Item No.:28.38

M.Tech.- Advanced Computing Programme

Scheme of Study and the Syllabi

(for the students to be admitted from the academic year 2015-'16)

Course Objective: At the end of the programme, the Advanced Computing graduate shall :

- Prepare them for a career in exploiting and advancing towards new computing technologies
- Understand the fundamental concepts in design and analysis of advanced computing systems, with specialisation in the areas as Big Data Analytics, High Performance, Distributed, Perceptual, Granular, Evolutionary and Cloud Computing
- Complement their degree by doing research.

I SEMESTER

Course Code	Course Name	L	T	P	Credits
MADC101R04	Logic for Computer Engineers	4	0	0	4
MADC102R05	Advanced Computer Architecture	4	0	0	4
MADC103R03	High Performance Scientific Computing	3	1	0	4
MADC104R03	Distributed Computing	3	0	0	3
MADC105EXX	Elective – 1	4	0	0	4
MADC106EXX	Elective – 2	4	0	0	4
MADC107	High Performance Computing Lab	0	0	4	2
	Total	22	1	4	25

IISEMESTER

Course Code	Course Name	Lecture	Tutorial	Practical	Credits
MADC 201	Big Data Analytics	4	0	0	4
MADC 202	Nano Computing	4	0	0	4
MADC 203	Semantic Web and Social Networks	3	1	0	4
MADC 204	Perceptual Computing	3	0	0	3
MADC 205EXX	Elective – 3	4	0	0	4
MADC 206EXX	Elective – 4	4	0	0	4
MADC 207	Big Data Analytics Lab	0	0	4	2
MADC 208	Seminar	0	0	2	1
	Total	22	1	6	26

III SEMESTER

Course Code	Course Name	Lecture	Tutorial	Practical	Credits
MADC 301	Randomized Algorithms	4	0	0	4
MADC 302EXX	Elective – 5	4	0	0	4
MADC 303EXX	Elective – 6	4	0	0	4
MADC 304	Project Phase – I	0	0	12	6
	Total	12	0	8	18

IV SEMESTER

Course Code	Course Name	Lecture	Tutorial	Practical	Credits
MADC 401	Project Phase-II	0	0	24	12
	Total	0	0	24	12

Semester-wise Credit Distribution

Semester I : 25

Semester II : 26

Semester III : 18

Semester IV : 12

Total Credits : 81

List of Electives

1. E01 Advanced Database Design
2. E02 Cloud Computing
3. E03 Computational Complexity
4. E04 Evolutionary Computing
5. E05 Fault Tolerant Computing
6. E06 Game Theory
7. E07 Granular Computing
8. E08 High Speed Networks
9. E09 Information Retrieval
10. E10 Internet of Things
11. E11 Mobile and Ubiquitous Computing
12. E12 Multi Agent Systems
13. E13 Optical Computing
14. E14 Spatial Computing
15. E15 Virtualization Techniques
16. E16 Wireless Sensor Networks

MADC 101R04 LOGIC FOR COMPUTER ENGINEERS

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course Objective: *To understand the basic principles of a wide variety of logic and put its use in practical real world applications.*

UNIT – I **Propositional and First Order Logic** **12 Hours**

Propositional Logic – Principles of Satisfiability, Validity, Soundness and Completeness – Consistency – Strong Completeness and Compactness - Davis Putnam Algorithm – DPLL algorithm – Usage of DPLL algorithm for solving real world problems – Improving DPLL algorithm – Stochastic algorithms – Complexity of SAT - First Order Logic – Gentzen System – Hilbert System – Equivalence – C-Rule – Skolem theorem

UNIT – II First Order Logic and Pi Calculus **12 Hours**

First Order Logic Normal Forms – Herbrand Models – Theorem – Ground Resolution – Substitution – Unification - Soundness and Completeness of General Resolution – Horn Clauses – Undecidability and Model Theory of First Order Logic Pi Calculus – Inductive Principles – Asynchronous Pi Calculus – Reduction semantics – Action semantics – Justifying bisimulation equivalence

UNIT – III Verification of sequential and concurrent programs using Temporal Logic **12 Hours**

Temporal Logic – Introduction – Properties – Linear Temporal Logic – Deductive System - Theorems of L – Soundness and Completeness of L - Verification of Sequential Programs – verification of Concurrent programs – Formalization of Correctness - Deductive Verification of Concurrent Programs - Programs as Automata - Model Checking of Invariance Properties - Model Checking of Liveness Properties – Expressing an LTL Formula as an Automaton - Model Checking Using the Synchronous Automaton - Branching-Time Temporal Logic - Symbolic Model Checking

UNIT – IV Lambda Calculus **12 Hours**

Lambda Calculus – Combinatory Logic – Power of Lambda and Combinators – Representing computable functions – Undecidability theorem

UNIT – V Application of Lambda calculus in Functional Programming 12 Hours

Functional Programming in Standard ML – Types – Lists – Tuples – Function types and expressions – Standard Functions – Comparison Operators - Recursion – Tuple selection – Pattern matching – Type expressions – Variables and Polymorphism – New Types - Trees – Lambda calculus in SML – Functional Programming and LISP – Applications of pi calculus in modelling a firewall

References

1. Mordechai Ben-Ari, Mathematical Logic for Computer Science Third Edition, Springer Publications, 2012.

2. Greg Michaelson, "An Introduction to Functional Programming through Lambda Calculus", Dover Publications, 2011

3. J. Roger Hindley, Jonathan P. Seldin, "Lambda-Calculus and Combinators, An Introduction," , Cambridge University Press, Second Edition, 2008.

4. Mathew Hennessy," A Distributed Pi Calculus ", Cambridge University Press, 2007

5. Henk Barendregt, Erik Barendsen, "Introduction to Lambda Calculus", Revised edition, March 2000.

Learning Outcomes

Unit I	The learner will understand the various properties associated with logic and apply the same to solve the associated problems.
Unit II	The learner will understand first order logic and pi calculus
Unit III	The learner will understand lambda calculus and apply to solve the associated problems
Unit IV	The learner will analyse sequential and concurrent programs using temporal logic.
Unit V	The learner will apply Lambda calculus and Pi calculus in solving real world problems using functional programming

MADC 102R05 ADVANCED COMPUTER ARCHITECTURE

L	T	P	C
4	0	0	4

Course Objective: *To help the learners to understand the fundamentals of various architectures and educate them how these concepts are applied in the modern computer architectures.*

Unit - I Fundamentals of Quantitative Design and Analysis 11 Hours

Introduction, Classes of Computers, Defining Computer Architecture, Trends in Technology, Trends in Power and Energy in Integrated Circuits, Trends in Cost, Dependability, Measuring, Reporting, and Summarising Performance, Quantitative Principles of Computer Design.

Unit - II Memory Hierarchy Design: 11 Hours

Introduction, Ten Advanced Optimisations of Cache Performance, Memory Technology and Optimisations, Protection: Virtual Memory and Virtual Machines, Crosscutting Issues: The Design of Memory Hierarchies, Memory Hierarchies in ARM Cortex-A8 and Intel Core i7 , Case Studies

Unit - III Instruction – Level Parallelism and Its Exploitation 14 Hours

Instruction – Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Reducing Branch Costs with Advanced Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling, Dynamic Scheduling: Examples and the Algorithm, Hardware– Based Speculation, Exploiting ILP Using Multiple Issue and Static Scheduling.

Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation, Advanced Techniques for Instruction Delivery and Speculation, Studies of the Limitations of ILP, Cross-Cutting Issues: ILP Approaches and the Memory System, Multithreading: Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput.

Unit - IV Data – Level Parallelism in Vector, SIMD, and GPU Architectures 12 Hours

Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Crosscutting Issues, Putting It All Together: Mobile Versus Server GPUs and Tesla versus Core i7.

Unit - V Thread – Level Parallelism 12 Hours

Introduction, Centralized Shared-Memory Architectures, Performance of Symmetric Shared-Memory Multiprocessors, Distributed Shared-Memory and Directory-Based Coherence, Synchronization: The Basics, Models of Memory Consistency: An Introduction, Crosscutting Issues, Putting It All Together: Multicore Processors and Their Performance.

References

1. John L. Henessy and David A. Patterson, "Computer Architecture: A Quantitative Approach", Fifth Edition, Elsevier, 2012.
2. Kai Hwang and Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", Second Edition, Tata McGraw Hill, 2011.

Learning Outcomes

Unit I	The learner will have an understanding about the basic concepts of computer architecture and its performance analysis
Unit II	The learner will have an understanding about the memory hierarchical design and how it is implemented in the modern computer architectures.
Unit III	The learner will have an understanding about the Instruction Level and Thread Level parallelism concepts. The learner will apply these concepts to improve the uniprocessor throughput.
Unit IV	The learner will understand the fundamentals of data level parallelism in Vector, SIMD and GPU architectures. The learner will analyse the performance of data level parallelism in Mobile & Server GPU's and Tesla & Core i7.
Unit V	The learner will understand the basic concepts of shared memory architectures. The learner will analyse the performance multicore architectures.

MADC 103 R03 HIGH PERFORMANCE SCIENTIFIC COMPUTING

(Common for MTech ADC and CSE)

L	T	P	C
3	1	0	4

Course Objective: *At the end of this course, the learner will 1.Understand the demand for computational speed, various types of parallel computers and cluster computing, 2.Apply various parallel programming techniques to solve simple problems like sorting, prime number generation, LU factorization, graph partioning etc.,3.Understand the basic concepts of synchronization and dynamic load balancing*

UNIT – I **10 Hours**

Parallel computers – Basic techniques – Demand for computational speed – Potential for increased computational speed – Types of parallel computers – Cluster computing.

UNIT- II **12 Hours**

Parallel computations – Pipeline techniques - Memory hierarchy and pipelines – Computing platform for pipelined applications – Pipeline program examples: adding numbers, sorting numbers, prime number generation.

UNIT- III **14 Hours**

Basics of programming using Message Passing Interface – Debugging and evaluating parallel programs – Basic linear algebra: Using BLAS – Vector norms and matrix norms– Parallel matrix multiplication: Triple nested for-loop algorithm, block matrix multiplication algorithms, BMR algorithm – Parallel LU factorization – Parallel triangular solve – Sparse matrices – Parallel direct solvers for sparse matrices.

UNIT- IV **12 Hours**

Partitioning – Partitioning strategies – Divide and conquer examples: sorting using bucket sort –Heuristic graph partitioning using Kernighan-Lin algorithm - Multilevel graph partitioning using Metis – Numerical integration – Synchronous computations - Barriers: counter based approach, tree based approach, butterfly approach.

UNIT- V **12 Hours**

Data parallel computations – Synchronous iterations –– Solving a system of linear equations by iteration–Conjugate Gradient method–Dynamic load balancing - Searching a graph - Shortest path problem.

References

1. Barry Wilkinson and Michael Allen, Parallel Programming Techniques and Applications using Networked Workstations and Parallel Computers, Second Edition, Pearson & Prentice Hall, 2005
2. Kai Hwang, zhiweixu, "Scalable parallel computing Technology / Architecture / programming",McGraw Hill International, 2000..
3. David.E. Culler, Jaswinder Pal Singh with Anoop Gupta, "Parallel computer Architecture, A Hardware or Software approach", Morgan Kaufmann Publication, First edition 1999.
4. MichaelJ.Quinn,"ParallelComputing,theory&Practice",McGrawHillSecond Edition, 1994.
5. IanFoster,"DesigningandBuildingParallelPrograms",Addison-Wesley,ISBN0-201-57594-9, 2004

Learning Outcomes

Unit - I	The learner will understand the basics of parallel computation, types of parallel computers, computational speed and cluster computers
Unit - II	The learner will understand basics of pipeline design and apply the same to generate prime numbers and to sort a list of numbers
Unit -III	The learner will understand the basics of MPI and BLAS. The learner will apply MPI to solve problems like Matrix multiplication and LU factorization. Analyse the performance of the Matrix operations in MPI and BLAS
Unit -IV	The learner will apply the divide and conquer technique to perform numerical integration and graph partition. They will also understand the basic concepts of barriers in parallel computation
Unit-V	The learner will apply the data parallelization techniques to search a given graph, solve a system of linear equations and computing the shortest path between two nodes in a graph

MADC 104R03 DISTRIBUTED COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To learn the basic concepts of distributed systems, communication with coordination and computing aspects of distributed systems.*

Unit – I **12 Hours**

Characterization of Distributed Systems: Introduction-Examples-Trends-Resource Sharing-Challenges. System Models: Introduction-Physical Models-Architectural models-Fundamental Models. Inter Process Communication: Introduction-API for IP's-External data representation and Marshalling-Multicast Communication-Network Virtualization-Case Study: MPI.

Unit - II **12 Hours**

Remote Invocation: Introduction-Request reply protocols-Remote Procedure Call-Remote Method Invocation-Case Study: Java RMI. Indirect Communication: Introduction-Group Communication-Publish Subscribe Systems-Message queues-Shared Memory approaches. Distributed Objects and Components: Introduction-Distributed Objects-Case study: CORBA-Object to Components-Case Studies: EJB and Fractals.

Unit – III **12 Hours**

Peer To Peer Systems: Introduction-Napster and its legacy-Peer to Peer Middleware-Routing overlays-Case Studies: Pastry, Tapestry, Squirrel, OceanStore,Ivy. Distributed File Systems: Introduction-File Service architecture-Case Studies: Sun NFS and Andrew NFS. Name Services: Introduction-Name Services and Domain Name System-Directory Services-Case Studies: Global Name Service-X.500 Directory Service. Time and Global States: Introduction-Clocks, events and Process States-Synchronizing Physical Clocks-Logical time and Logical Clocks-Global States-Distributed debugging.

Unit – IV **12 Hours**

Coordination and Agreement: Introduction-Distributed Mutual Exclusion-Elections-Coordination and agreement in group communication-Consensus and related problems. Transactions and Concurrency Control: Introduction-Transactions-Nested Transactions-Locks-Optimistic Concurrency control-Timestamp ordering-Comparison methods for concurrency control. Distributed Transactions: Introduction-Flat and nested distributed transactions-Atomic commit protocols-Concurrency control in distributed transactions-Distributed deadlocks-Transaction recovery.

Unit – V **12 Hours**

Replication: Introduction-Model and role of group communication-Fault tolerant services-Case Studies: Gossip, Bayou and Coda-Transactions with replicated data. Distributed Multimedia Systems: Introduction-Characteristic of Multimedia data-QOS-Resource Management-Stream adaptation-Case Studies: Tiger, BitTorrent and End System Multicast.

References

1. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair "Distributed Systems: Concepts and Design", Pearson, 2012.
2. AndrewS.Tanenbaum, Maarten van Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2007.

Learning Outcomes

Unit - I	The learner will understand the basic concepts of distributed systems, their physical and architectural models. They learn about the IPC in distributed systems.
Unit - II	The learner will understand the concepts of remote procedure call and remote method invocation in distributed systems.
Unit - III	The learner will have the knowledge of various file system concepts and naming services.
Unit - IV	The learner will understand the group communication and coordination for communicating in a distributed system.
Unit - V	The learner will understand the concepts of fault tolerant systems and QOS aspects.

MADC107R02 DISTRIBUTED AND HIGH PERFORMANCE COMPUTING LAB

L	T	P	C
0	0	4	2

Course Objective: *To help the learners understand the concept of parallel computation for a problem, concept of Message Passing Interface and implementation of various parallel algorithms using MPI library functions in C.*

List of Exercises

Implement the following programs in **MPI-C**:

1. Implementation of Miller -Rabin algorithm to test whether the given number is prime or not.
2. Implementation of Brute force attack on any cryptography technique.
3. Implementation of Parallel Matrix chain Multiplication algorithm.
4. Develop a parallel algorithm for finding the area under a curve using Trapezoidal rule.
5. Implementation of Regression analysis technique on Big-Data.
6. Implementation of parallel Fast Fourier transformation algorithm.
7. Implementation of Parallel Conjugate Gradient Method.
8. Implementation of parallel ACO technique to solve Travelling salesman problem.
9. Solve Resource scheduling problem using Parallel Genetic algorithm.
10. Implementation of shortest path algorithm in parallel.
11. Implementation of parallel sorting technique.
12. Solving system of equations using Parallel Jacobi Method.

Learning Outcomes

Exercise - 1	The learners will have the understanding of the Miller –Robin algorithm to test the given number is prime or not and the implementation of this algorithm using MPI libraries.
Exercise – 2	The learners will be able to perform brute force attack to predict the secrete key used in symmetric/asymmetric encryption and the implementation of this attack using MPI libraries
Exercise – 3	The learners will be able to solve matrix chain multiplication problem, and computes the product of matrices with lesser number of arithmetic operations and implements the algorithm using MPI libraries.
Exercise – 4	The learners will be able to find the area under the curve using Numerical Integration methods and implements it using MPI libraries.
Exercise – 5	The learners will have the understanding of the regression analysis on Big-Data and implements it using MPI libraries.
Exercise – 6	The learners will be able to compute Fourier transform of a function using FFT and implements it using MPI libraries.
Exercise – 7	The learners will have the understanding of Conjgate Gradient Method and implement using MPI libraries.
Exercise – 8	The learners will be able to solve combinatorial optimization problems using parallel ACO and implements it using MPI libraries.
Exercise – 9	The learners will have the understanding of solving resource scheduling problem using Genetic algorithm and implements the same using MPI libraries.
Exercise – 10	The learners will have the understanding of the concept of Dijkstra's algorithm to find the shortest path.
Exercise – 11	The learners will be able to implement the different parallel sorting techniques such as Quick sort, Merge sort, heap sort etc., in multi-processor system to reduce the time complexity.
Exercise – 12	The learners will be able to solve linear system of equations and implements the same using MPI libraries.

MADC 201 BIG DATA ANALYTICS

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course Objective: *This course covers foundational techniques and tools required for data science and big data analytics. The course focuses on concepts, principles, and techniques applicable to any technology environment and industry and establishes a baseline that can be enhanced by further formal training and additional real-world experience.*

UNIT - I INTRODUCTION TO BIG DATA **12 Hours**

Introduction to Big Data Platform – Traits of Big data -Challenges of Conventional Systems - Web Data – Evolution Of Analytic Scalability - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT - II DATA ANALYSIS **12 Hours**

Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear Systems Analysis - Nonlinear Dynamics - Rule Induction - Neural Networks: Learning And Generalization - Competitive Learning - Principal Component Analysis and Neural Networks - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees - Stochastic Search Methods.

UNIT - III MINING DATA STREAMS **12 Hours**

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

UNIT - IV FREQUENT ITEMSETS AND CLUSTERING **12 Hours**

Mining Frequent Item sets - Market Based Model – Apriori Algorithm – Handling Large Data Sets in Main Memory – Limited Pass Algorithm – Counting Frequent Item sets in a Stream – Clustering Techniques – Hierarchical – K-Means – Clustering High Dimensional Data – CLIQUE And PROCLUS – Frequent Pattern based Clustering Methods – Clustering in Non-Euclidean Space – Clustering for Streams and Parallelism.

UNIT - V HADOOP AND R FOR VISUALIZATION **12 Hours**

Background and fundamentals-moving data in and out of Hadoop-data serialization-applying Map Reduce patterns to big data- streaming big data-integrating R and Hadoop for statistics and more-predictive analytics with Mahout- Hacking with Hive-Programming pipelines with pig – HBase-MySQL-NoSQL- R Hadoop

References

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.

2. Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.

3. Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.

4. Glenn J. Myatt, “Making Sense of Data”, John Wiley & Sons, 2007

5. Pete Warden, “Big Data Glossary”, O’Reilly, 2011.

6. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier, Reprinted

7. Alex Holmes , “Hadoop in Practice” 2012 by Manning Publications.

8. A.Ohri, “R for Business Analytics”

9. Prabhanjan Narayanachar Tattar, “R Statistical Application Development by Example Beginner's Guide” .

Learning Outcomes

Unit - I	The learner will understand the basic concepts big data, comparison of reporting and analysing and sampling.
Unit - II	The learner will understand the concepts of various data analysis methods. They learn the basic aspects of neural and fuzzy networks.
Unit - III	The learner will have the knowledge of data streaming with the help of RTAP applications.
Unit - IV	The learner will learn to cluster the data using various clustering mechanisms.
Unit - V	The learner will be able to use the tools such as R and R-Studio, Map-Reduce/Hadoop and select visualization techniques and tools to analyze big data and create statistical models

MADC 202 NANO COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To help the learners understand the underlying principles of various technologies available, techniques, architecture and working of Nano Computers.*

UNIT - I **12 Hours**

Nano computing-Prospects and Challenges-Introduction History of Computing, Nano computing Quantum Computers, Nano computing Technologies, Quantum Computers, Nano computing Technologies, Nano Information Processing, Challenges. Physics of Nano computing-Digital Signals and Gates, Silicon Nano electronics, Carbon Nanotube Electronics, Carbon Nanotube Field-effect Transistors.

UNIT - II **12 Hours**

Nano computing with Imperfections- Introduction, Nano computing in the Presence of Defects and Faults, Defect Tolerance, Towards Quadrillion Transistor Logic Systems-Cell Matrix, Overcoming Manufacturing Defects.

UNIT - III **12 Hours**

Reliability of Nano computing-Markov Random Fields, Reliability Evaluation Strategies, NANOLAB & NANOPRISM. Nanoscale Quantum Computing-Quantum Computers, Hardware Challenges to Large Quantum computers, Fabrication, Test, and Architectural Challenges, Quantum-dot Cellular Automata, Computing with QCA, QCA Clocking, QCA Design Rules.

UNIT - IV **12 Hours**

QCA Designer Software and QCA Implementation-Basic QCA Circuits using QCA Designer-QCA Full-adder, QCA. The Basic Device and Circuit Elements, The Majority Gate, A Wire, A 45-degree Wire, Off-centre Wires, Wire Crossings in the Plane.

UNIT - V **12 Hours**

Molecular and Optical Computing-Molecular Computing, Optical Computing-Introduction, Current Use of Optics for Computing, Some Roles for Optics, Optical Computing Paradigms, Ultrafast Pulse Shaping and Tb/sec Data Speeds-The Role of Non-linear Optics in Optical Computing: Need for New Materials, Advances in Photonic Switches.

References

1. Vishal Sahni and Debabrata Goswami, “Nano Computing: The future of Computing” Tata Mcgraw Hill Edition 2008.
2. Mark A Ratner, Daniel Ratner, Mark Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", 1st Edition, Prentice Hall of India, 2002.
3. Jack Uldrich and Deb Newberry, "The Next Big Thing Is Really Small: How Nanotechnology Will Change the Future of Your Business",1st Edition, Crown Business, 2003.
4. Douglas Mulhall, "Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform Our World", Prometheus Books, 2002.

Learning Outcomes

Unit - I	The learner will understand the concepts and technologies in Nano technology, various types of transistor replacement available and the challenges involved in building such machines.
Unit - II	The learner will understand the defects and faults during design and the methods to overcome these defects.
Unit - III	The learner will analyse the reliability of the design of Nano circuits using the tools Nano lab and Nano prism.
Unit - IV	The learner will understand the principle involved in QCA designer and its implementation.
Unit - V	The learner will understand the working of optical and molecular computing.

MADC 203 PERCEPTUAL COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To educate the learner to interact with the Perceptual Computer (Per-C) using a context dependent vocabulary and to assist people to make subjective judgements.*

Unit – I **12 Hours**

Introduction: Perceptual Computing -Examples -Historical Origins of Perceptual Computing -Validation of the Perceptual Computer-The Choice of Fuzzy Set Models for the Per-C. Interval Type-2 Fuzzy Sets: Review of Type-1 Fuzzy sets-Introduction to Interval Type-2 Fuzzy Sets -Definitions -Wavy-Slice Representation Theorem -Set-Theoretic Operations -Centroid of an IT2 FS-KM Algorithms-Cardinality and Average Cardinality of an IT2 FS .

Unit – II **14 Hours**

Encoding: From a Word to a Model—The Code book : Introduction -Person FOU Approach for a Group of Subjects-Collecting Interval End-Point Data-Interval End-Points Approach-Interval Approach-Hedges. Decoding: Introduction-Similarity Measure Used as a Decoder-Ranking Method Used as a Decoder-Classifier Used as a Decoder. Novel Weighted Averages as a CWW Engine: Introduction-Novel Weighted Averages-Interval Weighted Average-Fuzzy Weighted Average-Linguistic Weighted Average-A Special Case of the LWA-Fuzzy Extensions of Ordered Weighted Averages.

Unit – III **14 Hours**

IF–THEN Rules as a CWW Engine—Perceptual Reasoning: Introduction-A Brief Overview of Interval Type-2 Fuzzy Logic Systems-Perceptual Reasoning: Computations-Perceptual Reasoning: Properties -Examples . Assisting in Making Investment Choices—Investment Judgment Advisor (IJA): Introduction-Encoder for the IJA-Reduction of the Codebooks to User-Friendly Codebooks-CWW Engine for the IJA-Decoder for the IJA-Examples-Interactive Software for the IJA.

Unit – IV **8 Hours**

Assisting in Making Social Judgments—Social Judgment Advisor (SJA): Introduction-Design an SJA -Using an SJA. Assisting in Hierarchical Decision Making—Procurement Judgment Advisor (PJA): Introduction - Missile Evaluation Problem Statement -Per-C for Missile Evaluation: Design -Per-C for Missile Evaluation: Examples -Comparison with Previous Approaches.

Unit – V **12 Hours**

Assisting in Hierarchical and Distributed Decision Making Journal Publication Judgment Advisor (JPJA): Introduction -The Journal Publication Judgment Advisor (JPJA)-Per-C for the JPJA-Examples.

References

1. JERRY M. MENDEL, DONGRUI WU, "PERCEPTUAL COMPUTING Aiding People in Making Subjective Judgments", John Wiley & Sons, 2010.
2. Intel(R) Perceptual Computing SDK Documentation.

Learning Outcomes

Unit - I	The learner will learn the basics about perceptual computer and be able to validate a Perceptual computer with the help of Fuzzy sets.
Unit -II	The learner will be able to transform words into Fuzzy sets and vice versa. (Encoder and decoder).
Unit-III	The learner will understand to comprehend a decision and will be able to choose an appropriate CWW engine for a specific application.
Unit IV	The leaner will understand the various judgement advisors.
Unit V	The learner will be able to assist in hierarchical and distributed decision making journal publication judgment advisor.

MADC 204 SEMANTIC WEB AND SOCIAL NETWORKS

L	T	P	C
3	1	0	4

Course Objective: *To describe the various concepts and technologies that make up the Semantic Web landscape, Prepare artifacts (e.g. component ontologies, architectures) and assess the value and applicability of Semantic Web approaches to various problems.*

UNIT – I **12 Hours**

Towards the idea of Semantic web - Building Block of Semantic Web – Abstract Model of RDF – RDF Serialization – Formats – Rules of RDF – XML vs RDF – Use of a RDF Validator

UNIT – II **12 Hours**

RDF related technologies – Micro formats – RDFa – GRDDL. RDFS and Ontology – Core Elements – Concept of Ontology – Building Bridge to Ontology – Inferencing based on RDF schema.

UNIT – III **14 Hours**

OWL : OWL1 Web ontology Languages - Defining Classes, Properties - Camera Ontology OWL2 Web ontology Languages - New Constructs for Common Patterns - Improved Expressiveness for Properties - Extended Support for Datatypes - Punning and Annotations - Other OWL 2 Features - OWL Constructs in Instance Documents v- OWL 2 Profiles - Camera Ontology.

UNIT – IV **10 Hours**

Managing Space and Time - Space and Time in Software - Spatial Information - Temporal Information - Representing Spatiotemporal Data on the Semantic Web - Working with Spatial Data – Spatial and Transaction Time Bounded Queries Framing the Problem - Approach and Rationale – Components. Aggregating Disparate Data Sources - Annotating Unstructured Data - Annotation Management.

UNIT – V **12 Hours**

Social Networks and the Semantic Web - Overview of Social Networking Websites -Facebook's Open Graph Protocol - Open Graph Protocol - How Does It Work: Creating Typed Links Using OGP - Implications for the Semantic Web -Twitter Cards for Structured Information - Rich Pins for Structured Information . Building the Foundation for Development on the Semantic Web - Development Tools for the Semantic Web - Frameworks for the Semantic Web Applications - Reasoners for the Semantic Web Applications - Ontology Engineering Environments - Other Tools: Search Engines for the Semantic Web - Semantic Web Application Development Methodology - From Domain Models to Ontology-Driven

Architecture - An Ontology Development Methodology Proposed by Noy and McGuinness

References

1. Liyang Yu, " A Developer's Guide to the Semantic Web, Springer, 2nd Edition, 2014
2. John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, "Semantic Web Programming", Wiley India, 1st edition, 2009
3. John Davies, Rudi Studer, Paul Warren, "Semantic Web Technologies: Trendz and Research in Ontology-Based Systems", Wiley India, 2006
4. Grigoris Antoniou, Frank Van Harmelen, "A Semantic Web Primer", 2nd Edition, Cooperative Information Systems, MIT Press, 2008.

Learning Outcomes

Unit - I	The learner will be able to provide a comprehensive exposition of the state-of-the art in Semantic Web research and key technologies.
Unit - II	The learner will be able to explain the use of ontologies and metadata to achieve machine-interpretability.
Unit - III	The learner will be able to describe methods for ontology learning and metadata generation.
Unit - IV	The learner will be able to identify and apply various tools and techniques for working with spatial data.
Unit - V	The learner will be able to Illustrate the theoretical concepts with case studies on industrial applications

MADC 207 BIG DATA ANALYTICS LAB

L	T	P	C
0	0	4	2

Course Objective: *To understand and apply the Big Data Flow to actual projects being able to describe and apply the Data Analytics lifecycle to Big Data projects process, To identify and successfully apply appropriate techniques (such as ML) and tools to solve actual Big Data problems (derive value from vast data sets), To have an in-depth understanding of the Big Data ecosystem, specifically the Apache projects HDFS,HIVE, MapReduce, NoSQL,Pig and Mahout.*

List of Experiments

1. Develop a single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux and configure a 3-node Hadoop cluster.
2. Loading unstructured data into Hadoop Distributed File System.
3. Develop a word count program using interactive Hadoop Map Reduce job flow.
4. Develop a Distributed Application using Map Reduce for finding the coolest year from the available Weather data
5. Find out the list of users who owns a file having maximum size in the current working directory using Pig.
6. Write a Map Reduce Application which processes a log file of a system. List out the users who have logged for max period on the system. Use sample Log file from the internet and process it using a pseudo distribution mode on Hadoop platform with Hive.
7. Develop a system to pull your data into Hadoop Map-Reduce jobs, process the data and return results back to a NoSQL database collection.
8. Develop a system to perform the following task. Clustering takes documents and groups them into groups of topically related documents. Classification learns from existing categorized documents what documents of a specific category look like and is able to assign unlabelled documents to the correct category using Mahout Machine learning library.
9. Develop a system to analyse attack patterns in network usage using counter based method, and access pattern based method using Hive Hadoop.
10. Develop R script that will determine the top 5 female names in 2010.
11. Create high quality data visualizations using R.
12. Develop a system to cluster the similar web documents based on the tag specified in the HTML file using R tool.

Learning Outcomes

Exercise 1	The Learners will understand the basic hadoop commands.
Exercise 2	The Learners will understand the concepts of HDFS file.
Exercise 3	The Learners will understand the concept of Hadoop MapReduce
Exercise 4	The Learners will understand the some application program using Hadoop MapReduce
Exercise 5	The Learners will understand how to work with Pig
Exercise 6	The Learners will understand how to work with Hive
Exercise 7	The Learners will understand how to process NoSQL
Exercise 8	The Learners will understand the concepts of classification and clustering technique in Hadoop
Exercise 9	The Learners will understand how to implement Security in hadoop
Exercise 10	The Learners will understand how to write R script
Exercise 11	The Learners will understand how to visualize the data using R
Exercise 12	The Learners will understand how to extract the web data from web pages using R

MADC301 RANDOMIZED ALGORITHMS

L	T	P	C
4	0	0	4

Course Objectives: *By the end of the semester each student will, understand the design of randomized algorithms, Analyse the asymptotic performance of randomized algorithms, Apply randomized algorithm design in common problems like Routing in a Parallel Computer, Linear Programming, Byzantine Agreement etc.*

Unit – I **12 Hours**

Introduction: Min-Cut algorithm-Las Vegas and Monte Carlo-Binary Planar Partitions-Probabilistic Recurrence-Computation Model and Complexity Classes. Game Theoretic Techniques: Game Tree Evaluation-Minimax Principle-Randomness and Non Uniformity. Moments and Deviations: Occupancy Problems-Markov and Chebyshev Inequalities-Randomized Selection-Two Point Sampling-Stable Marriage Problem-Coupon Collectors Problem.

Unit – II **12 Hours**

Tail Inequalities: Chernoff Bound-Routing in a parallel Computer-Wiring Problem-Martingales. Probabilistic Method: Overview-Maximum Satisfiability-Expanding Graphs-Routing-Lovasz Local Lemma-Method of Conditional Probabilities. Markov Chains and Random Walks: 2 SAT Example-Markov Chains-Random walks on Graphs-Electrical Networks-Cover times-Graph Connectivity-Expanders and Rapidly mixing Random walks-Probability amplification by Random Walks on Expanders.

Unit – III **12 Hours**

Algebraic Techniques: Fingerprinting and Freivald's Technique-Verifying Polynomial Identities-Perfect Matchings in Graphs-Verifying Equality of Strings-Comparison of Fingerprinting Techniques-Pattern Matching-Interactive Proof Systems-PCP and Efficient Proof Verification. Data Structures: Fundamental Data Structuring Problem-Random Treaps-Skip lists-Hash tables-Hashing with O(1) Search Time. Geometric Algorithms and Linear Programming: Randomized Incremental Construction-Convex Hulls in the Plane-Duality-Half space Intersections-Delaunay Triangulations-Trapezoidal decompositions-Binary space partitions-Diameter of a Point Set-Random Sampling-Linear Programming.

Unit – IV **12 Hours**

Graph Algorithms: All Pairs Shortest Paths-Min-Cut Problem-Minimum Spanning Trees. Approximate Counting: Randomized Approximation Schemes-DNF Counting Problem-Approximating the Permanent-Volume Estimation.

Unit – V **12 Hours**

Parallel and Distributed Algorithms: PRAM Model-Sorting on a PRAM-Maximal Independent Sets-Perfect Matchings-Choice Coordination Problem- Byzantine Agreement. Online Algorithms: Online Paging Problem-Adversary Models-Paging against an Oblivious Adversary-Relating the Adversaries-Adaptive Online Adversary-k-Server Problem.

References

1. Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms", Cambridge University Press, 2006.
2. Devdatt P. Dubhashi , Alessandro Panconesi, " Concentration of Measure for the Analysis of Randomized Algorithms", Cambridge University Press; 1 edition, 2009.

Learning Outcomes

Unit I	The learner will have an understanding about LasVegas and MonteCarlo methods. They will apply these methods respectively to solve Random Quick Sort and MinCut Problems
Unit II	The learner will understand tail inequalities, probabilistic methods and random walks. They will apply these concepts to solve wiring, routing in a parallel computer and resistive electrical network problems
Unit III	The learner will understand the various algebraic techniques and apply the same to determine perfect matchings and finger print verification. The learner will apply the randomized algorithmic techniques to create Skip lists, Hash tables, Delaunay Triangulations and Linear Programming
Unit IV	The learner will apply randomized algorithmic techniques to solve all pairs shortest paths, minimum spanning trees, DNF counting and volume estimation problems
Unit V	The learner will understand the design of randomized parallel, distributed and online algorithms. The Learners will apply these design techniques to sorting, Maximal Independent Sets, Perfect Matchings, Choice Coordination, Byzantine Agreement, Paging and k-server problems

Electives - ADVANCED DATABASE DESIGN

L T P C

4 0 0 4

Course Objective: *To understand the advanced concepts in DBMS with case studies on Oracle and Microsoft SQL Server.*

UNIT- I **12 Hours**

Object and Object Relational Databases: Overview of Object Database Concepts - Object-Relational Features: Object Database Extensions to SQL- The ODMG Object Model and the Object Definition Language ODL-Object Database Conceptual Design -The Object Query Language OQL-Overview of the C++ Language Binding in the ODMG Standard

XML: Structured, Semistructured, and Unstructured Data- XML Hierarchical (Tree) Data Model-XML Documents, DTD, and XML Schema-Storing and Extracting XML Documents from Databases -XML Languages- Extracting XML Documents from Relational Databases

UNIT- II **12 Hours**

Distributed Databases: Distributed Database Concepts-Types of Distributed Database Systems-Distributed Database Architectures - Data Fragmentation, Replication, and Allocation Techniques for Distributed Database Design-Query Processing and Optimization in Distributed Databases-Overview of Transaction Management in Distributed Databases-Overview of Concurrency Control and Recovery in Distributed Databases-Distributed Catalog Management. Current Trends in Distributed Databases -Distributed Databases in Oracle

UNIT- III **12 Hours**

Parallel Databases: Introduction-I/O Parellelism-Interquery Parallelism-Intraquery Parallelism-Intraoperation Parallelism-Interoperation Parellelism-Query optimization-Design of Parallel Systems-Parallelism on Multicore Processors

Information Retrieval: Overview-Relevance-Ranking Using Terms-Relevance Using Hyperlinks-Synonyms, Homonyms and Ontologies-Indexing of Documents-Measuring Retrieval Effectiveness-Crawling and Indexing the Web-Information Retrieval: Beyond Ranking of Pages-Directories and Categories

UNIT- IV **12 Hours**

Enhanced Data Models for Advanced Applications: Active Database Concepts and Triggers- Temporal Database Concepts-Spatial Database Concepts-Multimedia Database Concepts-Introduction to Deductive Databases

UNIT – V **12 Hours**

Case Studies: Oracle-Database Design and Querying Tools-SQL Variations and Extensions-Storage and Indexing-Query Processing and Optimization-Concurrency Control and Recovery-System Architecture-Replication, Distribution and External Data-Database Administration Tools-Data Mining

Microsoft SQL Server-Management, Design and Querying Tools-SQL Variations and Extensions-Storage and Indexing-Query Processing and Optimization-Concurrency and Recovery-System Architecture-Data Access-Distributed Heterogeneous Query Processing-Replication-XML Support-SQL Server Service Broker-Business Intelligence

References

1) **Databasae System Concepts,** Abraham Silberschatz, Henry F. Korth,S.Sudarshan, McGraw-Hill International Edition, Sixth Edition, 2011 (Unit – III and V).
2) **Fundamentals of Database Systems,** Elmasiri Navathe, Sixth Edition, Pearson Education, 2011 (Unit – I, II and IV).
3) **Distributed Databases Principles & Systems,** Stefano Ceri, Giuseppe Pelagatti, McGraw Hill International Editions, International Edition,1985.
4) **Principles of Distributed Database Systems,** Tamer Ozsu, Patrick Valduriez, Third Edition, Springer, 2011.
5) **Advanced Database Technology and Design** – ebook, Mario Piattini, Oscar Diaz, Artech House, Boston. London. www.artechhouse.com.

Learning Outcomes

Unit-I	The learner will be able to understand about objects and object relational Databases and XML.
Unit-II	The learner will be able to understand the main concepts of Distributed Databases.
Unit-III	The learner will understand Parallel Databases and Concepts of Information Retrieval
Unit-IV	The learner will get a quick overview of enhanced data models for Advanced Applications.
Unit-V	The Learner will make a case study on the two main databases, namely Oracle and SQL Server.

CLOUD COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To help the learner understand current cloud computing technologies, different services, cloud security and its applications.*

Unit-I **12 Hours**

Defining Cloud Computing: Defining Cloud Computing - Cloud Types - Examining the Characteristics of Cloud Computing - Assessing the Role of Open Standards. Assessing the Value Proposition: Measuring the Cloud's Value - Avoiding Capital Expenditures - Computing the Total Cost of Ownership - Specifying Service Level Agreements - Defining Licensing Models. Understanding Cloud Architecture: Exploring the Cloud Computing - Connecting to the Cloud.

Unit-II **12 Hours**

Understanding Services and Applications by Type: Defining Infrastructure as a Service (IaaS) - Defining Platform as a Service (PaaS) - Defining Software as a Service (SaaS) - SaaS characteristics- Defining Identity as a Service (IDaaS) - Defining Compliance as a Service (CaaS). Understanding Abstraction and Virtualization: Using Virtualization Technologies - Load Balancing and Virtualization - Understanding Hypervisors - Understanding Machine Imaging - Porting Applications. Exploring Platform as a Service: Defining Services - Using PaaS Application Frameworks.

Unit-III **12 Hours**

Using Google Web Services: Exploring Google Applications - Surveying the Google Application Portfolio - Exploring the Google Toolkit - Working with the Google App Engine. Using Amazon Web Services: Understanding Amazon Web Services- Amazon Web Service Components and Services - Working with the Elastic Compute Cloud (EC2) - Working with Amazon Storage Systems - Understanding Amazon Database Services. Using Microsoft Cloud Services: Exploring Microsoft Cloud Services - Defining the Windows Azure Platform - Using Windows Live.

Unit-IV **12 Hours**

Understanding Cloud Security: Securing the Cloud - Securing Data - Establishing Identity and Presence. Understanding Service Oriented Architecture: Introducing Service Oriented Architecture - Defining SOA Communications - Managing and Monitoring SOA - Relating SOA and Cloud Computing. Moving Applications to the Cloud: Applications in the Clouds -

Applications and Cloud APIs. Working with Cloud-Based Storage: Measuring the Digital Universe Provisioning Cloud Storage - Exploring Cloud Backup Solutions - Cloud Storage Interoperability.

Unit-V **12 Hours**

Understanding Scientific Applications for Cloud Environments: Classification of Scientific Applications and Services in the Cloud - SAGA-based Scientific Applications that Utilize Clouds. MapReduce Programming Model and Implementations: MapReduce Programming Model -Major MapReduce Implementations for the Cloud - MapReduce Impacts and Research Directions.

An Architecture for Federated Cloud Computing: A Typical Use Case- The Basic Principles of Cloud Computing- A Model for Federated Cloud Computing – Security. SLA Management in Cloud Computing: Inspiration - Traditional Approaches to SLO Management -Types of SLA - Life Cycle of SLA- SLA Management in Cloud - Automated Policy-based Management.

References

1. Barrie Sosinsky, “Cloud Computing Bible”, Wiley Publishing, 2011. (Unit I, II, III, IV)
2. Rajkumar Buyya, James Broberg, Andrzej Goscinski, “Cloud Computing Principles and Paradigms”, John Wiley & Sons, 2011. (Unit V)
3. Dan Sullivan, “The Definitive Guide to Cloud Computing”, Realtime publishers, 2010.

Learning Outcomes

Unit-I	The learner will understand the basics of cloud computing, its pros & cons and the cloud architecture.
Unit-II	The learner will acquire knowledge on different services and the virtualization technologies.
Unit-III	The learner will understand the services provided by different providers like Google, Amazon and Microsoft.
Unit-IV	The learner will understand the service models and their security levels, standards used to create cloud service and cloud storage.
Unit-V	The learner will understand the scientific applications for cloud environment, MapReduce programming model and SLA management.

COMPUTATIONAL COMPLEXITY

L	T	P	C
4	0	0	4

Course Objectives: At the end of the Semester, the learner will understand the basic concepts of Computational Complexity, analyse a computational problem and classify whether it is simple or hard, understand the various complexity classes and apply the techniques used in reasoning about computational complexity.

Unit – I **12 Hours**

Computational Model: Encodings and languages-Modeling computation and efficiency-Universal Turing Machine-Deterministic Time and Class P. **NP and NP Completeness**: Class NP-Non Deterministic Turing Machines-Reducibility and NP Completeness-Decision versus Search-coNP, EXP, NEXP. **Space Complexity**: Configuration Graphs-Some space Complexity classes-PSPACE Completeness-NL Completeness.

Unit – II **12 Hours**

Diagonalization: Time and Space Hierarchy theorem-Non deterministic time hierarchy theorem-Ladner's theorem-Oracle machine's and the limits of diagonalization. **Polynomial Hierarchy and Alternations**: Sum and Product classes-Polynomial Hierarchy-Alternating Turing Machines-Time Space trade off for SAT-Hirerarchy definition via Oracle machines. **Circuits**: Boolean Circuits-Karp Lipton theorem-Circuit lower bounds-Non-Uniform Hierarchy theorem-Finer gradations among circuit classes-Circuits of Exponential size-Circuit Satisfiability.

Unit – III **12 Hours**

Decision Trees: Certificate Complexity-Randomized Decision Trees-Lower Bounds on Randomized Complexity-Techniques for decision tree lower bounds-Comparison trees and sorting lower bounds-Yao's Minmax lemma. **Communication Complexity**: Definition-Lower bound methods-Multiparty Communication Complexity-Probabilistic Communication Complexity-Other Communication models-Application of Computational Complexity. **Circuit lower bounds**: Hastad's Switching Lemma-Circuits with Counters-Lower bounds for monotone circuits-Various approaches using communication complexity.

Unit – IV **12 Hours**

Algebraic Computation Models: Algebraic computation trees-Algebraic circuits-Blum-Shub-Smale model. **Average Case Complexity**: Distributional Problems-DistNP and its Complete problems-Existence of Complete problems-Polynomial time Samplability.

Hardness Amplification and Error Correcting Codes: Hardness and Hardness Amplification-Yao's XOR lemma-Proof of Impagliazzo's Lemma-Constructions of Error Correcting Codes-Local decoding of explicit codes-List decoding-Local list decoding.

Unit – V **12 Hours**

PCP and Hardness of Approximation: PCP and locally testable proofs-PCP and Hardness of Approximation-$n^{-\delta}$ approximation of Independent set-PCP based on Walsh Hadamard Code-Proof of the PCP theorem. **More PCP theorems and Fourier Transform Technique**: Parallel repetition of PrPCP's-Hastad's 3 bit PCP theorem-Fourier Transform and its connection to PCP-Learning Fourier Coefficients-Other PCP theorems.

References

1. Sanjeev Arora and Boaz Barak, "Computational Complexity: A Modern Approach", Cambridge University Press, 2009.
2. Oded Goldreich, "Computational Complexity A Conceptual Perspective", Cambridge University Press, 2008.
3. Neil D. Jones "Computability and Complexity from a Programming Perspective", MIT Press, 1999.

Learning Outcomes

Unit-I	The learner will understand the basic concepts of various computational models, NP Completeness and Space Complexity.
Unit-II	The learner will understand diagonalization, Polynomial Hirerarchy and Boolean Circuits. The learner will apply these techniques to prove Space -Time Hirerachy theorem, Time and Space tradeoff for SAT and Circuit Satisfiability respectively.
Unit-III	The learner will understand the basic concepts of Decision Trees, Communication Complexity and Circuit Complexity. The learner will also analyze the lower bounds these concepts.
Unit-IV	The learner will understand the basic concepts of algebraic computational models, distribution models and error correcting codes. The learner will also apply these concepts to design BSS model, define random samplablility and construct error correcting codes.
Unit-V	The learner will understand Post Correspondence Problem theorems. The learner will also analyze the relationship between PCP and Fourier Transform.

EVOLUTIONARY COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *The main objective of this course is to develop knowledge of evolutionary computation techniques and methodologies set in the context of modern heuristic methods and to gain experience in matching various evolutionary computation methods and algorithms for particular classes of problems.*

UNIT-I **12 Hours**

Evolutionary algorithm: What is an Evolutionary algorithm? –components of evolutionary algorithm-example applications-working of an evolutionary algorithm-evolutionary computing and global optimization.

Genetic Algorithms: Representation of individuals-mutation-recombination-population models-parent selection-survivor selection-examples.

UNIT-II **12 Hours**

Evolution Strategies: Representation-selfadaptation, Evolutionary Programming, Genetic Programming. Learning classifier systems: Introduction-background-Zeroth Level Classifier System(ZCS)-XCS-Extensions-Examples.

UNIT-III **12 Hours**

Parameter Control Evolutionary Algorithms: Introduction-classification of control techniques-examples. **Multimodal problems and spatial distribution:** Introduction-Implicit measures-explicit diversity maintainenance-Multiobjective evolutionary algorithms-examples**.**

Memetic algorithms: Motivation-a brief introduction to local search-structure of a memetic algorithm-Design issues of memetic algorithms-Example.

UNIT-IV **12 Hours**

Theory: Schema Theorem-Dynamical systems-Markov Chains-Statistical Mechanics approaches-reductionist approaches-analysis of continuous search spaces-no free lunch theorem. **Constraint Handling:** Constrained Problems-main types of constraints handling-methods to handle constraints-examples.

UNIT-V **12 Hours**

Special Forms of Evolution: Coevolution-interactive evolution-non stationary function optimization. **Working with evolutionary algorithms:** performance measures-test problems-examples.

References

1. Introduction to Evolutionary computing by A.E.Eiben, J.E.Smith, Natural Computing Series, Springer, 2003.
2. Evolutionary Computation 1: Basic Algorithms and Operators by Thomas Back, David B Fogel and Zbigniew Michalewicz IOP Publishing Ltd, 2000.
3. Kenneth A. De Jong, " Evolutionary Computation A Unified Approach ", MIT Press, 2006.

Learning Outcomes

Unit-I	The learner will understand the basic concepts of evolutionary algorithm and genetic algorithm.
Unit-II	The learner will understand the evolutionary strategies and classifier system.
Unit-III	The learner will understand parameter control evolutionary algorithms, multi modal problems and spatial distribution.
Unit-IV	The learner will understand schema theorem, statistical mechanics and constraint handling.
Unit-V	The learner will understand the special forms of evolution and apply evolutionary algorithms to simple problems.

FAULT TOLERANT COMPUTING

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course Objective: *To enable the learners understand various techniques and approaches used in Fault Tolerance in computer systems. To gain knowledge in sources of faults and means for their prevention and to understand merits and limitations of fault-tolerant design.*

Unit-I **12 Hours**

Introduction: Fault Classification -Types of Redundancy - Basic Measures of Fault Tolerance - **Hardware Fault Tolerance :**The Rate of Hardware Failures - Failure Rate, Reliability, and Mean Time to Failure - Canonical and Resilient Structures - Other Reliability Evaluation Techniques -Fault-Tolerance Processor-Level Techniques - Byzantine Failures – **Information Redundancy:** Coding - Resilient Disk Systems

Unit-II **12 Hours**

Fault-Tolerant Networks: Measures of Resilience - Common Network Topologies and Their Resilience- Fault-Tolerant Routing - **Software Fault Tolerance:** Acceptance Tests - Single-Version Fault Tolerance -*N*-Version Programming - Recovery Block Approach - Preconditions, Post conditions, and Assertions - Exception-Handling - Software Reliability Models – Fault-Tolerant Remote Procedure Calls

Unit-III **12 Hours**

Check pointing : Check pointing- Checkpoint Level - Optimal Check pointing—An Analytical Model - Cache-Aided Rollback Error Recovery (CARER) – Check pointing in Distributed Systems – Check pointing in Shared-Memory Systems - Other Uses of Check pointing – **Fault Detection in Cryptographic Systems:** Overview of Ciphers - Security Attacks Through Fault Injection - Countermeasures - **Simulation Techniques:** Parameter Estimation - Variance Reduction Methods - Fault Injection

Unit-IV **12 Hours**

Nonstop Systems- Stratus Systems - Cassini Command and Data Subsystem - IBM G5 - IBM Sysplex – Itanium **Defect Tolerance in VLSI Circuits -**Manufacturing Defects and Circuit - Probability of Failure and Critical Area - Basic Yield Models - Yield Enhancement through -**Programs for Reliability Modeling and Analysis:** Introduction-Various Types of Reliability and Availability Programs-Testing Programs- Partial List of Reliability and

Availability Programs-An Example of Computer Analysis

Unit-V **12 Hours**

Software Reliability and Recovery Techniques: Introduction-The Magnitude of the Problem- Software Development Life Cycle- Reliability Theory- Software Error Models- Reliability Models- Estimating the Model Constants-Other Software Reliability Models- Software Redundancy-Rollback and Recovery

References

1. Koren and C. M. Krishna, " Fault Tolerant Systems", Elsevier, 2007.(Unit I,II,III,IV)
2. M. L. Shooman, "Reliability of Computer Systems and Networks: Fault Tolerance, Analysis and Design", Wiley Interscience, 2002.(Unit IV,V)

Learning Outcomes

Unit-I	The learner will have knowledge about the basic classification of the faults, hardware failures and basics about the reliability.
Unit-II	The learner will have clear idea about the fault tolerant networks and software faults and Tests.
Unit-III	The learner will have an understanding of checkpointing, detecting faults using cryptographic techniques and simulation techniques.
Unit-IV	The learner will able to understand of VLSI circuit tolerance and analysis and modelling of program for reliability.
Unit-V	The learner will have an understanding of Techniques for failure recovery and methods to improve software reliability.

GAME THEORY

L	T	P	C
4	0	0	4

Course Objective: *To help the learner to apply game-theoretic analysis algorithm, both formally and intuitively, to negotiation and bargaining situations*

Unit-I **12 Hours**

Strategic Form to Two Player Game:The Cournot duopoly -Continuous improvement procedure-The Bertrand duopoly-The Hotelling duopoly-The Hotelling duopoly in 2D space-The Stackelberg duopoly-Convex games-Examples of bimatrix games-Randomization-2x2 Games-Games 2 × n and m × 2-The Hotelling duopoly in 2D space with non-uniform distribution of buyers-Location problem in 2D space. Zero Sum Games: Introduction-Minimax and maximin-Randomization-Games with discontinuous payoff functions-Convex-concave and linear-convex games-Convex games-Arbitration procedures-Two-point discrete arbitration procedures-Three-point discrete arbitration procedures with interval constraint -General discrete arbitration procedures

Unit-II **12 Hours**

Non-cooperative strategic-form n-player games: Introduction-Convex games: The Cournot oligopoly-Polymatrix games-Potential games-Congestion games-Player-specific congestion games-Auctions-Wars of attrition-Duels, truels, and other shooting accuracy contests-Prediction games. **Extensive-form n-player games:** Introduction-Equilibrium in games with complete information-Indifferent equilibrium-Games with incomplete information-Total memory games.

Unit-III **12 Hours**

Parlor games and sport games: Introduction-Poker. A game-theoretic model-The poker model with variable bets-Preference. A game-theoretic model-The preference model with cards play-Twenty-one. A game-theoretic model-Soccer. A game-theoretic model of resource allocation. **Negotiation Models:** Introduction- Models of resource allocation-Negotiations of time and place of a meeting-Stochastic design in the cake cutting problem-Models of tournaments-Bargaining models with incomplete information-Reputation in negotiations.

Unit-IV **12 Hours**

Optimal stopping games: Introduction- Optimal stopping game: The case of two observations-Optimal stopping game: The case of independent observations-The game Γ_N

(G) under N ≥ 3-Optimal stopping game with random walks-Best choice games-Best choice game with stopping before opponent-Best choice game with rank criterion. Lottery-Best choice game with rank criterion. Voting-Best mutual choice game. **Coperative Games**: Introduction-Equivalence of cooperative games-Imputations and core-Balanced games-The τ-value of a cooperative game-Nucleolus-The bankruptcy game-The Shapley vector-Voting games. The Shapley–Shubik power index and the Banzhaf power index -The mutual influence of players. The Hoede–Bakker index.

Unit-V 12 Hours

Network Games: Introduction-The KP-model of optimal routing with indivisible traffic. The price of anarchy-Pure strategy equilibrium. Braess's paradox-Completely mixed equilibrium in the optimal routing problem with inhomogeneous users and homogeneous channels - Completely mixed equilibrium in the optimal routing problem with homogeneous users and inhomogeneous channels -Completely mixed equilibrium: The general case -The price of anarchy in the model with parallel channels and indivisible traffic-The price of anarchy in the optimal routing model with linear social costs and indivisible traffic for an arbitrary network-The mixed price of anarchy in the optimal routing model with linear social costs and indivisible traffic for an arbitrary network-The price of anarchy in the optimal routing model with maximal social costs and indivisible traffic for an arbitrary network-The Wardrop optimal routing model with divisible traffic-The optimal routing model with parallel channels. The Pigou model. Braess's paradox-Potential in the optimal routing model with indivisible traffic for an arbitrary network -Social costs in the optimal routing model with divisible traffic for convex latency functions -The price of anarchy in the optimal routing model with divisible traffic for linear latency functions-Potential in the Wardrop model with parallel channels for player-specific linear latency functions-The price of anarchy in an arbitrary network for player-specific linear latency functions.

References

1. Vladimir Mazalov , "Mathematical Game Theory and Applications ", John Wiley and Sons, 2014.
2. Joel Watson, "Strategy-An Introduction to Game Theory", Third Edition, W.W Norton & Company, 2013.

Learning Outcomes

Unit-I	The learner will have knowledge about the two player game and zero sum games.
Unit-II	The learner will have clear idea about non-cooperative and extensive form n players games.
Unit-III	The learner will have an understanding of Parlor games, sport games and Negotiation Models.
Unit-IV	The learner will have an understanding of Optimal stopping games and Cooperative Games.
Unit V	The learner will have an understanding of network games and dynamic games

GRANULAR COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To educate the learner in the emerging computing paradigm of information processing. This concerns the processing of complex information entities called information granules, which arise in the process of data abstraction and derivation of knowledge from information or data.*

Unit – I **12 Hours**

Information Granularity, Information Granules, and Granular Computing: Information Granularity and the Discipline of Granular Computing - Formal Platforms of Information Granularity-Information Granularity and Its Quantification-Information Granules and a Principle of the Least Commitment-Information Granules of Higher Type and Higher Order-Hybrid Models of Information Granules-A Design of Information Granules-The Granulation–Degranulation Principle-Information Granularity in Data Representation and Processing-Optimal Allocation of Information Granularity. Key Formalisms for Representation of Information Granules and Processing Mechanisms: Introduction to interval analysis and fuzzy sets - Rough Sets-Shadowed Sets as a Three-Valued Logic Characterization of Fuzzy Sets. Information Granules of Higher Type and Higher Order, and Hybrid Information Granules: Fuzzy Sets of Higher Order-Rough Fuzzy Sets and Fuzzy Rough Sets-Probabilistic Sets-Hybrid Models of Information Granules-Realization of Fuzzy Models with Information Granules of Higher Type and Higher Order.

Unit – II **12 Hours**

Representation of Information Granules-Description of Information Granules by a Certain Vocabulary of Information Granules - Information Granulation –Degranulation Mechanism in the Presence of Numeric Data -Granulation–Degranulation in the Presence of Triangular Fuzzy Sets. The Design of Information Granules: The Principle of Justifiable Granularity-Construction of Information Granules through Clustering of Numeric Experimental Evidence-Knowledge-Based Clustering-Refinement of Information Granules through Successive Clustering -Collaborative Clustering and Higher-Level Information Granules.

Unit – III **12 Hours**

Building granular mappings: From Mappings and Models to Granular Mappings and Granular Models - Granular Mappings - Protocols of Allocation of Information Granularity-Design Criteria Guiding the Realization of the Protocols for Allocation of Information Granularity-Granular Neural Networks as Examples of Granular Nonlinear Mappings

-Problems of Optimal Allocation of Information Granularity. Granular Description of Data and Pattern Classification: Granular Description of Data-Building Granular Representatives of Data-A Construction of Granular Prototypes with the Use of the Granulation–Degranulation Mechanism-Information Granularity as a Design Asset and Its Optimal Allocation-Design Considerations-Pattern Classification with Information Granules-Granular Classification Schemes.

Unit – IV **12 Hours**

Granular Models: Architectures and Development: The Mechanisms of Collaboration and Associated Architectures-Realization of Granular Models in a Hierarchical Modeling Topology-From Fuzzy Rule-Based Models to Granular Fuzzy Models-A Single-Level Knowledge Reconciliation: Mechanisms of Collaboration -Structure-Free Granular Models -The Essence of Mappings between Input and Output Information Granules and the Underlying Processing-The Design of Information Granules in the Output Space and the Realization of the Aggregation Process -The Development of the Output Information Granules with the Use of the Principle of Justifiable Granularity-Interpretation of Granular Mappings-Examples. Granular Time Series: Introduction-Information Granules and Time Series -A Layered Approach to the Interpretation of Time Series-A Classification Framework of Granular Time Series-Granular Classifiers.

Unit – V **12 Hours**

From Models to Granular Models: Knowledge Transfer in System Modeling-Fuzzy Logic Networks—Architectural Considerations-Granular Logic Descriptors-Granular Neural Networks-The Design of Granular Fuzzy Takagi–Sugeno Rule-Based Models. Collaborative and Linguistic Models of Decision Making: Analytic Hierarchy Process (AHP) Method and Its Granular Generalization - Concept of Analytic Hierarchy Process Model- Granular Reciprocal Matrices -A Quantification (Granulation) of Linguistic Terms as Their Operational Realization- Granular Logic Operators-Modes of Processing with Granular Characterization of Fuzzy Sets.

References

1. Witold pedrycz, “ Granular Computing Analysis And Design Of Intelligent Systems”, CRC Press, 2013.
2. Ling Zhang and Bo Zhang, “Quotient Space Based Problem Solving: A Theoretical Foundation of Granular Computing”, Tsinghua University Press, 2014.

Learning Outcomes

Unit I	The learner will understand Information Granularity, Information Granules, and the basics of Granular Computing
Unit II	The learner will understand the representation of Information Granules and apply these to design Information Granules.
Unit III	Thee learner will understand how to build granular mappings.
Unit IV	The learner will understand the architecture of granular models.
Unit V	The learner will be able to develop Granular models from models.

HIGH SPEED NETWORKS

L	T	P	C
4	0	0	4

Course Objective: *To help the learners understand the importance of increasing the speed of communication and providing higher Quality of Service support through various mechanism.*

UNIT – I

12 Hours

Principle of network and design: Capacity planning**,** Design objectives –Addressing and Routing***:*** Addressing - Flat, Classes, Hierarchical, Multicast routing - Routing for mobile hosts. designing the LAN topology –High speed LANs: Emergence of high speed LANs – Bus Topology LAN – CSMA/CD – Medium specifications – IEEE 802.3, 10BASE5, 10BASE-T – Hubs and switches – Layer 3 switches – Fast Ethernet – Gigabit Ethernet – 10 Gbps Ethernet – Fibre channel –Fibre channel protocol architecture – Fibre channel physical media and topologies Optical networks

UNIT – II **12 Hours**

Designing the WAN and Internet Routing : Designing the WAN topology –flat WAN topology – limitations of a flat design – hierarchical WAN topology –- issues with hierarchical design – hierarchical layers – WAN design parameters- choosing the WAN technology – design considerations for serial links –Interior routing protocols – Internet routing principles –designing IP over frame relay , and ISDN design issues with IP – fundamental IP routing design – designing an IP addressing plan – categorizing IP routing protocol distance vector protocol (RIP) – Link state protocol(OSPF) .Exterior routing protocols and multicast – path vector protocol – BGP and IDRP – multicasting.

UNIT – III **12 Hours**

Frame Relay and ATM: Packet switching networks – Switching Techniques. Frame Relay Networks – Architecture – User Data Transfer –ATM: ATM protocol architecture –Main Features of ATM, cell format & Switching Addressing, signaling and routing, internetworking with ATM. Design issues for networked multimedia information systems- interface design and information retrieval issues. Congestion and control –Congestion control in packet switching networks – Frame Relay call control. Frame relay congestion

control – ATM traffic and congestion control, Flow control, error detection and error control,– TCP traffic control.

UNIT IV **12 Hours**

Wireless LANs: General Characteristics –– Infrared LANs – Spread spectrum Technology - Narrowband microwave LANs - IEEE 802.11 Wireless LAN standard – Architecture & services - Medium access control - Channel Access and MAC sub layers, Physical layer. adhoc network,; Blue tooth – user scenarios, Networking and security; Wireless ATM.

UNIT – V **12 Hours**

OSPF:OSPF fundamentals, characteristics, OSPF design guidelines, design goals, functionality, scalability, OSPF network design methodology, OSPF network topology, router design, area design considerations, OSPF Security

References

1. William Stallings, "**High Speed Networks and Internets**", 2nd Edition, Pearson Education Asia, 2002.
2. William Stallings, "**Wireless Communications and Networks**", Prentice Hall, 2002.
3. John A. Vacca, "**Wireless Broadband Networks Handbook**", Tata McGraw Hill, 2001.
4. Jean Walrand and Pravin Varaiya, "**High Performance Communication Networks**", HARCOURT Asia PTE Ltd., 2nd edition, 2001.
5. Tony Kenyon, "**High Performance Data Network Design**" (Paperback – December 2001).
6. TOM Thomas, "**OSPF network design solutions**", CISCO press, 2003.

Learning Outcomes

Unit-I	The learner will be able to understand the recent technologies for supporting high speed local area networks
Unit-II	The learner will be able to understand the issues in designing wide area networks and the working principles of interior and exterior routing protocols for Internet
Unit-III	The learner will be able to understand the importance of Quality of Service support and the working of ATM and Frame Relay networks and how they provide higher QoS support
Unit-IV	The learner will be able to understand the standards for Wireless Networks like IEEE 802.11 and Bluetooth
Unit-V	The learner will be able to understand the design and working principles of the OSPF routing protocol

INFORMATION RETRIEVAL

L	T	P	C
4	0	0	4

Course Objective: *To provide foundation knowledge in information retrieval. To appreciate and equip students with sound skills to solve computational problems and to evaluate different applications of information retrieval.*

Unit – I **12 Hours**

Boolean Retrieval – Term Vocabulary and Posting 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-Phonetic correction.

Unit – II **12 Hours**

Index construction: Hardware basics-Blocked sort-based indexing-Single-pass in-memory indexing- Distributed indexing-Dynamic indexing-Other types of indexes. Index Compression: Statistical properties of terms in information retrieval- Dictionary compression-Postings file compression.

Unit – III **12 Hours**

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

Unit – IV **12 Hours**

Evaluation in information retrieval: Information retrieval system evaluation-Standard test collections-Evaluation of unranked retrieval sets-Evaluation of ranked retrieval results-Assessing relevance- A broader perspective: System quality and user utility-Results snippets. 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.

Unit – V **12 Hours**

Probabilistic Information Retrieval: Basic Probability theory-The Probability ranking principle-Binary Independence Model - Appraisal and some Extensions. Language Models for Information Retrieval: Language Models-Query Likelihood models-Language models vs other approaches in IR-Extended language modeling approaches.

References

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, “An Introduction to Information Retrieval”, Cambridge University Press, 2009.
2. C.J.van RIJSBERGEN, “Information Retrieval”, Second Edition, Information Retrieval Group, University of Glasgow, 1979.

Learning Outcomes

Unit-I	The learner will understand the basic concepts and terms in information retrieval.
Unit-II	The learner will understand index construction and compression.
Unit-III	The learner will understand the concepts of vector space model for scoring.
Unit-IV	The learner will understand the various methods to evaluate information retrieval and information retrieval through XML.
Unit-V	The learner will understand the role of probability concepts in information retrieval.

INTERNET OF THINGS

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course Objective: *The learner familiarizes with functioning of devices, architecture, technologies and Application scenarios of Internet of things.*

Unit-I **12 Hours**

Introduction to IoT: Introduction - Definition & Characteristics of IoT - Physical Design of IoT - Things in IoT - IoT Protocols - Logical Design of IoT - IoT Functional blocks - IoT Communication Models - IoT Communication APIs - IoT Enabling Technologies - Wireless Sensor Networks - Cloud Computing - Big Data Analysis - Communication protocols - Embedded Systems - IoT Levels & Deployment Templates - **IoT and M2M**: Introduction - M2M - Difference between IoT and M2M-SDN and NFV for IoT **- Ubiquitous IoT Applications:** A Panoramic View of IoT Applications-Important Vertical IoT.

Unit-II **12 Hours**

Four pillars of IoT: The Horizontal, Verticals, and Four Pillars, M2M, RFID, WSN, SCADA.**The DNA of IoT** - Device, Connect and Manage - Device: Things That Talk - Connect: Via Pervasive Networks - Manage: To Create New Business Value.

Unit-III **12 Hours**

Middleware and IoT: An Overview of Middleware - Communication Middleware for IoT- **Protocol standardization of IoT :** Web of Things versus Internet of Things - IoT Protocol Standardization Efforts- Unified Data Standards: A Challenging Task.

Unit-IV **12 Hours**

Architecture Standardization for WoT: Platform Middleware for WoT - Unifid Multitier WoT Architecture - WoT Portals and Business Intelligence - Challenges of IoT Information Security - **The Cloud of Things:** Cloud Middleware - NIST's SPI Architecture and Cloud Standards - Cloud Providers and Systems - **The Cloud of Things :** The Internet of Things and Cloud Computing, Mobile Cloud Computing - MAI versus XaaS: The Long Tail and the Big Switch - The Cloud of Things Architecture.

Unit-V **12 Hours**

Thinking about Prototyping: Prototypes and Production - Open Source versus Closed Source - **Prototyping Embedded devices :** Electronics - Embedded Computing Basics - Arduino, Raspberry pi - Beagle Bone Black - Electric Imp - Other Notable Platforms.

References

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands of Approach" , published by Arshdeep Bagha & Vijay Madisetti, 1st Edition, 2014. **Unit I and V.**
2. Honba Zhou, "The Internet of things in the Cloud: A Middleware Perspective", CRC Press, 1st Edition, 2012. **Unit I(DNA of IoT), III**
3. Adrian McEwen, Hakim Cassimally, " Designing The Internet things", John Wiley and Sons, 1st Edition, 2014.**Unit IV**

Learning Outcomes

Unit-I	The learner will understand the concepts of IoT Protocols and working principles of different types IoT enabling technologies
Unit-II	The learner will analyse the difficulties in cloud of things architecture
Unit-III	The learner will comprehend the Protocol standardization of IoT and Middleware
Unit-IV	The learner will analyze open source versus closed source in IoT
Unit-V	The learner will gain insight on applications of IoT

MOBILE AND UBIQUITOUS COMPUTING

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course objectives: *To understand the characteristics of wireless mobile communication and various protocols used in different layers of ad hoc networks.*

UNIT – I **12 Hours**

Introduction to Ad Hoc networks: Introduction – characteristics of Wireless channel – differences between cellular and ad hoc wireless networks – applications of ad hoc wireless networks – issues in ad hoc wireless networks – Standards – IEEE 802.11 – HIPERLAN – Bluetooth.

UNIT – II **12 Hours**

MAC Protocols: Design issues – design goals – classification of MAC protocols – contention based protocols – MACAW – FAMA – BTMA – MACA-BI – MARCH – contention based protocols with reservation – D-PRMA – CATA – HRMA – SRMA/PA – FPRP – MACA/PR – RT-MAC - contention based protocols with scheduling algorithms – DPSMA – DWOP – DLPS – protocols using directional antennas – MMAC – MCSMA – PCMAC – RBAP – ICSMA.

UNIT – III **12 Hours**

Routing Protocols: Design issues, goals and classification – table-driven protocols – DSDV – WRP – CGSR – STAR – on demand protocols – DSR – AODV – TORA – LAR – ABR – SAR – FORP – hybrid protocols – CEDAR – ZRP – Z-HLSR – efficient routing with flooding mechanism – PLBR – OLSR – hierarchical routing – HSR – FSR – power aware routing.

UNIT – IV **12 Hours**

Multicast routing protocols: issues, operation, architecture and classification – tree-based multicast routing – mesh-based multicast routing – energy efficient multicast routing – multicasting with QoS guarantees – application dependant multicasting

UNIT – V **12 hours**

Transport layer: design issues, goals and classification – Traditional TCP – TCP-F – TCP-ELFN – TCP-BuS – ad hoc TCP – split TCP

Security: Issues and challenges, network security attacks, key management – secure routing protocols.

References

1. C.Siva Ram Murthy and B.S.Manoj, "**Ad hoc Wireless Networks Architectures and protocols"**, 2nd Edition, Pearson Education. 2012
2. Subir Kumar Sarkar, T.G. Basavaraju, C. Puttamadappa, "**Ad Hoc Mobile Wireless Networks: Principles, Protocols and Applications",** CRC Press, 2013
3. Charles E. Perkins, "**Ad hoc Networking**", Addison – Wesley, 2000
4. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, "**Mobile adhoc networking**", Wiley-IEEE press, 2004.
5. Chai K Toh, **"Ad Hoc Mobile Wireless Networks: Protocols and Systems"**, Prentice Hall, 2001

Learning Outcomes

Unit-I	The learner will understand the characteristics of wireless communication, issues in ad hoc network design and the wireless communication standards
Unit-II	The learner will explore the different kinds MAC protocols designed for ad hoc networks
Unit-III	The learner will comprehend the various routing protocols designed for mobile networks
Unit-IV	The learner will comprehend the various multicast routing protocols designed for mobile networks
Unit-V	The learner will explore the various transport protocols and security protocols designed for mobile networks

MULTIAGENT SYSTEMS

L	T	P	C
4	0	0	4

Course Objective: *To understand the basic principles of the Multi Agent Systems operation main techniques and to know how to use them in the environment of an intelligent service or system*.

UNIT – I **12 Hours**

Multi Agent problem Formulation – Utility, Markov Decision Process, Hierarchical Planning Distributed Constraint Satisfaction – Domain Pruning Algorithms, Heuristic Search Algorithms –Distributed Optimization – Action selection in multi agent MDP's – Negotiations, Auctions and Optimization - Distributed Constraint Optimization – Adopt, OptAPO.

UNIT – II **12 Hours**

Self-interested Agents - Games in Normal Form – Analysing games – Computing solution concepts of normal form games – Games with sequential actions – Perfect and Imperfect Information Extensive form games.

UNIT – III **12 Hours**

Richer representation – Beyond the Normal and extensive forms - Repeated, Stochastic – Bayesian – Congestion Games – Computationally motivated Compact representations – Terms of Selfish Agents – Coalition Games with transferable utility – Analysis – Compact representations.

UNIT – IV **12 Hours**

Learning and Teaching – Introduction – Fictitious Play – Rational Learning – Reinforcement Learning – No Regret Learning – Targeted Learning – Evolutionary Learning and Large Population Models – Communication. Protocols for Strategic Agents – Mechanism Design with unrestricted preferences – Quasilinear preferences

UNIT – V **12 Hours**

Logics of Knowledge and Belief – Partition Model of Knowledge – Modal Logic – Axiomatic theory of partition model – Common knowledge and related applications – Knowledge to Belief – Combining Knowledge and Belief. Beyond Belief – Knowledge and Probability – Dynamics of Knowledge and Belief – Logic, Games and Coalition Logic – Towards a logic of intention.

References

1. Yoav Shoham , Kevin Leyton-Brown, “MULTIAGENT SYSTEMS Algorithmic, Game-Theoretic, and Logical Foundations “, Cambridge University Press, 2011
2. Jos´e M Vidal, “Fundamentals of Multiagent Systems with NetLogo Examples “, 2010
3. Richard Murch, Tony Johnson, "Intelligent Software Agents", Prentice Hall, 2000
4. Michael Woodridge, “ An Introduction to Multiagent Systems “, John Wiley & Sons Ltd., 2002

Learning Outcomes

Unit-I	The learner will be able to formulate problems and deal with suitable methods of optimization.
Unit-II	The learner will be able to understand the working of conflicting agents and use the knowledge in identifying solutions.
Unit-III	The learner will be able to make appropriate representation for various stochastic problems.
Unit-IV	The learner will be able to identify the kind of learning technique to be used in solving real world problems
Unit-V	The learner will be able to design a belief network for a real world problem

OPTICAL COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To help the learners understand the basic concepts of optical processing, devices, switching, data storage and cellular architecture and educate them to apply these concepts in real time applications.*

UNIT – I **12 Hours**

Introduction : Basic Components of optical processing -Light and the Laser, Fundamental Optics lenses, polarizers and beam splitters Lenses for optical processing, image filtering, pattern recognition.Light emitting diodes, semiconductor injection lasers super luminescent diodes Thermal detectors - Photo detectors - Noise and Noise equivalent power, coherent and incoherent detection - Acousto-optic devices and systems, Matrix-vector multipliers -Fibre optic sensors

UNIT – II **12 Hours**

Optical Bistable Devices and Logic gates: Operation- Desirable features and material requirements for nonlinear devices - Optical Logic Etalons- light valves, Fredkin gates, symbolic substitution, multiplexers smart pixels Self-Electro Optic Effect Devices- Gain limits- Fan in, Fan out- Architectural concepts- Achieving fundamental limits, computing power - Tri-stability and multi valued logic - Multivalued logic for Optical Computing - Completeness in binary logic - Residue based multivalued logic networks - Optical multivalued residue logic Processors - Completeness in multivalued logic Nonlinear optical logic gates, smart pixels

UNIT – III **12 Hours**

Optical Interconnects and Switching: Limitations of electrical interconnects, applications of interconnects, static, dynamic, free space interconnects, holographic, perfect shuffle, crossbars, multiplexers, shuffle-exchange. Limitations of electronic switches, types of optical switch Arithmetic UNITs Binary bit slice, residue, modified signed-digit, input to output mapping. Threshold and waiting in optical computing- External Thresholding design - Internal Thresholding design - Multiple Valued Threshold Logic.-Multi-lineal Separable functions - Optical Matrix Multiplication - Digital Optics Time, Space, Wavelength based systems, device technology

UNIT IV **12 Hours**

Optical memories and Optics for Data Storage : Types of optical storage systems - ROM, WORM, RAM, Case Study – CD-DVD, Future systems, Holographic, Associative Optical image processing and pattern recognition Holography, correlators, SAR, wedge-ring detectors Spatial light modulators, CCD detector arrays

UNIT - V **12 Hours**

Cellular Logic Architectures: Cellular logic architectures - cellular logic - optical binary logic and SIMD pipelined arrays ,MIMD architecture - Optical Implementation - Fiber Optic Programmable Arrays - Characteristics - Synthesis problem - Re-configurable fiber systems. Applications – bitonic sort, image processing, routing, encryption.

References

1. Pollock, "**Fundamentals of Opto Electronics**", IRWIN,1995
2. Raymond Arrathoon, "**Optical Computing - Digital and Symbolic**", Marcel Dekker, 1985
3. J.H.Franz & V.K.Jain , "**Optical Communications**", Narosa Pub, 1998
4. Rajiv Ramasamy & Kumar N Sivarajan, "**Optical Networks : A Practical Prespective**", Mourgan Kauffman Publishers, Feb 1998
5. Feitelson, D. G., "Optical **Computing: A Survey for Computer Scientists"**, (ISBN 0-262-061-120)", MIT Press 1988.
6. Mohammad A. Karim, Abdul A. S. Awwal, "**Optical Computing: An Introduction",** Wiley, 1992.
7. Mc Alastair.D, "**Optical Computing Architecture: Application of Optical Concepts To next Generation Computers**", JW, NY, 1991.

Learning Outcomes

Unit-I	The learner will understand the basic components of the optical processing.
Unit-II	The learner will understand the operations of non linear devices and multi valued logic non linear gates
Unit-III	The learner will understand the advantages and limitations of electrical inter connects and switches.
Unit-IV	The learner will understand the various types of optical storage system. The learner will be able to illustrate the various applications in which optical image processing and pattern recognition holography are applied.
Unit-V	The learner will understand the basic concepts of cellular architecture, fibre optic programmable arrays and reconfigurable fiber systems. The learner will be able to apply these concepts in the applications like bitonic sort, image processing, routing and encryption.

SPATIAL COMPUTING

L	T	P	C
4	0	0	4

Course Objective: *To impart knowledge on spatial data collection methods and description of spatial data analysis and understanding the application of spatial data.*

Unit – I **12 Hours**

Introduction-Spatial data analysis: scientific and policy context: Spatial data analysis in science -Place and space in specific areas of scientific explanation-Spatial data analysis in the policy area -Some examples of problems that arise in analysing spatial data. The nature of spatial data :The spatial data matrix: conceptualization and representation issues-Form of Spatial Data Matrix-Quality of Spatial Data Matrix-Quantifying spatial dependence.

Unit – II **12 Hours**

Obtaining spatial data through sampling: Sources of spatial data-Spatial sampling - Maps through simulation. Data quality: implications for spatial data analysis: Errors in data and spatial data analysis- Data resolution and spatial data analysis-Data consistency and spatial data analysis-Data completeness and spatial data analysis.

Unit – III **12 Hours**

Exploratory spatial data analysis: conceptual models: EDA and ESDA-Conceptual models of spatial variation-Exploratory spatial data analysis: visualization methods:Data visualization and exploratory data analysis -Visualizing spatial data -Data visualization and exploratory spatial data analysis.

Unit – IV **12 Hours**

Exploratory spatial data analysis: numerical methods: Smoothing methods-The exploratory identification of global map properties: overall clustering - The exploratory identification of local map properties -Map comparison. Hypothesis testing in the presence of spatial dependence: Spatial autocorrelation and testing the mean of a spatial data set-Spatial autocorrelation and tests of bivariate association.

Unit – V **12 Hours**

Models for the statistical analysis of spatial data: Descriptive models-Explanatory models. Statistical modelling of spatial variation: descriptive modelling: Models for representing spatial variation-Some general problems in modelling spatial variation-Hierarchical Bayesian models. Statistical modelling of spatial variation: explanatory modelling: Methodologies for spatial data modelling-Some applications of linear modelling of spatial data.

References

1. Robert Haining, “Spatial Data Analysis Theory and Practice”, Cambridge University Press, 2004.
2. Roger S. Bivand, Edzer J. Pebesma, Virgilio Gómez-Rubio, “Applied Spatial Data Analysis with R”, Springer, 2008.

Learning Outcomes

Unit-I	The learner will understand the basic concepts of spatial data, representation and analysis.
Unit-II	The learner will understand about the data collection sources and issues related to novelty of spatial data.
Unit-III	The learner will understand the conceptual methods to visualize the spatial data.
Unit-IV	The learner will understand the numerical methods to explore the spatial data.
Unit-V	The learner will be able to understand the statiscal analysis on spatial data.

VIRTUALIZATION TECHNIQUES

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course Objective: *To help the learner to understand virtual machine technologies in a number of contexts to enable new capabilities and to solve a variety of problems in interfacing major computer system components.*

Unit-I **12 Hours**

Overview of Virtualization: Virtualization - Basic approaches to Virtual systems - Advantages of Virtualization - Virtualization Caveats - A Model of Virtualization - Access Virtualization - Application Virtualization - Processing Virtualization - Network Virtualization - Storage Virtualization - Security for Virtual Environments - Management for Virtual Environments.

Unit-II **12 Hours**

Computer Architecture - Process Virtual Machines - System Virtual Machines. **Emulation: Interpretation and Binary Translation:** Basic Interpretation-Threaded Interpretation-Predecoding and Direct Threaded Interpretation-Interpreting a Complex Instruction Set-Binary Translation-Code Discovery and Dynamic Translation-Control Transfer Optimizations-Instruction Set Issues.

Unit-III **12 Hours**

Process Virtual Machines: Virtual Machine Implementation-Compatibility-State Mapping-Memory Architecture Emulation-Instruction Emulation-Exception Emulation-Operating System Emulation-Code Cache Management-System Environment.

Dynamic Binary Optimization: Dynamic Program Behavior-Profiling-Optimizing Translation Blocks-Optimization Framework - Code reordering-Code Optimizations. **High-Level Language Virtual Machine Implementation:** Object-Oriented High-Level Language Virtual Machines-The Java Virtual Machine Architecture-Completing the Platform: APIs

Unit-IV **12 Hours**

Codesigned Virtual Machines: Memory and Register State Mapping-Self-Modifying and Self-Referencing Code-Support for Code Caching-Implementing Precise Traps-Input/Output-Applying Codesigned Virtual Machines-Case Study: Transmeta Crusoe.

System Virtual Machines: Key Concepts-Resource Virtualisation-Processors-Resource Virtualisation-Memory-Resource Virtualisation-Input/Output-Performance Enhancement of

System Virtual Machines-Case Study: VMware Virtual Platform.

Unit-V **12 Hours**

Multiprocessor Virtualization: Partitioning of Multiprocessor Systems-Physical Partitioning-Logical Partitioning-Case Study: Cellular Disco System Virtual Machine-Based Partitioning-Virtualization with Different Host and Guest ISAs.

Emerging Applications: Security-Migration of Computing Environments-Grids: Virtual Organisations.

REFERENCES

1. Dan Kusnetzky, "Virtualization: A Manager's Guide", O'Reilly Media, Inc., 1st Edition, 2011. [Unit – I]
2. William Von Hagen , "Professional Xen Virtualization" , Wiley Publishing Inc. ,1st Edition, 2009. [Unit –I]
3. James E. Smith, Ravi Nair, "Virtual machines Versatile platforms for systems and processes",Morgan Kaufmann Publishers, 2005. [Unit II – V]
4. Danielle Ruest and Nelson Ruest, "Virtualization: A Beginner's Guide", Mcgraw Hill, 2009.
5. Ivanka Menken, "Virtualization: The Complete Corner Stone Guide to Virtualization Best Practices " Copyright @ Arts of Service, 2009.
6. Sander van Vugt, "A Practical Guide to XEN High Availability Configuring Enterprise Virtualization on SUSE Linux Enterprise Server", Books4Brains, 2010.

Learning Outcomes

Unit-I	The learner will understand the concepts behind virtualization technology, the different categories of virtualization, how they are used and merits & demerits Virtualization.
Unit-II	The learner will comprehend the implementation of process virtual machines and examine the techniques for the optimization of translated code for better emulation performance.
Unit-III	The learner will understand the high-level language virtual machines implementation and traces the transition from the early Pascal P-code VMs to object-oriented VMs.
Unit-IV	The learner will understand the implementation of co-designed and classic system virtual machines.
Unit-V	The learner will explore the different types of system partitioning and emerging applications for virtual machine technology.

WIRELESS SENSOR NETWORKS

(Common for MTech ADC and CSE)

L	T	P	C
4	0	0	4

Course Objectives: *The learner will understand different sensor node technology, routing design and the requirements of operating system to deploy WSN.*

Unit-I **12 Hours**

Introduction and Overview of Wireless Sensor Networks- Basic Sensor Network Architectural Elements- Challenges and Hurdles, Examples of category 1 and 2 WSN application, Sensor node technology- Hardware and Software- Wireless Node Operating environment, Wireless Transmission Technology and System- Available Wireless Technologies, Medium Access Control Protocols for Wireless Sensor Network- Fundamentals of MAC protocols- MAC protocols for WSNs.

Unit-II **12 Hours**

Routing Protocols for Wireless Sensor Networks- Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Network, Network Layer - Data-centric and Flat-Architecture Protocols, Hierarchical Protocol-LEACH-PEGASIS, Geographical Routing Protocols- MECHC and SMECN-PRADA, Transport Layer-Challenges for Transport layer-RMST -CODA-ESRT- Real-Time and Reliable Transport Protocol $(RT)^2$ protocol.

Unit-III **12 Hours**

Node Clustering and Security in WSN-Node Clustering structures-Node Clustering Algorithms-Cluster-Head Election Algorithms-Node Clustering algorithms for WSNs, Query processing and Data Aggregation-query processing in WSNs-Data Aggregation in WSNs, Network Security and Attack.Defense-confidentiality-integrity-authenticity-nonrepudiation-availability-Intrusion detection-key management.

Unit-IV **12 Hours**

Network management and operating system- Network management requirements, Traditional network management models, Network management design issues, MANNA, Operating system-design issues, TinyOS, Mate, MagnetOS, MANTIS, OSPM, EYES OS, SenOS, EMERALDS, PicOS. Performance and Traffic Management –WSN design issues-performance modeling of WSNs Case study: Simple computation of the System Life Span.

Unit-V **12 Hours**

TOPOLOGY CONTROL - Distributed Topology Control- Design Guidelines -Ideal Features of a Topology Control Protocol.Future Trends in WSNs-Wireless Multimedia Sensor Networks-Wireless Sensor and Actor Networks -sensor network applications in Challenging Environments-underwater acoustic sensor networks-wireless underground sensor networks.

References

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks Technology - Protocols and Applications”, John Wiley & Sons, Ltd.,2007. (UNIT-I)
2. Jun Zheng, Abbas Jamalipour Wireless Sensor Networks: A Networking Perspective John Wiley & Sons, Ltd 2009 (UNIT-III,V)
3. Ian F. Akyildiz , “Wireless Sensor Networks, John Wiley and Sons, Ltd,2010

Learning Outcomes

Unit-I	The learner will understand the overview of sensor architecture for WSN.
Unit-II	The learner will understand the design and challenges of Routing protocol in network layer, protocol design for Transport layer.
Unit-III	The learner will have knowledge about the node selection, algorithm used for node clustering and learn about the security issues.
Unit-IV	The Learner will have knowledge about the network management and Operating system used for WSNs
Unit-V	The Learner will have knowledge about the design guideline of topology and about the future trends available in WSNs.