Loading and using Data Analysis Tool Pack *[Tools: Microsoft Excel / Open office]*

**Thesis writing & Scientific editing tool**. [Tool: Latex]: Introduction, Document Structure, Typesetting Text, Tables, Figures, Equations, Inserting References

**Suggested Reading:**

1. R.Ganesan; Research Methodology for Engineers; MJP Publishers; Chennai, 2011.
2. Paul R Cohen. Empirical Methods in AI. PHI, New Delhi, 2004
3. C.R.Kothari, Research Methodology, Methods & Technique; New age International Publishers, 2004
4. Kumar, Ranjit. Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, Pearson Education, 2005
5. https://arxiv.org/pdf/physics/0601009.pdf
6. https://pdfs.semanticscholar.org/e1fa/ec8846289113fdeb840ff3f32d102e46fbff.pdf
7. LaTEX for Beginners, Workbook, Edition 5, March 2014.
8. Chapter 13, An introduction to using Microsoft Excel for quantitative data analysis: Management Research: Applying the Principles © 2015 Susan Rose, Nigel Spinks & Ana Isabel Canhoto.

**CS 151** Advanced Data Structures lab

*Credits: 1.5*

*Instruction**:** 3 hrs per week* *CIE**:** 50 marks*

1. Write a program that implements stack and Queue operations using
    a. Arrays
    b. linked list
2. Write a program to perform the following operations on singly linked list and doubly linked list
    a. Creation
    b. Insertion
    c. Deletion
    d. Traversal.
3. Implement recursive and non recursive i) Linear search ii) Binary search
4. Study and Implementation of Different sorting algorithms and Find Time and Space complexities.
5. Implement Recursive functions to traverse the given binary tree in
    a. Preorder
    b. Inorder
    c. Postorder
6. Study and Implementation of different operations on
    a. Binary Search Tree
    b. AVL tree
    c. Red Black Tree
7. perform the following operations
    a. Insertion into a B-tree
    b. Deletion from a B-tree
8. Implement Different Collision Resolution Techniques.
9. Study and Implementation of Following String Matching algorithms:
    a. Rabin-Karp algorithm
    b. Knuth-Morris-Pratt algorithm
    c. Boyer-Moore algorithm
10. **Implement the following using java:**
    1. Single Source Shortest Path algorithms
    2. All pairs shortest path algorithms
    3. Minimal Spanning Tree algorithms
    4. String and Pattern matching algorithms
    5. Maximum Flow/ Minimum cut algorithms

**Note :** The students have to submit a report at the end of the semester.

## CS 152 Cloud Computing Lab

*Credits: 1.5*

*Instruction: 3 hrs per week* *CIE: 50 marks*

1) Study and implementation of Infrastructure as a Service.
2) Installation of ESXI 6.5 by using Virtual Machine.
3) Create a Virtual Machine with different platforms.
4) Installation of VCenter appliance.
5) Study and Implementation of different VCenter Features(Cloning, Template, Migration ,Snapshot etc).
6) Study and Creation of a Cluster (Multiple Hosts).
7) Case Study : SAAS(Application service).
8) Case Study: AWS, Microsoft Azure.

**CS 111**

## MOBILE COMPUTING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction:** Wireless Transmission, Frequencies for Radio Transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulations, Spread Spectrum, MAC, SOMA, FDMA, TDMA, CDMA, Cellular Wireless Networks.

**UNIT-II**

**Telecommunication Systems:** GSM, GPRS, Satellite Networks, Basics, Parameters and Configurations, Capacity Allocation, FAMA and DAMA, Broadcast Systems, DAB, DVB, CDMA and 3G.

**UNIT-III**

**Wireless LAN:** IEEE 802.11 Architecture, Services, MAC – Physical Layer, IEEE 802.11a – 802.11b standards, Bluetooth.

**UNIT-IV**

**Routing Ad-hoc Network Routing Protocols:** Ad-hoc Network Routing Protocols, Destination Sequenced Distance Vector Algorithm, Cluster Based Gateway Switch Routing, Global State Routing, Fish-eye state Routing, Dynamic Source Routing, Ad-hoc on-demand Routing, Location Aided Routing, Zonal Routing Algorithm.

**Mobile IP -** Dynamic Host Configuration Protocol.

**Traditional TCP -** Classical TCP Improvements – WAP, WAP 2.0.

**UNIT-V**

**Publishing & Accessing Data in Air:** Pull and Push Based Data Delivery models, Data Dissemination by Broadcast, Broadcast Disks, Directory Service in Air, Energy Efficient Indexing scheme for Push Based Data Delivery.

**File System Support for Mobility:** Distributed File Sharing for Mobility support, Coda and other Storage Manager for Mobility Support.

**Mobile Transaction and Commerce:** Models for Mobile Transaction, Kangaroo and Joey transactions, Team Transaction, Recovery Model for Mobile Transactions, Electronic Payment and Protocols for Mobile Commerce.

**Suggested Reading:**

1. Jochen Schiller, *Mobile Communications*, Pearson Education, 2nd Edition, 2009.
2. Kurnkum Garg, *Mobile Computing*, Pearson Education , 2010
3. Asoke K Talukder, Roopa R Yavagal, *Mobile Computing*, TMH 2008.
4. Raj Kamal, *Mobile Computing*, Oxford, 2009.
5. "*A Survey of Mobile Transactions appeared in Distributed and Parallel databases*" 16,193-230, 2004, Kluwer Academics Publishers.
6. S. Acharya, M. Franklin and S. Zdonil, "*Balancing Push and Pull for Data Broadcast, Proceedings of the ACM SIGMOD*", Tuscon, AZ, May 1997.
7. S.Acharya, R. Alonso, M.Franklin and S.Zdonik, "*Broadcast Disks: Data Management for Assymetric Communication Environments, Proceedings of the ACM SIGMOD Conference*", San Jose, CA, May 1995.

**CS 112**

## REAL TIME SYSTEMS

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

### UNIT-I

**Introduction:** Definition, Applications and Types of Real Time Systems, Typical Case Studies of Real Time Systems, Time Constraints.

**A Reference Model for Real Time Systems:** Processors and Resources, Periodic Task Model, Precedence and Data Dependency, Temporal, Foundational and Resource Parameters, Scheduling Hierarchy.

### UNIT-II

**Real Time Scheduling:** Different Approaches- Clock Driven, Priority Driven, Scheduling of Periodic and Sporadic Jobs in Priority- Driven Systems.

### UNIT-III

Resource Management Resources and Resource Access Control, Critical Section, Priority-Ceiling Protocols, concurrent Access to Data Objects.

### UNIT-IV

**Implementation Aspects:** Timing Services and Scheduling Mechanisms, Other Basic Operating System Functions, Processor Reserves and Resource Kernel, Open System Architecture, Capabilities of Commercial Real Time Operating Systems, Predictability of General Purpose Operating Systems.

### UNIT-V

**Case Studies:** Vx – Works, and RT Linux.

**Suggested Reading:**

1. Jane W.S. Liu, *Real Time Systems*, Pearson Education, 2001.
2. C.M. Krishna and Kang G. Shin, *Real Time Systems*, Mc-Graw Hill Companies Inc., 1997.
3. Raymond J.A. Buhr, Donald L. Bailey, *An Introduction to Real Time Systems*, Prentice Hall International, 1999.
4. K.V.K.K. Prasad, *Embedded Real Time Systems, Concepts, Design and Programming*, Dreamtech Press, 2003.

**CS 113**

## WEB ENGINEERING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Web Engineering:** Concepts and Reference Model , Introduction and Perspectives, Web Engineering Resources Portal (WEP): A Reference Model and Guide.

**UNIT-II**

**Web Application Development:** Methodologies and Techniques, Web Application Development Methodologies, Relationship Analysis: A Technique to Enhance Systems Analysis for Web Development, Engineering Location-Based Services in the Web.

**UNIT-III**

**Web Metrics and Quality:** Models and Methods, **Architectural Metrics for E-Commerce:** A Balance between Rigor and Relevance, The Equal Approach to the Assessment of E-Commerce Quality: A Longitudinal Study of Internet Bookstores, Web Cost Estimation: An Introduction

**UNIT-IV**

**Web Resource Management:** Models and Techniques, Ontology Supported Web Content Management, Design Principles and Applications of XRML.

**UNIT-V**

**Web Maintenance and Evolution:** Techniques and Methodologies, Program Transformations for Web Application Restructuring, The Requirements of Methodologies for Developing Web Applications. A Customer Analysis-Based Methodology for Improving Web Business Systems.

**Web Intelligence :** Techniques and Applications, Analysis and Customization of Web-Based Electronic Catalogs, Data Mining using Qualitative Information on the Web.

**Suggested Reading:**

1. Woojong Suh, *Web Engineering Principles and Techniques*, Idea Group Publications 2005.

CS 114

## MULTIMEDIA TECHNOLOGIES

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Media and Data Streams**: Properties of multimedia systems, Data streams characteristics: Digital representation of audio, numeric instruments digital interface Bark concepts, Devices, Messages, Timing Standards Speech generation, analysis and transmission.

**UNIT-II**

**Digital Image**: Analysis, recognition, transmission, **Video**: Representation, Digitalization transmission **Animations**: Basic concepts, animation languages, animations control transmission

**UNIT-III**

**Data Compression Standards**: JPEG, H-261, MPEG DVI

**Optical storage devices and Standards**: WORHS, CDDA, CDROM, CDWO, CDMO.

Real Time Multimedia, Multimedia file System.

**UNIT-IV**

**Multimedia Communication System**: Collaborative computing session management, transport subsystem, QOS, resource management.

**Multimedia Databases**: Characteristics, data structures, operation, integration in a database model. **A Synchronization**: Issues, presentation requirements, reference to multimedia synchronization, MHEG

**UNIT-V**

**Multimedia Application**: Media preparation, Composition, integration communication, consumption, entertainment.

**Suggested Reading:**

1. Ralf Steninmetz, Klara Hahrstedt, *Multimedia: Computing, Communication and Applications,* PHI PTR Innovative Technology Series.
2. John F.Koegel Bufford, *Multimedia System*, Addison Wesley, 1994.
3. Mark Elsom – Cook, *Principles of Interactive Multimedia* , Tata Mc-Graw Hill, 2001.
4. Judith Jefcoate, *Multimedia in Practice: Technology and Application* , PHI 1998.

**CS 115**

## DATA MINING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**Introduction**: Why Data Mining? What is Data Mining? What kinds of data can be mined? What kinds of patterns can be mined? Which technologies are used ? Which kinds of applications are Targeted? Major issues in Data Mining. Getting to know your data: Data objects and attributed types. Basic statistical descriptions of data. Data visualization, Measuring data similarity and dissimilarity.

**UNIT-II**

Mining frequent patterns, Associations and correlations, Basic concepts and methods, Basic concepts, Frequent Item set Mining Methods, Which patterns are interesting? Pattern evaluation methods.

**UNIT-III**

Classification : Basic concepts, Decision tree induction, Bayes classification methods,

Classification: Advance methods, Bayesian Belief Network, Classification by back propagation, Support vector machine,

**UNIT-IV**

Cluster Analysis: Concepts and Methods: Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of clustering.

**UNIT-V**

Data Mining Trends and Research Frontiers, Mining Complex Data Types, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining trends.

**Suggested Reading:**

1. Jiawei Han, Micheline Kamber, Jin Pei, Data Mining: Concepts & Techniques, 3rd Edition.,Morgon Koffman ,2011
2. Vikram Pudi P.Radha Krishna, *Data Mining*, Oxford University Press, 1st Edition, 2009.
3. Pang-Ning Tan, Michael Steinbach, Vipin kumar, *Introduction to Data Mining*, Pearson Education, 2008.

**CS 116**

## NETWORK SECURITY

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction:** Attributes of Security, Integrity, Authenticity, Non-repudiation, Confidentiality Authorization, Anonymity, Types of Attacks, DoS, IP Spoofing, Replay, Man-in-the-Middle attacks General Threats to Computer Network, Worms, Viruses, -Trojans

**UNIT-II**

**Secret Key Cryptography :** DES, Triple DES, AES, Key distribution, Attacks

**Public Key Cryptography:** RSA, ECC, Key Exchange (Diffie-Hellman), Java Cryptography Extensions, Attacks

**UNIT-III**

**Integrity, Authentication and Non-Repudiation :** Hash Function (MD5, SHA5), Message Authentication Code (MAC), Digital Signature (RSA, DSA Signatures), Biometric Authentication.

**UNIT-IV**

**PKI Interface:** Digital Certificates, Certifying Authorities, POP Key Interface, System Security using Firewalls and VPN's.

**Smart Cards:** Application Security using Smart Cards, Zero Knowledge Protocols and their use in Smart Cards, Attacks on Smart Cards

**UNIT-V**

**Applications:** Kerberos, Web Security Protocols ( SSL ), IPSec, Electronic Payments, E-cash, Secure Electronic Transaction (SET), Micro Payments, Case Studies of Enterprise Security (.NET and J2EE)

**Suggested Reading:**

1. William Stallings, *Cryptography and Network Security*, 4th Edition. Pearson,. 2009.

2. Behrouz A Forouzan, *Cryptography and Network Security*, TMH, 2009

3. Joseph Migga Kizza, *A Guide to Computer Network Security*, Springer, 2010

4. Dario Cataiano, *Contemporary Cryptology*, Springer, 2010.

CS 117 **MACHINE LEARNING**

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction:** Learning, Types of Machine Learning.
**Concept learning:** Introduction, Version Spaces and the Candidate Elimination Algorithm. **Learning with Trees:** Constructing Decision Trees, CART, Classification Example

**UNIT-II**

**Linear Discriminants**: The Perceptron, Linear Separability, Linear Regression

**Multilayer Perceptron (MLP):** Going Forwards, Backwards, MLP in practices, Deriving back **Propagation SUPPORT Vector Machines**: Optimal Separation, Kernels

**UNIT-III**

**Some Basic Statistics:** Averages, Variance and Covariance, The Gaussian, The Bias-Variance Tradeoff Bayesian learning: Introduction, Bayes theorem. Bayes Optimal Classifier, Naive Bayes Classifier.

**Graphical Models:** Bayesian networks, Approximate Inference, Making Bayesian Networks, Hidden Markov Models, The Forward Algorithm.

**UNIT-IV**

**Evolutionary Learning:** Genetic Algorithms, Genetic Operators, Genetic Programming **Ensemble learning:** Boosting, Bagging

**Dimensionality Reduction:** Linear Discriminant Analysis, Principal Component Analysis

**UNIT-V**

**Clustering:** Introduction, Similarity and Distance Measures, Outliers, Hierarchical Methods, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes, Comparison

**Suggested Reading:**

1. Tom M. Mitchell, *Machine Learning*, Mc Graw Hill, 1997
2. Stephen Marsland, *Machine Learning - An Algorithmic Perspective*, CRC Press, 2009
3. Margaret H Dunham, *Data Mining*, Pearson Edition., 2003.
4. Galit Shmueli, Nitin R Patel, Peter C Bruce, *Data Mining for Business Intelligence*, Wiley India Edition, 2007
5. Rajjan Shinghal, *Pattern Recognition*, Oxford University Press, 2006.

**CS 118**

## INFORMATION RETRIEVAL SYSTEM

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**Boolean Retrieval**: An example information, Building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval.

**The term vocabulary and postings lists**: Document delineation and character sequence decoding, determining the vocabulary of terms, Faster postings list intersection via skip pointers, Positional postings, and Phrase queries.

**Dictionaries and tolerant retrieval**: Search structures for dictionaries, Wildcard queries, Spelling correction.

**Index Construction**: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes.

**UNIT-II**

**Index Compression**: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression.

**Scoring, term weighting and the vector space model:** Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, and Variant tf-idf functions.

**Computing scores in a complete search system**: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.

**Evaluation in information retrieval**: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

**UNIT-III**

**Relevance feedback and query expansion**: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

**XML retrieval**: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval.

**Probabilistic information retrieval**: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model.

**Language models for information retrieval**: Language models, The query likelihood model.

**UNIT-IV**

**Text classification and Naive Bayes**: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, and Feature selection.

**Vector space classification**: Document representations and measures of relatedness in vector spaces, Rocchio classification, k- nearest neighbor, Linear versus nonlinear classifiers.

**Flat clustering**: Clustering in information retrieval, Problem statement, Evaluation of clustering, k-means.

**Hierarchical clustering:** Hierarchical agglomerative clustering, Single-link and complete-link clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering.

**UNIT-V**

**Matrix decompositions and Latent semantic indexing**: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing.

**Web search basics**: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.

**Web crawling and Indexes**: Overview, Crawling, Distributing indexes, Connectivity servers.

**Link analysis**: The Web as a graph, Page Rank, Hubs and Authorities.

**Suggested Reading:**

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, *An Introduction to Information Retrieval*, Cambridge University Press, Cambridge, England, 2008
2. David A. Grossman, Ophir Frieder, *Information Retrieval – Algorithms and Heuristics*, Springer, 2nd Edition (Distributed by Universities Press), 2004.
3. Gerald J Kowalski, Mark T Maybury. *Information Storage and Retrieval Systems*, Springer, 2000
4. Soumen Chakrabarti, *Mining the Web: Discovering Knowledge from Hypertext Data*, Morgan-Kaufmann Publishers, 2002.

**CS 119**

## NATURAL LANGUAGE PROCESSING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

Introduction of Elementary Probability Theory, Essential Information Theory

**UNIT-II**

Linguistic Essentials Corpus-Based Work Collocations.

**UNIT-III**

**Statistical Inference:** Bins: Forming Equivalence Classes, Reliability vs. Discrimination, n-gram models, Building ngram models, An Information Theoretic Approach.
**Word Sense Disambiguation:** Methodological Preliminaries, Supervised and unsupervised learning, Pseudo words, Upper and lower bounds on performance, Supervised Disambiguation, Bayesian classification.

**UNIT-IV**

**Evaluation Measures, Markov Models:** Hidden Markov Models, Use, General form of an HMM Part-of-Speech Tagging

**UNIT-V**

**Probabilistic Context Free Grammars:** Introduction of Clustering **Information Retrieval:** Background, The Vector Space Model.

**Suggested Reading:**

1. Christopher D. Manning, Hinrich Schutze, *Foundations of Statistical Natural Language Processing*, MIT Press, 1999.
2. James Allan, *Natural Language Understanding*, Pearson Education, 1994.
3. Tanveer Siddiqui, US Tiwary, *Natural Language Processing and Information Retrieval*, Oxford University Press, 2008.

**CS 120** **SOFTWARE QUALITY AND TESTING**

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT - I**

The Software Quality Challenge, Introduction Software Quality Factors, The Components of the Software Quality Assurance System – Overview, Development and Quality Plans.

**UNIT - II**

Integrating Quality Activities in the Project Life Cycle, Assuring the Quality of Software Maintenance Components, CASE Tools and their effect on Software Quality, Procedure and Work Instructions, Supporting Quality Devices, Configuration Management, Documentation Control, Project Progress Control.

**UNIT - III**

Software Quality Metrics, Costs of Software Quality, Quality Management Standards - ISO 9000 and Companion ISO Standards, CMM, CMMI, PCMM, Malcom Balridge, 3 Sigma, 6 Sigma, SQA Project Process Standards – IEEE Software Engineering Standards.

**UNIT - IV**

Building a Software Testing Strategy, Establishing a Software Testing Methodology, Determining Your Software Testing Techniques, Eleven – Step Software Testing Process Overview, Assess Project Management Development Estimate and Status, Develop Test Plan, Requirements Phase Testing, Design Phase Testing, Program Phase Testing, Execute Test and Record Results, Acceptance Test, Report Test Results, Test Software Changes, Evaluate Test Effectiveness.

**UNIT - V**

Testing Client / Server Systems, Testing the Adequacy of System Documentation, Testing Web-based Systems, Testing Off – the – Shelf Software, Testing in a Multiplatform Environment, Testing Security, Testing a Data Warehouse, Creating Test Documentation, Software Testing Tools, Taxonomy of Testing Tools, Methodology to Evaluate Automated Testing Tools, Load Runner, Win Runner and Rational Testing Tools, Java Testing Tools, JMetra, JUNIT and Cactus.

**Suggested Reading:**

1. Daniel Galin, *Software Quality Assurance – From Theory to Implementation*, Pearson Education.2004
2. Mordechai Ben – Menachem / Garry S.Marliss, *Software Quality – Producing Practical, Consistent Software*, BS Publications, 2014
3. William E. Perry, *Effective Methods for Software Testing*, 3 rd Edition, 2006, Wiley .
4. Srinivasan Desikan, Gopalaswamy Ramesh, *Software Testing, Principles and Practices*, 2006. Pearson Education.
5. Dr.K.V.K.K. Prasad, *Software Testing Tool*, Wiley Publishers

**Web Resources :**

1. http://www.sei.cmu.edu/cmmi/
2. www.ibm.com/**software**/awdtools/**test**er/functional/index.html
3. www.ibm.com/**software**/awdtools/**test**/manager/
4. java-source.net/open-source/testing-tools
5. www.junit.org
6. java-source.net/open-source/web-testing-tools

**CS 121**

## CLOUD COMPUTING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**Unit- I**

Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning

**Unit -II**

Scaling in the Cloud, Capacity Planning , Load Balancing, File System and Storage,

**Unit-III**

Multi-tenant Software, Data in Cloud , Database Technology, Content Delivery Network, Security Reference Model , Security Issues, Privacy and Compliance Issues

**Unit-IV**

Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

**Unit- V**

Enterprise architecture and SOA, Enterprise Software , Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem.

**Suggested Reading:**

1. Cloud Computing - Sandeep Bhowmik, Cambridge University Press, 2017.

2. Enterprise Cloud Computing - Technology, Architecture, Applications by Gautam Shroff, Cambridge University Press, 2016.

3. Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, "*Distributed and Cloud Computing From Parallel Processing to the Internet of Things*", Elsevier, 2012.

**CS 122**

## SOFT COMPUTING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction to Soft Computing and Neural Networks:** Evolution of Computing Soft Computing Constituents From Conventional AI to Computational Intelligence-Machine Learning Basics.

**UNIT II**

**Genetic Algorithms:** Introduction to Genetic Algorithms (GA) –Applications of GA in Machine Learning-Machine Learning Approach to Knowledge Acquisition.

**UNIT III**

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

**UNIT IV**

**Fuzzy Logic:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems ,Fuzzy Expert Systems, Fuzzy Decision Making.

**UNIT V**

**Neuro-Fuzzy Modeling:** Adaptive Neuro, Fuzzy Inference Systems, Coactive Neuro, Fuzzy Modeling, Classification and Regression Trees, Data Clustering Algorithms, Rule base Structure Identification, Neuro-Fuzzy Control, Case studies.

**Suggested Reading:**

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, *Neuro-Fuzzy and Soft Computing*, Prentice- Hall of India, 2003.
2. George J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic-Theory and Applications*, Prentice Hall, 1995.
3. James A. Freeman and David M. Skapura, *Neural Networks Algorithms, Applications, and Programming Techniques*, Pearson Edn., 2003.
4. Mitchell Melanie, *An Introduction to Genetic Algorithm*, Prentice Hall, 1998.
5. David E. Goldberg, *Genetic Algorithms in Search, Optimization and Machine Learning*, Addison Wesley, 1997.

**CS 123**

## ARTIFICIAL NEURAL NETWORKS

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**Unit-I**

**Background to ANN**: Introduction to artificial neural networks (ANN), intelligence, learning and knowledge. Historical development of Artificial Intelligence (AI) leading to ANN. PDP models -- Interactive and competetion (IAC) and Constraint Satifaction (CS) models.

**Unit-II**

**Baiscs of ANN:** Basics of ANN, terminology, models of neurons, topology, basic learning laws, activation and synaptic dynamics models

**Unit-III**

**Analysis of Feedforward Neural Networks (FFNN)**: Overview, linear associative networks, perceptron network, multilayer perceptron, gradient descent methods, backpropagation learning

**Unit-IV**

**Analysis of Feedback Neural Networks (FBNN):** Overview, Hopfield model, capacity, energy analysis, state transition diagrams, stochastic networks, Boltzmann-Gibbs Law, simulated annealing, Boltzmann machine

**Unit-V**

**Applications of ANN:** Travelling salesman problem, image smoothing, speech recognition and texture classification.

**Suggested Reading:**

1.B Yegnanarayana, Artificial Neural Networks, Prentice-Hall of India, New Delhi, 1999

2. Simon Haykin, Neural networks and learning machines, Pearson Education, 2011

3. Jacek M Zurada, Introduction to artificial neural systems, PWS publishing Company, 1992

4. David E Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 1, Cambridge MA: MIT Press, 1986a

5. James McClelland, David E Rumelhart, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 2, Cambridge MA: MIT Press, 1986b

6. David Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: A handbook of models, Cambridge MA: MIT Press, 1989

**CS 124**

## SOFTWARE PROJECT MANAGEMENT

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

Conventional Software Management, Evolution of Software Economics, Improving Software Economics, Old Way & New.

**UNIT-II**

Life – Cycle phases, Artifacts of the process, Model Based Software Architectures, Workflows of the Process, Checkpoints of the process.

**UNIT-III**

Iterative Process Planning, Project Organizations & Responsibilities, Process Automation, Project Control of Process Instrumentation, Tailoring the Process.

**UNIT-IV**

Modern Project profiles, Next Generation Software Economics, Modern process Transitions, Managing Contacts, Managing People & Organizing Terms.

**UNIT-V**

Process improvement & mapping to the CMM, ISO 12207 – an overview, programme management.

### Suggested Reading:

1. Walker Royce, *Software Project Management – A Unified frame work*, Pearson Education, Addision, 1998,
2. Bob Hughes and Mike Cotterell , *Software Project Management*, Tata Mc Graw Hill, 3rd Edition, 2010.
3. Watt.S. Humphery, *Managing Software Process* , Addison - Wesley, 2008.

*CS 125*

**IMAGE PROCESSING**

*Credits: 3*

*Instruction: (3L) hrs per week* *Duration of SEE: 3 hours*

*CIE: 30 marks* *SEE: 70 marks*

**UNIT I**

**Image Processing:** Introduction, Examples, Fundamental steps, Components, Elements of visual perception, Light and Electromagnetic Spectrum, Image sensing and Acquisition, Image Sampling and Quantization, Basic relationships between pixels.

**Intensity Transformations and Spatial Filtering**: Background, Some basic intensity transformation functions, Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Combining Spatial Enhancement Methods.

**UNIT II**

**Filtering in the Frequency Domain:** Background, Preliminary concepts, Sampling and Fourier Transform of Sampled Functions, Discrete Fourier Transform (DFT) of one variable, Extension to functions of two variables, Some Properties of the 2-D Discrete Fourier Transform, Basics of Filtering in the Frequency Domain, Image Smoothing, Image Sharpening, Homomorphic Filtering.

**Image Restoration:** Noise Models, Restoration in the presence of noise only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering.

Linear Degradation, Position-invariant Degradation, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error Filtering, Constrained Least Squares Filtering, Geometric Mean Filter.

**UNIT III**

**Color Image Processing:** Color fundamentals, Color models, Pseudocolor Image Processing, Basics of Full-color Image Processing, Color Transformations, Smoothing and Sharpening, Color-based Image Segmentation, Noise in Color Images, Color Image Compression.

**Wavelets and Multi resolution Processing:** Background, Multiresolution Expansions, Wavelet Transforms in One Dimension, The Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets.

**UNIT IV**

**Image Compression:** Fundamentals, Image Compression Models, Elements of Information Theory, Error- free Compression, Lossy Compression, Image Compression Standards, Some Basic Compression Methods.

**Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms, Some Basic Gray-Scale Morphological Algorithms.

**UNIT V**

**Image Segmentation:** Fundamentals, Point, Line and Edge Detection, Thresholding, Region-based Segmentation, Segmentation using Morphological Watersheds, The use of Motion in Segmentation.

**Object Recognition:** Patterns and Pattern Classes, Recognition based on Decision-theoretic Methods, Structural Methods.

**Suggested Reading:**

1. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, PHI Learning Pvt. Limited, 3rd Edition, 2008.

2. William K. Pratt, *Digital Image Processing*, John Wiley & Sons, Inc., 3rd Edition, 2001.

**CS 126**

## SOFTWARE REUSE TECHNIQUES

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

Software Reuse Success Factors, Reuse Driven Software Engineering Business, Object Oriented Software Engineering, Applications and Component Subsystem, Use case Components, Object Components

**UNIT-II**

**Design Patterns:** Introduction, **Creational Patterns:** Factory, Factory Method, Abstract Factory, Singleton, Builder Prototype.

**UNIT-III**

**Structural Patterns:** Adapter, Bridge, Composite, Decorator, Fiacade, Flyweight, Proxy.

**Behavioral Patterns:** Chain of Responsibility, Command, Interpreter.

**UNIT-IV**

**Behavioral Patterns:** Iterator, Mediator, Momento, Observer, Stazte, Strategy, Template, Visitor, Other Design Pattern: Whole Part, Master-Slave, View Handler-reciever, Client-Dispatcher-Server, Publisher-Subscriber.

**UNIT-V**

**Architectural Patterns:** Layers, Pipes and Filters, Black Board, Broker, Model View Controller.

**Presentation:** Abstraction-Control, Micro Kernet, Reflection.

**Suggested Reading:**

1. Ivar Jacobson, Martin Griss, Patrick Kohnson, *Software Resue. Architecture, Process and Organisation for Business for Business Success*, ACM Press, 1997.
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, *Design Patterns*, Pearson Education, 1995.
3. Frank Buschmann, Kevlin Henney, Douglas C. Schmidt, *Pattern Oriented Software Architecture* , Wiley 1996.
4. James W Cooper, *Java Design Patterns, A Tutorial*, Addison Wesley Publishers 2000

***CS 127***

## RELIABILITY AND FAULT TOLERANCE

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction to Reliability Engineering**: Reliability, Repairable and Non-repairable Systems, Maintainability and Availability, Designing, Reliability, Repairable and Non-repairable Systems, MTBF MTBF, MTTF MDT, k out of in systems.

**UNIT-II**

**Software Reliability**:Software Reliability, Software Reliability Vs Hardware Reliability, Failures and Faults, Classification of Failures, Counting, System configuration, Components and Operational Models, Concurrent Systems, Sequential Systems, Standby Redundant Systems.
**Software Reliability Approaches**: Fault Avoidance, Passive Fault Detection, Active Fault Detection, Fault Tolerance, Fault Recovery, Fault Treatment.

**UNIT-III**

**Software Reliability Modeling**: Introduction to Software Reliability Modeling, Parameter Determination and Estimation, Model Selection, Markovian Models, Finite and Infinite failure category Models, Comparison of Models, Calendar Time Modeling.

**UNIT-IV**

**Fault Tolerant Computers**: General Purpose Commercial Systems, Fault Tolerant Multiprocessor and VLSI based Communication Architecture.
Design – N – Version programming Recovery Block, Acceptance Tests, Fault Trees, Validation of Fault Tolerant Systems.

**UNIT-V**

**Fault Types**: Fault Detection and Containment, Redundancy, Data Diversity, Reversal, Reversal Checks, Obtaining Parameter Values, Reliability Models for Hardware Redundancy, Software Error Models, Checks, Fault /Tolerant Synchronization, Synchronization in Software.

**Suggested Reading:**

1. John D. Musa, *Software Reliability*, McGraw Hill, 1995.
2. Patrick O'Connor, *Practical Reliability Engineering*, 4th Edition, John Wesley & Sons, 2003.
3. C.M. Krishna, Kang G. Shin, *Real Time Systems*, McGraw Hill, 1997.

**CS 128**

**Web Mining**

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction:** The World Wide Web, History of the Web and the Internet, Web Data Mining

**Association Rules and Sequential Patterns:** Basic Concepts, Apriori Algorithm, Data Formats for Association Rule Mining, Mining with Multiple Minimum Supports, Mining Class Association Rules

**Supervised Learning:** Basic Concepts, Decision Tree Induction, Classifier Evaluation, Naïve Bayesian Classification, Naïve Bayesian Text Classification, K-Nearest Neighbor Learning, Ensemble of Classifiers

**UNIT-II**

**Unsupervised Learning:** Basic Concepts. K-means Clustering, Representation of Clusters, Hierarchical Clustering, Distance Functions, Data Standardization, Handling of Mixed Attributes, Which Clustering Algorithm to Use? Cluster Evaluation

**Information Retrieval and Web Search:** Basic Concepts, Relevance Feedback, Evaluation Measures, Text and Web Page Pre-Processing, Inverted Index and Its Compression

**UNIT-III**

**Information Retrieval and Web Search:** Web Search, Meta-Search: Combining Multiple Rankings, Web Spamming

**Link Analysis:** Social Network Analysis, Co-Citation and Bibliographic Coupling, PageRank , HITS, Community Discovery

**UNIT-IV**

**Web Crawling:** A Basic Crawler Algorithm, Implementation Issues, Universal Crawlers, Focused Crawlers, Topical Crawlers, Evaluation, Crawler Ethics and Conflicts

**Structured Data Extraction:** Wrapper Generation**,** Preliminaries, Wrapper Induction, Instance-Based Wrapper Learning, Automatic Wrapper Generation, String Matching and Tree Matching, Multiple Alignment, Building DOM Trees, Extraction based on a single list page, extraction based on a single list page : Nested doda records, Extraction based on multiple pages, Some other issues.

**Information Integration:** Introduction to Schema Matching, Pre-Processing for Schema Matching, Schema-Level Match, Domain and Instance-Level Matching, Combining Similarities, 1: Match,

Some other issues, Integration of Web Query Interfaces, Constructing a Unified Global Query Interface.

**UNIT-V**

**Opinion Mining and Sentiment Analysis:** Sentiment Classification, Feature-Based Opinion Mining and Summarization, Comparative Sentence and Relation Mining, Opinion Search, Opinion Spam.

**Web Usage Mining:** Data Collection and Pre-Processing, Data Modeling for Web Usage Mining, Discovery & analysis of web usage patterns.

**Suggested Reading:**

1. Bing Liu , *Web Data Mining*, Springer India, 2010
2. Soumen Chakrabarti, *Mining the Web*, Morgan-Kaufmann Publishers, Elseiver, 2002
3. Manu Konchady, *Text Mining Application Programming*, Cengage Learning, 2006

**CS 129**

## Human Computer Interaction

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT- I**

**Interaction Paradigms:** Computing Environments, Analyzing Interaction Paradigms, Interaction Paradigms
**Interaction Frameworks and Styles**: Frameworks for Understanding Interaction, Coping with Complexity, Interaction Styles.

**UNIT- II**

**Interaction Design Process:** Iterative Design, User-Centered Design, Interaction Design Models, Overview of Interaction Design Models
**Discovery**: Discovery Phase Framework, Collection, Interpretation , Documentation
**Design**: Conceptual Design, Physical Design, Evaluation, Interface Design Standards, Designing the Facets of the Interface.

**UNIT- III**

**Design Principles:** Principles of Interaction Design, Comprehensibility, Learnability, Effectiveness/Usefulness, Efficiency/Usability, Grouping, Stimulus Intensity , Proportion , Screen Complexity, Resolution/Closure, Usability Goals
**Interaction Design Models:** Model Human Processor, Keyboard Level Model, GOMS, Modeling Structure, Modeling Dynamics, Physical Models
**Usability Testing:** Usability, Usability Test, Design the Test, Prepare for the Test, Perform the Test, Process the Data

**UNIT- IV**
**Interface Components:** The WIMP Interface, Other Components
**Icons**: Human Issues Concerning Icons, Using Icons in Interaction Design, Technical Issues Concerning Icons
**Color:** The Human Perceptual System, Using Color in Interaction Design, Color Concerns for Interaction Design, Technical Issues Concerning Color

**UNIT- V**

**Text**: Human Issues Concerning Text, Using Text in Interaction Design, Technical Issues Concerning Text
**Speech and Hearing**: The Human Perceptual System, Using Sound in Interaction Design, Technical Issues Concerning Sound
**Touch and Movement:** The Human Perceptual System, Using Haptics in Interaction Design, Technical Issues Concerning Haptics

**Suggested Reading:**

1. Steven Heim, *The Resonant Interface: HCI Foundations for Interaction Design*, Addison-Wesley, 2007
2. J. Preece, Y. Rogers, and H. Sharp, *Interaction Design: Beyond Human-Computer Interaction*, Wiley & Sons, 2nd Edition, 2007
3. Ben Shneiderman , Catherine Plaisant, *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, Addison-Wesley, 5th Edition, 2009.

**CS 130**

## Advanced Computer Graphics

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Raster Graphics System and its Working**: Line-Drawing Algorithms (DDA and Bresenham's algorithms), Polygon Filling, 2-D Transformations.

**UNIT-II**

**Fundamentals of 3-D Graphics**: Projections (Parallel projection and Perspective projection), 3-D Transformations, Bezier curves and B-spline curves, Visible-Surface Detection Methods (Painter's algorithm and Z-buffer method).

**UNIT-III**

**Structures and Hierarchical Modeling:** Structure Concepts, Editing Structures, Basic Modeling Concepts, Hierarchical Modeling with Structures.

**UNIT -IV**

**Graphics Standards**: GKS, PHIGS-their salient features.

**OpenGL**-the new graphics standard, important OpenGL functions, advantages of OpenGL, Sample graphics programs showing the use of OpenGL functions.

**UNIT-V**

**Fractals:** Fractal-Geometry Methods, Fractal-Generation Procedures, Classification of Fractals, Fractal Dimension, Geometric Construction of Deterministic Self-Similar Fractals, Geometric Construction of Statistically Self-Similar Fractals. Affine Fractal-Construction methods, Random Midpoint-Displacement Methods, Controlling Terrain Topography, Self-squaring Fractals, Self-inverse Fractals.

**Suggested Reading:**

1. Hearn Donald, Pauline Baker M., *Computer Graphic*s, Pearson Education, 2nd Edition, 1997.
2. Foley, Vandam, Feiner, Hughes, *Computer Graphics - Principles & Practice*, Addison- Wesley, 2nd Edition, 1996.
3. David F Rogers, *Procedural Elements for Computer Graphics*, McGraw-Hill, 2nd Edition, 2001
4. Hill, Jr. & Kelley by F. S.,Hill Jr,Kelley Jr,Stephen M**,** *Computer Graphics Using OpenGL*, PHI, 3rd Edition, 2009.

**CS 131**

## Software Engineering for RTS

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

I**ntroduction:** Review of Software Engineering Concepts, Characteristics of Real Time Systems, Importance of including Time Factor, The Real Time System Life Cycle: Requirement Specifications, State Charts.

**UNIT-II**

**Structured Design Approaches:** Event Based Model, Process-Based Structured Design, Graph-Based Theoretical Model, Petri Net Models: Stochastic Petri Net (SPN) Model Analysis, Annotated Petri Nets, Time-Augmented Petri Nets, Assessment of Petri Net Methods.

**UNIT-III**

**Axiomatic Approaches:** Weakest Precondition Analysis, Real Time Logic, Time Related History variables, State Machines and Real-Time Temporal Logic.

**UNIT-IV**

**Language Support Restrictions:** Real-Time Programming Descipline, Real-Time Programming Languages, Schedulability Analysis.

**UNIT-V**

**Verification and Validation of Real-Time Software:** Testing Real Time Properties, Simulation as Verification Tool, Testing Control and Data Flow, Proof Systems, Operational Approach.

**Suggested Reading:**

1. Shem – Tow Levi and Ashok K. Agarwal, *Real Time System Design*, McGraw Hill International Editions, 1999.
2. Cooling J.E. Jim Cooling, *Software Engineering for Real Time Systems*, Addison Wesly,2002

**CS 132**

## Simulation and Modeling

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction to simulation:** Advantages & Dis-advantages of simulation – Areas of applications, Systems and Systems Environment, Concept of a system, Discrete & Continuous system – Models, types of models, Steps in a simulation study – Examples, Discrete – Event System simulation.

**UNIT-II**

**Overview of Statistical Models and Queuing Systems, Programming languages for Simulation:** Continuous and Discrete Simulation Languages – GPSS, SIMAN, SIMSCRIPT, MATLAB and SIMULINK

.

**UNIT-III**

**Random Numbers:** Generation, Properties of Random Numbers, Generation of Pseudo Random Numbers, Tests for Random Numbers.

**Random Variate:** Generation, Inverse Transformation Technique, Uniform Distribution, Exponential Distribution, Weibul's Distribution, Triangular Distribution, Empirical Continuous Distribution, Discrete Distributions, Direct Transformation for the Normal Distribution, Convolution Method of Erlang Distribution, Acceptance Rejection Techniques: Poisson Distribution, Gamma Distribution.

**UNIT-IV**

**Input Data Analysis:** Data Collection: Identify the Distribution, Parameter and Estimation.

**Goodness of fit tests:** Chi-Square Test – KS Test; Multivariate and time series input models, Verification and Validations of Simulation Models, Model Building, Verification and Validation: Verification of Simulation Models, Calibration and Validation of Models, face validity, Validation of Model Assumptions. Validation Input/output Transformations, Input/output Validation using Historical Input Data, Input/output Validation Sing Turning Test.

**UNIT-V**

Output Data Analysis, Stochastic, Nature of output data, Types of Simulation with respect to output Analysis, Measures of Performance and their Estimation, output Analysis for Terminating Simulations, Output Analysis for steady – State Simulations.

**Comparison and Evaluation of Alternative System Designs:** Comparison of several system Designs, Statistical Models for Estimating the Effect of Design Alternatives

**Suggested Reading:**

1. Jabey Banks, John S. Cansen and Barry L. Nelson, *Discrete – Event System Simulation*, Prentice Hall of India, 2001.
2. Nursing Deo, *System Simulation with Digital computer*, Prentice Hall of India, 1979.
3. Anerill M. Law and W. David Kelton, *Simulation Modelling and Analysis*, McGraw Hill. 2001.
4. Agam kumar tyagi, MATLAB and Simulink for Engineers, Oxford Publishers, 2011

**CS133**

## ADVANCED OPERATING SYSTEMS

*Credits: 3:*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Architecture of Distributed Systems**: Types, Distributed Operating System, Issues in Distributed Operating Systems, Theoretical Foundations: Global Clock, Lamport's Logical Clock, Vector Clocks, Global State, and Termination Detection.

**UNIT-II**

**Distributed Mutual Exclusion:** Classification, requirement, performance, non-token based algorithms, Lamport's algorithm, the Richart-Agarwala algorithm, token-based algorithm-Suzuki liasamil's broadcast algorithm, Singhals heuristic algorithm.

**Deadlock Detection:** Resource Vs Communication deadlock, A graph- theoretic model, prevention, avoidance, detection, control organization, centralized deadlock-detection algorithm, the completely centralized algorithm, the HO-Ramamoorthy algorithm. Distributed deadlock detection algorithm - path - pushing, edge-chasing, hierarchical deadlock detection algorithm, menace-muntz and Ho-Ramamoorthy algorithm. Agreement Protocols: The system model, the Byzantine agreement, and the consensus problem.

**UNIT-III**

**Distributed File System:** Mechanisms, Design Issues.

**Case Studies:** Sun NFS, Sprite File System, DOMAIN, Coda File System.

**Distributed Shared Memory:** Algorithms for Implementing DSM, Memory Coherence, Coherence Protocols, Design Issues.

**Case Studies:** IVY, Mirage, Clouds.

**Distributed Scheduling :** Issues in Load Distribution, Components of Algorithm, Stability Load Distributing Algorithm, Performance.

**UNIT IV**

**Failure Recovery:** Backward, Forward Error Recovery in Concurrent Systems, Consistent Set of Check Points, Synchronous and Asynchronous Check Pointing and Recovery.

**Fault Tolerance:** Commit Protocols, Non-Blocking Commit Protocols, Voting Protocols.

**Protection and Security:** Access Matrix, Private Key, Public key, and Kerberos System.

**UNIT -V**

**Multiprocessor Operating Systems:** Motivation, Basic Multiprocessor System Architecture, Interconnection Networks for Multiprocessor Systems, Caching, Hypercube Architecture. Threads, Process Synchronization, Processor Scheduling, and Memory Management.

**Database Operating System:** Concurrence Control, Distributed Databases, and Concurrency Control Algorithms.

**Suggested Reading:**

1. Singhal M, Shivaratri N.G, *Advanced Concepts in Operating Systems*, McGraw-Hill Intl., 1994.
2. Pradeep K Sinha, *Distributed Operating Systems Concepts and Design*, PHI, First Edition, 2002.
3 Andrew S. Tanenbaum, *Distributed Operating Systems*, Pearson Education India, First Edition, 2011

**CS 134**

## OBJECT ORIENTED SOFTWARE ENGINEERING

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Information Systems:** Problems in Information systems Development, Project life cycles, Managing Information System Development, User Involvement and Methodological Approaches, Basic Concepts and Origins of Object Orientation Modeling Concepts.

**UNIT-II**

Requirement Capture, User Requirements, Requirements Capture and Modelling, Requirement Analysis, Use Case Realization, The Class Diagram, Assembling the Analysis Class Diagram, Refining the Requirement Models, Component-based Development, Software Development Patterns, Object Interaction, Object Interaction and Collaboration, Interaction Sequence Diagrams, Collaboration Diagrams, Model Consistency

**UNIT-III**

Specifying Operations, The Role of Operation Specifications, Contracts, Describing Operation Logic, Object Constraint Language, Creating an Operation Specification, Specifying Control, States and Events, Basic Notation, Further Notation, Preparing a Statechart, Consistency Checking, Quality Guidelines, Moving Into Design, Logical and Physical Design, System Design and Detailed Design, Qualities and Objectives of Analysis and Design, Measurable Objectives in Design, Planning for Design, System Design, The Major Elements of System Design, Software Architecture, Concurrency, Processor Allocation, Data Management Issues, Development Standards, Prioritizing Design Trade-offs, Design for Implementation

**UNIT-IV**

Object design, Class Specification, Interfaces, Criteria for Good Design, Designing Associations, Integrity Constraints, Designing Operations, Normalization, Design Patterns, Software Development Patterns, Documenting Patterns-Pattern Templates, Design Patterns, How to use Design Patterns, Benefits and Dangers of Using Patterns, Human Computer Interaction, The User Interface, Approaches to User Interface Design, Standards and Legal Requirements, Designing Boundary Classes, The Architecture of the Presentation Layer, Prototyping the User Interface, Designing Classes, Designing Interaction with Sequence Diagrams, The Class Diagram Revisited, User Interface Design Patterns, Modelling the Interface Using Statecharts.

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**UNIT-V**

Data Management Design, Persistence, File Systems, Database Management Systems, Designing for Relational Database Management Systems, Designing for Object Database Management Systems, Distributed Databases, Designing Data Management Classes, Implementation, Software Implementation, Component Diagrams, Deployment Diagrams, Software Testing, Data Conversion, User Documentation and Training, Implementation Strategies, Review and Maintenance, Reusable Components, Planning a Strategy for Reuse, Commercially Available Componentware, Managing Object Oriented Projects, Resource Allocation and Planning, Managing Iteration, Dynamic Systems Development Method, Extreme Programming, Software Metrics, Process Patterns, Legacy Systems, System Development Methodologies, 'Method' and 'Methodology', A Brief Historical Review, The Unified Software Development Process, Participative Design Approaches, Issues in Choosing a Methodology, Hard versus Soft Methodologies.

**Suggested Reading:**

1. Simon Benett, Steve McRobb and Ray Farmer, *Object Oriented System Analysis and Design using UML*, McGraw-Hill Education, 2010.
2. Grady Booch, James Rumbaugh, Ivar Jacobson, *The Unified Modeling language-User guide*, Pearson Education India, 2nd Edition, 2005.
3. Subhash Mehta, Suresh K. Basandra, *Object Oriented Software Engineering*, Galgotia, 2004.

**CS 135**

## DISTRIBUTED COMPUTING

*Credits: 3 Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT -I**

**Introduction:** Definition of Distributed Systems, Goals: Connecting Users and Resources, Transparency, Openness, Scalability, Hardware Concepts: Multiprocessors, Homogeneous Multicomputer systems, Heterogeneous Multicomputer systems, Software Concepts: Distributed Operating Systems, Network Operating Systems, Middleware, The client-server model: Clients and Servers, Application Layering, Client-Server Architectures.

**UNIT II**

**Communication:** Layered Protocols, Lower-Level Protocols, Transport Protocols, Higher-Level Protocols, Remote Procedure Call: Basic RPC Operation, Parameter Passing, Extended RPC Models, Remote Object Invocation: Distributed Objects, Binding a Client to an Object; Static verses Dynamic Remote Method Invocations, Parameter Passing, Message Oriented Communication: Persistence and synchronicity in Communication, Message-Oriented Transient Communication, Message-Oriented' Persistent Communication, Stream Oriented Communication: Support for Continuous Media, Streams and Quality of Service, Stream Synchronization.

**UNIT -III**

**Process: Threads:** Introduction to Threads, Threads in Distributed Systems, Clients: user Interface-:, Client-Side Software for Distribution Transparency, Servers: General Design Issues, Object Servers, Software Agents: Software Agents in Distributed Systems, Agent Technology, Naming: Naming Entities: Names, Identifiers, and Address, Name Resolution, The Implementation of a Name System, Locating Mobile Entities: Naming verses Locating Entities, Simple Solutions, Home-Based Approaches, Hierarchical Approaches.

**UNIT -IV**

**Distributed Object Based Systems:** CORBA: Overview of CORBA, Communication, Processes, Naming, Synchronization, Caching and Replication, Fault Tolerance, Security, Distributed COM: Overview of DCOM, Communication, Processes, Naming, Synchronization, Replication, Fault Tolerance, Security, GLOBE: Overview of GLOBE, Communication, Process, Naming, Synchronization, Replication, Fault Tolerance, Security, Comparison of CORBA, IDCOM, and

**Globe:** Philosophy, Communication, Processes, Naming, Synchronization, Caching and Replication Fault Tolerance, Security, MTN

**UNIT-V**

**Distributed Multimedia Systems:** Introduction, Characteristics of Multimedia Data, Quality of Service Management: Quality of Service negotiation, Admission Control, Resource Management Resource Scheduling.

**Suggested Reading:**

1. Andrew S. Tanenbaum and Marteen Van Steen, *Distributed System*s: *Principles and Paradigms*, Pearson Prentice Hall, 2nd Edition, 2010.
2. Colouris G., Dollimore Jean, Kindberg Tim, *Distributed Systems Concepts and Design*, 3rd Edition Pearson Education, 5th Edition, 2011.

**CS 136**

## ADVANCED DATABASES

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

### UNIT-I

**Object Based Databases:** Overview, Complex Data Types, Structured Types and Inheritance in SQL, Table Inheritance, Array and Multi-set. Types in SQL, Object-Identity and Reference Types in SQL, Implementing O-R features, Persistent Programming Languages, Object-Relational Mapping, Object-Oriented versus Object-Relational.

### UNIT-II

**X M L:** Motivation, Structure of XML data, XML Document Schema, Querying and Transformation, Application Program Interface to XML, Storage of XML data, XML applications.

### UNIT-III

**Query Processing :** Overview, Measures of Query Cost, Selection Operation, Sorting, join Operation, Other Operations, Evaluation of Expressions.

**Query Optimization:** Overview, Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans, Materialized Views.

### UNIT-IV

**Parallel Databases:** Introduction,1/0 Parallelism, Interquery Parallelism, Intraquery Parallelism, Intra-operation Parallelism, Interoperation Parallelism, Query Optimization, Design of Parallel Systems.

**Distributed Databases:** Homogeneous and Heterogeneous Database, Distributed Data Storage, Distributed. Transactions, Commit Protocols, Concurrency Control in Distributed Databases, Availability, Distributed Query Processing, Heterogeneous Distributed Databases, Cloud-Based Databases, Directory Systems.

### UNIT- V

**Advanced Application Development:** Performance Tuning, Performance Benchmarks Other Issues in Application Development, Standardization.

**Spatial and Temporal Data and Mobility:** Motivation, Time in Databases, Spatial and Geographic Data, Multimedia Databases, Mobility and Personal Databases.

**Suggested Reading:**

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, *Database System Concepts*, McGrawHill International Edition, 6th Edition, 2010.

2. Elmasri Navathe, Somayajulu, Gupta , *Fundamentals of Database Systems*, Pearson Education, 4th Edition, 2006.

3. CJ Date, A Kannan, S Swamynathan, *An Introduction to Database Systems*, Pearson Education, 8th Edition, 2006.

4. Raghu Ramakrishnan, and Johannes Gehrke, *Database Managemen*t *Systems*, McGraw-Hill International Edition, 3rd Edition, 2002.

**CS 211**

**Parallel Algorithms**

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction to Parallel Algorithms and Architectures**: Approaches to Design of Parallel Algorithms, Architectural Constraints and Design and Analysis of Parallel Algorithms, Performance Measures of Parallel Algorithms

**UNIT-II**

**Parallel Design Strategies**: Parallel Prefix. Computations, Pointer Jumping, Matrix Operations in Parallel.

**Dense Matrix algorithms:** Matrix vector Multiplication and Matrix- matrix multiplication

**UNIT-III**

**Parallel Sorting:** Issues in Sorting on Parallel Computers, Sorting Networks, Bubble Sort and its Variants, Quicksort, Bucket and Sample Sort.

**UNIT-IV**

**Parallel Graph Algorithms:** Definitions and Representations, Minimum Spanning Tree: Prim's Algorithm, Single Source Shortest Path - Dijkstra's Algorithm, All pairs shortest path algorithms, Algorithms for Sparse Graphs.

**UNIT-V**

**Search Algorithms for Discrete Optimization Problems**: Definitions, Sequential search Algorithms, Search Overhead Factor, Parallel Depth first Search, Parallel Breadth first Search, Speedup factors in Parallel Search Algorithms.

**Suggested Reading:**

I. Kenneth A. Berman and Jerome Paul, *Parallel Algorithms* , Cengage Learning, 2002.

2. Ananth Grama and Anshul Gupta, *Introduction to Parallel Computing*, Pearson Education Second Edition, 2004.

**CS 212**

## Grid Computing

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction to Grid Computing:** Grid Computing Concept, History of Distributed Computing, Computational Grid Applications, Grid Computing Infrastructure Development, Grid Computing Software Interface.

**Job Submission:** Introduction, Globus Job Submission. Transferring Files.

**UNIT-II**

**Schedulers:** Scheduler Features, Scheduler Examples, Grid Computing Meta-Schedulers Distributed Resource Management Application (DRMAA).

**Security Concepts:** Introduction, Symmetric Key Cryptography, Asymmetric Key Cryptography (Public Key Cryptography), Public Key Infrastructure. Systems/Protocols Using Security Mechanisms.

**Grid Security:** Introduction, Grid Security Infrastructure (GSI), Delegation, Higher-Level Authorization Tools.

**UNIT-III**

**System Infrastructure I:** Web Services: Service-Oriented Architecture, Web Services and Web Service Implementation.

**System Infrastructure II:** Grid Computing Services: Grid Computing and Standardization Bodies, Interacting Grid Computing Components, Open Grid Services Architecture (OGSA), WSRF.

**User-Friendly Interfaces:** Introduction, Grid Computing Workflow Editors, Grid Portals.

**UNIT-IV**

**Grid-Enabling Applications:** Introduction, Parameter Sweep, Using an Existing Program on Multiple Grid Computers, Writing an Application Specifically for a Grid, Using Multiple Grid Computers to Solve a Single Problem.

**UNIT-V**

**Case Studies: Globus-**Overview of Globus Toolkit 4, Installation of Globus, GT4 Configuration, Main Components and programming Model using Globus.

**gLite:** Introduction, Internal Workings of gLite, Logging and Bookkeeping (LB), Security Mechanism Using gLite, Resource management using Gridway and Gridbus Scheduling using Condor, SGE, PBS, LSF Grid scheduling with QoS.

**Suggested Reading:**

1. Barry Wilkinson, *Grid Computing Techniques and Applications*, CRC Press, 2010.
2. Frederic Magoules, Jie Pan, Kiatan Tan, Abhinit Kumar , *Introduction to Grid Computing*, CRC Press, 2009.
3. Vladimir Silva, *Grid Computing for Developers*, Dreamtech Press, 2006.
4. Ian Foster, and Carl Kesselman, *The Grid 2: Blueprint for a new computing Infrastructure*, Elsevier Series, 2004
5. Fran Berman, Geoffrey Fox, Anthony J.G Hey, *Grid Computing: Making the Global Infrastructure a Reality*, Wiley Publishers, 2003.
6. Joshey Joseph, Craig Fellenstein, *Grid Computing*, IBM Press, 2004.

**CS 213**

**Real Time Operating Systems**

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT I**

Brief Review of Unix Operating Systems (Unix Kernel – File system, Concepts of – Process, Concurrent Execution & Interrupts. Process Management – forks & execution. Programming with system calls, Process Scheduling. Shell programming and filters).

Portable Operating System Interface (POSIX) – IEEE Standard 1003.13 & POSIX real time profile. POSIX versus traditional Unix signals, overheads and timing predictability.

**UNIT II**

Hard versus Soft Real-time systems – examples, Jobs & Processors, Hard and Soft timing constraints, Hard Real-time systems, Soft Real-time systems. Classical Uniprocessor Scheduling Algorithms – RMS, Preemptive EDF, Allowing for Preemptive and Exclusion Condition.

**UNIT III**

Concept of Embedded Operating Systems, Differences between Traditional OS and RTOS. Real-time System Concepts, RTOS Kernel & Issues in Multitasking – Task Assignment, Task Priorities, Scheduling, Intertask Communication & Synchronization – Definition of Context Switching, Foreground ISRs and Background Tasks. Critical Section – Reentrant Functions, Interprocess Communication (IPC) – IPC through Semaphores, Mutex, Mailboxes, Message Queues or Pipes and Event Flags.

**UNIT IV**

VxWorks – POSIX Real Time Extensions, timeout features, Task Creation, Semaphores (Binary, Counting), Mutex, Mailbox, Message Queues, Memory Management – Virtual to Physical Address Mapping.

**UNIT V**

Debugging Tools and Cross Development Environment – Software Logic Analyzers, ICEs.

Comparison of RTOS – VxWorks, µC/OS-II and RT Linux for Embedded Applications.

**Suggested Reading:**

1. Jane W.S.Liu , *Real Time Systems* , Pearson Education, Asia, 2001.
2. Betcnhof, D.R., *Programming with POSIX threads*, Addison - Wesley Longman, 1997.
3. *VxWorks Programmers Guide*, Windriver, 1999.
4. Jean.J.Labrosse, *MicroC/OS-II*, Taylor & Francis, 2002.
5. C.M.Krishna and G.Shin, *Real Time Systems*, McGraw-Hill International Edition, 1997.

**CS 214**

**Scripting Languages for Design Automation**

*Credits: 3:*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT I**

**Introduction to Python Programming**: Program Development Cycle, Input, Processing, and Output, Variables, Performing Calculations (Operators, Type conversions, Expressions),

**Decision Structures and Boolean Logic:** if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables.

**Repetition Structures**: Introduction, while loop, for loop, Input Validation Loops, Nested Loops.

**UNIT II**

**Functions:** Introduction, Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value-Returning Functions.

**Lists and Tuples**: Sequences, Introduction to Lists, List slicing, Finding Items in Lists with the in Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, Tuples.

**UNIT III**

**File and Exceptions:** Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions.

**Strings:** Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

**Dictionaries and Sets**: Dictionaries, Sets, Serializing Objects.

**UNIT IV**

**Recursion:** Introduction, Problem Solving with Recursion, Examples of Recursive Algorithms.

**Object-Oriented Programming:** Procedural and Object-Oriented Programming, Classes, Working with Instances, Techniques for Designing Classes, Inheritance, Polymorphism.

**UNIT V**

**GUI Programming:** Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

**Suggested Reading:**

1. Tony Gaddis, *Starting out With Python* , Pearson College Division, 3rd Edition, 2014.
2. John V Guttag, *Introduction to Computation and Programming using Python,* MIT Press, 3rd Edition, 2016.

**CS 215**

# Storage Management

*Credits:3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT -I**

Introduction to Information Storage and Management, Storage System Environment, Intelligent Storage System.

**UNIT-II**

Direct-Attached Storage and Introduction to SCSI, Storage Area Networks, Network-Attached Storage.

**UNIT-III**

IP SAN, Content-Addressed Storage, Storage Virtualization.

**UNIT-IV**

Introduction to Business Continuity, Backup and Recovery, Local Replication.

**UNIT -V**

Remote Replication,Securing the Storage Infrastructure, Managing the Storage Infrastructure.

**Suggested Reading:**

1. G. Somasundaram, Alok Shrivastava, *Information Storage and Management*, Wiley Publishing Inc., 2009.
3. Raplh H. Thornburgh, Burry J Schoenborn, *Storage Area Networks*, Prentice-Hall, 2000.

**CS 216**

# Performance Evaluation of Computing

*Credits:3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT -I**

**Fundamental Concepts and Performance Measures**

Tiem, Events, Measurements, .Intervals, Response, Independence, Randomness, Workload Problems Encountered in Model Development and Use. A Case Study.

General Measurement Principles, Scheduling Algorithms, Workloads.

**UNIT –II**

**Probability:**Random Variables, Jointly Distributed Random Variables, Probability Distributions, Densities Expectation, Some Example Probability Distributions.

**Stochastic Processes:**Basic Definitions, Poisson Process, Birth-Death Process, Markov Process.

**UNIT -III**

**Queuing Theory:Networks of Queues, Estimating Parameters and Distributions**

**Computational Methods for Queuing Network Solutions, Simulation Analysis**

Simulation Process, Time Control, Systems and Modeling, Simulation Languages, Applications of Simulation.

**UNIT -IV**

**Petri Nets:**Basic Notation, Classical Petri Nets, Times Petri Nets, Priority-Based Petri Nets, Colored Pt Nets, Generalized Petri Nets.

**Hardware Testbeds, Instrumentation, Measurement, Data Extraction, and Analysis**

Derivation of Performance Evaluation parameters, Network performance tests, General Methods of Data Extraction, Tested and Model Workloads, Experimental Design, Data presentation.

**System Performance Evaluation Tool Selection and Use:**Validation of Results, Conducting Experiments, Performance Metrics, Evaluation

**UNIT -V**

**Analysis of Computer Architectures:**Case I : Central Server Computer System

Case II : Multiple Server Computer System

Case III : Petri Net Example

**Analysis of Operating System Components**

System Architectures, Workloads, Experimental Design and Simulation, Experimental Analysis and Conclusion.

**Database Systems Performance Analysis**

The Testbed Systems, The Database Systems Tested Performance Analysis Testing, The Results.

**Analysis of Computer Networks Components**

Analytical Modeling Examples, Simulation Modeling of Local Area Networks.

**Suggested Reading**:

1. Paul. J. Fortier and Howard E. Michel, *Computer Systems Performance Evaluation and Prediction*, 1st Edition, Digital Press, 2002.

2. Raj Jain, *The art of Computer Systems performance analysis, techniques for experimental design, measurement and modeling*, John Wiley & Sons, 1991.

3. Neil J. Gunther, *Analyzing Computer System Performance with Peri::PDQ*, 2nd Edition, Springer, 2011.

**CS 217**

# Parallel and Distributed Databases

*Credits:3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT- I**

**Introduction**: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Object-Based and Semistructured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators, History of Database Systems.

**Relational Model**: Structure of Relational Databases, Fundamental Relational-Algebra Operations, Additional Relational-Algebra Operations, Extended Relational-Algebra Operations, Null Values, Modification of the Database.

**UNIT-II**

**Query Processing** : Overview, Measures of query cost, Selection operation, sorting, Join operation, Other operations, Evaluation of Expressions.

**Query Optimization** : Overview, Transformation of Relational expressions, Estimating statistics of expression results, Choice of evaluation plans, Materialized views.

**UNIT-III**

**Parallel Systems**: Speedup and Scaleup, Interconnection Networks, Parallel Database Architectures.

**Parallel Databases**: Introduction, I/O Parallelism, Interquery Parallelism, Intraquery Parallelism, Interoperation Parallelism, Intraoperation Parallelism, Design of Parallel Systems.

**UNIT-IV**

**Distributed Databases**: Reference architecture for DDB, Types of Data Fragmentation, Distribution Transparency for Read-only applications, Distribution Transparency for Update applications, Distributed Database Access Primitives, Integrity Constraints in DDB.

**Distributed Database Design**: A frame work for Distributed Database Design, The design of Database fragmentation, The allocation of fragmentation.

**UNIT-V**

**Translation of Global Queries to Fragment Queries**: Equivalence transformations for queries, Transforming global queries into fragment queries, Distributed grouping and aggregate function evaluation, Parametric queries.

**Optimization of Access Strategies**: Access Control Models, Database Security, A framework for query optimization, Join queries, General queries.

**Suggested Reading:**

1. Silberschatz A, Korth HF, Sudarshan S, *Database System Concepts*, McGraw-Hill International Edition, 5th Edition, 2006.
2. Ceri S, Pelagatti G, *Distributed Databases: Principles and Systems*, McGraw-Hill International Edition, 1984.

**CS 201**

## Parallel Computer Architecture

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT I**

**Instruction Level Parallelism:** Concepts and challenges, Instruction Pipeline Design, Hardware and software approaches, Dynamic scheduling, Speculation, Compiler techniques for exposing ILP, Branch Handling Techniques.

**UNIT-II**

**Advanced Processor Technologies:** CISC and RISC Architectures, Superscalar Processors, and VLIW Architectures.

**Memory Hierarchy Design:** Cache basics and Cache performance, Reducing miss rate and Miss penalty, Multilevel cache hierarchies, Main memory organizations, and Design of Memory Hierarchies.

**UNIT-III**

**Parallel Computer Models:** Classification of Parallel Computers, Multiprocessors and Multicomputer, and Multi-vector and SIMD computers.

**Shared Memory Multiprocessors:** Cache Coherence, Memory Consistency, Snoopy-based Cache coherence protocols (MSI, MESI, MOESI).

**UNIT-IV**

**Snoopy-based Multi-Processor Design**: Single-level Caches with an Atomic Bus, Multi-level Cache Hierarchies, and Split-Transaction Bus.

**Directory-Based Cache Coherence:** Scalable Cache Coherence, Overview of Directory-based approaches, Design Challenges for Directory Protocols, Memory-Based Directory Protocols, Cache-Based Directory Protocols.

**UNIT -V**

**Interconnection Network Design:** Basic Definitions, Basic Communication Performance, Organizational Structure, Interconnection Topologies, Routing, Switch Design, and Flow Control.

**Latency Tolerance:** Overview of Latency Tolerance, Latency Tolerance in Explicit Message Passing, Latency Tolerance in a Shared Address Space - Block Data Transfer, Proceeding Past Long-Latency Events, Pre communication in a Shared Address Space, and Multithreading.

**Suggested Reading:**

1. John L. Hennessy, David A. Patterson, *Computer Architecture: A Quantitative Approach*, Morgan Kaufmann Publishers Inc., 5th Edition, 2012.
2. Id. Culler, Jaswinder Pal Singh, and Anoop Gupta, *Parallel Computer Architecture: A Hardware/Software Approach*, Morgan Kaufmann, 1999.
3. Kai Hwang, *Advanced Computer Architecture*, Tata McGraw-Hill Education, 2nd Edition, 2011.

**CS 202**

# Parallel Programming

*Credits:3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT -I**

**Principles of Parallel Algorithm Design** - Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

**UNIT-II**

**Communication Operations** - One-to-All Broadcast and All-to-one Reduction, All-to-all Broadcast and Reduction, All-Reduce and Prefix-sum Operations, All-to-all Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations.

**UNIT-III**

**Analytical Modeling of Parallel Programs** - Sources of Overhead in Parallel Programs, Performance Metrics for Parallel Systems, The Effect of Granularity on Performance, Scalability of Parallel Systems, Minimum Execution Time and Minimum Cost-Optimal Execution Time,

Asymptotic Analysis of Parallel Programs: Sorting and Graph Algorithms, Search algorithms for discrete optimization problems.

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**UNIT-IV**

**Introduction to Parallel Programming:** Introduction to Parallel Programming, Introduction to OpenCL, OpenCL Device Architectures, Basic OpenCL Examples, Parallel programming using OpenCL/C++ AMP/CUDA.

**UNIT-V**

**Introduction to OpenCL:** Understanding OpenCL's Concurrency and Execution Model, Dissecting a CPU/GPU OpenCL Implementation.

**Suggested Reading:**

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, *Introduction to Parallel Computing* , 2nd Edition, Pearson Publishers.
2. David Kaeli, Perhaad Mistry, Dana Schaa and Dong Ping Zhang **,** *Heterogeneous Computing with OpenCL 2.0***,** 1st Edition, Mourgan Kaufmann, 2015.
3. Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, and Dana Schaa, *Heterogeneous Computing with OpenCL™ 1.2***,** Mourgan Kaufmann , 2011
4. Gregory V. Wilson, *Practical Parallel Programming*, PHI, 1998.

**CS 301**

**Embedded System Design**

*Credits: 3*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Introduction to Embedded Systems:** Characteristics and quality attributes of Embedded Systems Challenges in Embedded System Design, Application and Domain specific Embedded Systems.

**UNIT –II**

**Embedded System Architecture:** Instruction Set Architecture, CISC and RISC instruction set architecture, Basic Embedded Processor/Microcontroller Architecture, C1SC Examples-Motorola (68HCI1), RISC Example- ARM, DSP Processors, Harvard Architecture Microcontroller Example - PIC.

**UNIT -III**

**Embedded Hardware Design and Development:** VLSI and Integrated Circuit Design, EDA tools, usage of EDA tools and PCB layout.

**Embedded firmware and Design and Development:** Embedded Firmware Design Approaches and Development languages and Programming in Embedded in C.

**UNIT -IV**

**Introduction to Real Time Operating System:** Tasks and Task States, Tasks and Data, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer functions, Events, Memory Management, Interrupt Routines in an RTOS Environment, OS Security Issues and Mobile OS.

**UNIT-V**

**Embedded Systems Development Environment:** IDE, Cross Compilation, Disassembler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan. Product Enclosure Design and Development Tools, Embedded Product Development Life Cycle- Different phases and Approaches' of EDLC. Trends in Embedded Industry.

**Suggested Reading:**

1. Shibu K V, *Introduction to Embedded Systems*, Tata McGraw HilI,2010.
2. Raj Kamal, *Embedded Systems Architecture, Programming & Design*, Tata McGraw Hill, 2010.
3. Dr K.V.K.K. Prasad, *Embedded/Real Time Systems: Concepts, Design and Programming*, Dreamtech Press, 2004.

**CS 302**

**Hardware and Software Co-design**

*Credits: 3:*

*Instruction : 3L hrs per week* *Duration of SEE : 3 hours*

*CIE : 30 Marks* *SEE : 70 Marks*

**UNIT-I**

**Nature of Hardware and Software**: Introduction to Hardware/Software Codesign, Issues in co-designs, Driving factors in Hardware/Software Codesign,
Data Flow Modelling and Implementation: Need for Concurrent Models, Analyzing Synchronous Data Flow Graphs, Software and Hardware Implementation of Data Flow.
Analysis of Control and Data Flow-Implementing Data and Control Edges and Construction of Data Flow Graphs and Applications.

**UNIT-II**

**Design Space of Custom Architectures**: Finite State Machine with Data Path- Cycle based Bit-parallel Hardware, Hardware Modules, Finite Sate machines with data path, Simulation and RTL Synthesis of FSMD, Limitations of Finite State Machines.
**Micro programmed Architectures**: Microprogrammed Control, Encoding, Datapath. Implementing Microprogrammed Machine, Interpreters and Pipelining.

**UNIT-III**

**General-Purpose Embedded Cores**: Processors, RISC Pipeline, Program Organization and Analysis of quality of Compiled Code.
**System On Chip**: Concept and Design Principles in SoC Architectures.

**UNIT-IV**

**Hardware/Software Interfaces:** On-Chip Busses-Connecting Hardware and Software, OnChip Bus Systems, Bus Transfers, Multimaster Bus Systems, OnChip Networks.
**Hardware/Software Interfaces:** Synchronization Schemes, Memory-mapped Interfaces, Coprocessor Interfaces and Custom-Instruction Interfaces.

**UNIT-V**

**Co Processor Control Shell Design:** CoProcessor Control Shell, Data Design, Control Design, Programmers Model, AES encryption coprocessor.
**Case Study:** Trivium Crpto-Coprocessor and CORDIC Coprocessor**.**

**Suggested Reading:**

1. Schaumont, Patric R, *A Practical Introduction to Hardware/Software Codesign*, 2nd Edition, Springer publishers, 2013.
2 Jargen Staunstrup, Wayne Wolf, *Hardware/Software Co-Design, Principles and Practice*, Kluwer Academic Publishers, 1997.

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