## First Semester

| Sl No | Code | Course Title | L-T-P | Credit |
|---|---|---|---|---|
| 1 | MCSE – 501 | Advanced Data Structure &Algorithms | 3-0-0 | 3 |
| 2 | MCSE – 502 | Cryptography & Internet Security | 3-0-0 | 3 |
| 3 | MCSE – 503 | Internet Technology | 3-0-0 | 3 |
| 4 | MCSE – 504 | Advanced Data Structure & Algorithms Laboratory | 0-0-2 | 1 |
| 5 | MCSE – 505 | Cryptography & Internet Security Laboratory | 0-0-2 | 1 |
| 6 | MCSE - 506 | Internet Technology laboratory | 0-0-2 | 1 |
| 7 | MA - X | Probability and Random Process | 3-0-0 | 3 |
| 9 | HM - Y | Research Paper Communication | 3-0-0 | 3 |
| | | **TOTAL** | **15-0-6** | **18** |

## Second Semester

| Sl No | Code | Course Title | L-T-P | Credit |
|---|---|---|---|---|
| 1 | MCSE - 507 | Virtualization and Cloud Computing | 3-0-0 | 3 |
| 2 | MCSE - 508 | Distributed Operating System | 3-0-0 | 3 |
| 3 | MCSE - 509 | Distributed Operating System Laboratory | 0-0-2 | 2 |
| 4 | MCSE – 510X | Elective-I | 3-0-0 | 3 |
| 5 | MCSE – 511X | Elective-II | 3-0-0 | 3 |
| | | **TOTAL** | **15-0-2** | **14** |

## Third Semester

| Sl No | Code | Course Title | L-T-P | Credit |
|---|---|---|---|---|
| 1 | MCSE - 601 | Teaching in UG | X-X-X | |
| 3 | MCSE - 603 | Dissertation-I | X-X-X | 12 |
| | | **TOTAL** | **15-0-2** | **12** |

## Fourth Semester

| Sl No | Code | Course Title | L-T-P | Credit |
|---|---|---|---|---|
| 1 | MCSE - 604 | Teaching in UG | X-X-X | |
| 2 | MCSE – 605 | Dissertation-II | X-X-X | 20 |
| | | **TOTAL** | **15-0-2** | **17** |

## *Proposed Courses for First Semester*

| Sl No | Code | Course Title | L-T-P | Credit |
|---|---|---|---|---|
| 1 | MCSE – 501 | Advanced Data Structure &Algorithms | 3-0-0 | 3 |
| 2 | MCSE – 502 | Cryptography & Internet Security | 3-0-0 | 3 |
| 3 | MCSE – 503 | Internet Technology | 3-0-0 | 3 |
| 4 | MCSE – 504 | Advanced Data Structure & Algorithms Laboratory | 0-0-2 | 1 |
| 5 | MCSE – 505 | Cryptography & Internet Security Laboratory | 0-0-2 | 1 |
| 6 | MCSE - 506 | Internet Technology laboratory | 0-0-2 | 1 |
| 7 | MA - X | Probability and Random Process | 3-0-0 | 3 |
| 9 | HM - Y | Research Paper Communication | 3-0-0 | 3 |
| | | **TOTAL** | **15-0-6** | **18** |

***Name of the Module: Advanced Data Structure &Algorithms***
***Module Code: MCSE - 501***
***Semester: 1st***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet the objectives of:

1. Imparting theoretical and practical application to the students in the area of Data Structure application and Analysis of various algorithms paradigm.
2. Learning efficiency and scaling of algorithms.
3. Learning essential algorithms in computing.

**B. Learning outcomes:**

Students who complete the course will have demonstrated the ability to do the following:

1. Assess performance efficiency of sequential algorithms,
2. Design data structures to enable algorithms and design sequential algorithms for performance.
3. Demonstrate the use of algorithm design methods such as divide and conquer.
4. Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.
5. Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic-programming algorithms, and analyze them.
6. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize greedy algorithms, and analyze them.
7. Explain the major graph algorithms and their analyses. Employ graphs to model engineering problems, when appropriate. Synthesize new graph algorithms and algorithms that employ graph computations as key components, and analyze them.
8. Explain the different ways to analyze randomized algorithms (expected running time, probability of error). Recite algorithms that employ randomization. Explain the difference between a randomized algorithm and an algorithm with probabilistic inputs.

**C. Subject matter:**

**Unit I:**

- Complexity and analysis, Asymtotic notations and their properties, best case, worse case & average case, recursive complexity, logarithmic complexity, optimal sorting, Sorting techniques complexity analysis

**Unit II:**

- Dynamic data structures and their applications: stack, queue and their different types, tree and their different types, graph, dynamic graphs, data structures for memory optimization.

**Unit III:**

- Dynamic programming: matrix chain multiplication, Greedy Paradigm, Graph algorithms: Strongly connected components, single source shortest paths, all pairs shortest path, Travelling salesman problems, Graph colouring; Amortized analysis.

**Unit IV:**

- Matrix operations: Linear equations solver; Polynomials and FFT; String matching algorithms: Naïve approach, Rabin-Karp algorithm, Knuth-Morispratt algorithm, Approximation algorithms; Local search heuristics; Randomized algorithms. Introduction to P and NP, definition & characteristics of P and NP, examples and solutions.

**A. Books**

*1. T H Cormen, C E Leiserson, R L Rivest and C Stein, "Introduction to Algorithms", MIT Press.*

*2. Ellis Horowitz, Sartaj Sahni and Rajasekaran "Fundamentals of Algorithms", Galgotia publications.*

*3. Jon Kleinberg and Tremblay and Eva Tardos, "Algorithm Design", Addison Wesley.*

*4. Jean-Paul Tremblay and Paul-G Sorenson, An introduction to data structures with applications, Mc Graw Hill.*

*5. Adam Drozdek, "Data Structures and Algorithms in C++", Cengage Learning, 2012. 6. Michael McMillan, "Data Structures and Algorithms Using C#", Cambridge University Press, 2007.*

*7. Weiss, Weiss Mark Allen, "Data Structures and Algorithm Analysis in C++", Pearson Education India, 2007.*

*8. Akepogu Ananda Rao, "Data Structures and Algorithms Using C+", Pearson Education India, 2010.*

*9. Peter Brass, "Advanced Data Structures", Cambridge University Press, 2008.*

*10. J.A. Storer, "An Introduction to Data Structures and Algorithms", Springer Science & Business Media, 2012.*

***Name of the Module: Cryptography & Internet Security Laboratory***
***Module Code: MCSE - 502***
***Semester: M. Tech 1st***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:** The course is designed to meet with the objectives of:

1. Understanding the state-of-the-art of cryptography and their security goals.
2. Examining and studying of different cryptographic methods for achieving confidentiality of date.
3. Examining and studying of different cryptographic methods for achieving integrity of date.
4. Understanding message authentication and hash function
5. Understanding the various protocol in network security.

***B.*** **Learning outcomes:** After successfully completion this module students will be able to:

1. Identify some of the factors driving the need for network security,
2. Identify and classify particular examples of attacks,
3. Define the terms vulnerability, threat and attack,
4. Identify physical points of vulnerability in simple networks,
5. Compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems,
6. Explain the implications of implementing encryption at different levels of the OSI reference mode,
7. Explain what is meant by data integrity and give reasons for its importance,
8. Describe methods of providing assurances about data integrity,
9. Describe the use of hash functions and explain the characteristics of one-way and collision-free functions,
10. Describe and distinguish between different mechanisms to assure the freshness of a message,
11. Explain the role of third-party agents in the provision of authentication services,
12. Discuss the effectiveness of passwords in access control and the influence of human behaviour,

***C.*** **Subject matter:**

**Unit I:**

Introduction of Information Security: Cryptography, Conventional Encryption, Traditional technique: Substitution cipher, Transmission cipher, Stream Cipher, Block Cipher, Roaster Machine.

**Unit II:**

Modern Symmetric Techniques, Mathematics of symmetric key cryptography, Cryptanalysis of classical ciphers, General Attacks, Secret and Private Key Cryptography, DES, Modes of operation of DES, Automatic Variable Key, Proof of DES, Merits and Demerits of DES, Quantification of Performance, TDES, Advanced Encryption Standard/AES, Comparison of Secret Key Systems, Modes of operation of AES Limitations of AES, Limitation of Secret or Private Key Crypto systems. Asymmetric key cryptography: Mathematics of Asymmetric key cryptography, Public Key Cryptography RSA Algorithm, Limitations of RSA Algorithm, Comparison of RSA and TRAP DOOR Public Key Crypto systems, Rabin Cryptosystem, ElGamal Cryptosystem, Elliptic Curve Cryptosystems.

**Unit III:**

Key management: Key Transport Protocols, Needham Schroeder Protocol, Key Agreement Protocol, Diffie -Hellman Protocol, Station to Station Protocol, Merkless Puzzle Technique of key agreement, Public Key Distribution,
Message integrity and message authentication, Cryptography hash function, Digital Signature, Entity Authentication.

**Unit IV:**
Networks security: Application Layer: PGP and S/MIME, Transport Layer: SSL and TLS, Network Layer: IPSec.

**D.** Text Books:


1. *AtulKahate,—Cryptography and Network Security, Tata McGraw-Hill Education, 07-2008.*
2. *Behrouz A. Forouzan & D. Mukhopadhyay - Cryptography and Network Security, Tata McGraw-Hill Education, 3E, 2015*
3. *William Stallings - Cryptography and Network Security, Principle and Practice, Pearson Education India, 5E, 2011*
4. *Michael Erschloe, —Information Warfare: How to Survive Cyber Attacks‖, Osborne/McGraw-Hill, 2001.*
5. *Brian Hatch, James Lee and George Kurtz, —Hacking Exposed : Linux: Linux Security Secrets and Solutions‖, Osborne McGraw-Hill, 1983.*
6. *Kenneth R. Van Wyk, Richard Forno, —Incident Response‖, O'Reilly, 2001.*
7. *Kevin Mandia, Chris Prosise, —Incident Response: Investigating Computer Crime‖, Osborne/McGraw-Hill, 2001.*
8. *Mike Schiffman, —Hacker's Challenge‖, McGraw Hill Professional, 2002.*
9. *Julia Allen, —The CERT Guide to System and Network Security Practices‖ Addison-Wesley, 2001.*
10. *Richard E. Smith —Authentication: From Passwords to Public Keys‖, Addison-Wesley, 2002.*
11. *Stuart McClure, Saumil Shah, ShreerajShah ,—Web Hacking: Attacks and Defense‖, Addison-Wesley Professional, 2003 .*
12. *Mike Shema, Bradley C. Johnson, Keith J. Jones, —Anti Hacker Tool Kit: Key Security Tools and Configuration Techniques‖, San Val, Incorporated, 2002.*

***Name of the Module: Internet Technology***
***Module Code: MCSE - 503***
***Semester: 1st***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**Objectives:**

The course is design to meet with the objectives of:

1. study of Structure of Network and its different protocols,
2. study of TCP/IP and OSI model,
3. study of configuration of different types of server in windows and Linux based platform,
4. to complete an in-depth knowledge of web technology,
5. to know and to have the idea for different web application that most web developers are likely to use,
6. to be aware of, and to have used, the enhancements of the web applications,
7. to know the different types of web application software.

**Learning outcomes:**

After completion of the module students will be able to:

1. Explain the roles of key elements in data communication.
2. Explain the uses, hardware requirements and advantages of WANs.
3. Describe the application and operation of protocols.
4. Describe and distinguish features of node addressing methods.
5. Describe the standards for industry network architectures.
6. develop client/server applications

**Subject matters:**

## Unit I:

**Introduction:**Internet, History and Evolution of internet, Types of Network, OSI model, TCP/IP model

**Switching:** Switched Networks, Circuit-Switching Networks, Switching Concepts, Routing in Circuit-Switched Networks, Packet-Switching Principles,routing

**Addressing:** IPv4 addressing-routing and forwarding datagram-datagram format-datagram fragmentation-, ICMP, DHCP, Network Address Translators (NATs), IPv6 packet format-transition from IPv4 to IPv6.

**Routing:** Routing principles- Link state routing-distant vector routing, hierarchical routing, multicast routing, Routing in the Internet: Intra Autonomous System Routing: RIP, OSPF, Inter Autonomous System Routing: BGP

## Unit II:

Application Layer Protocols and Internet applications: FTP, Telnet, Email, Chat. World Wide Web: HTTP protocol, FTP, DNS, SMTP. Remote Procedure Call

## Unit III:

**Designing web pages:** HTML, forms, JAVA applets, JAVA script, JAVA servlets, JSP.JDBC/ODBC DHTML, XML.

## Unit IV:

**E-commerce applications:** E-business models, E-commerce and WWW, secure electronic payment protocols, e-commerce payment systems, web based marketing, search engine and directory registration, e-commerce site designing tools etc.
**Security issues**: Symmetric and asymmetric key, encryption and digital signature, authentication. Emerging trends, Internet telephony, virtual reality over the web, etc. Intranet and extranet, firewall design issues.

**Reading lists:**


1. *TCP/IP Internetworking, Behrouz A. Fourouzan, Publisher Tata McGraw Hill, Second Edition*
2. *Computer Networking – A Top-Down Approach Featuring the Internet, James F. Kurose and Keith W. Ross, Pearson Education, Second Edition*
3. *Data Communication, Computer Networks and Open Systems, F. Halsall, Addison Wesley, First Edition*
4. *Internet Routing Architectures, Sam Halabi and Danny McPherson, Cisco Press, Second Edition*
5. *Xavier C, "Web Technology & Design New Age Publication.*
6. *"Java Server Programming, J2EE edition. (VOL I and VOL II) ", WROX publishers.*
7. *Chris Bates, "Web Programming, building internet applications, 2nd edition", WILEY*
8. *Patrick Naughton and Herbert Schildt, "The complete Reference Java 2 Fifth Edition ", McGraw- Hill Education*
9. *Hans Bergsten "Java Server Pages ", SPD O 'Reilly.*
10. *Dietel and Nieto, "Internet and World Wide Web - How to program ", PHI/Pearson Education Asia*
11. *W3schools tutorials, http://www.w3schools.com/*

***Name of the Module: Advanced Data Structure & Algorithms Laboratory***
***Module Code: MCSE - 504***
***Semester: M.Tech. 1st Year***
***Credit Value: 1 [L=0, T=0, P=2]***
***Module Leader:***

Laboratory experiments will be based on the materials covered in the theory of this paper, specially emphasize on the following topics.

**Searching and Sorting:**

1. Linear Search, Binary Search
2. Selection Sort, Bubble Sort, Insertion Sort, Merge Sort, Heap Sort, Quick Sort, Radix Sort, Counting Sort, Bucket Sort, Shell Sort
3. K'th Smallest/Largest Element in Unsorted Array
4. Find k closest elements to a given value
5. Sort n numbers in range from 0 to n^2 – 1 in linear time

**Backtracking:**

1. Print all permutations of a given string
2. The Knight's tour problem
3. Rat in a Maze
4. N Queen Problem
5. Subset Sum
6. m Coloring Problem
7. Hamiltonian Cycle
8. Sudoku
9. Tug of War

**Dynamic Programming:**

1. Optimal Substructure Property
2. Longest Increasing Subsequence
3. Longest Common Subsequence
4. Matrix Chain Multiplication
5. 0-1 Knapsack Problem

**Greedy Algorithms:**

1. Activity Selection Problem
2. Kruskal's Minimum Spanning Tree Algorithm
3. Huffman Coding

**Pattern Searching:**

1. Naive Pattern Searching
2. KMP Algorithm
3. Rabin-Karp Algorithm
4. A Naive Pattern Searching Question
5. Finite Automata

**B. Books**

*1. T H Cormen, C E Leiserson, R L Rivest and C Stein, "Introduction to Algorithms", MIT Press.*

*2. Ellis Horowitz, Sartaj Sahni and Rajasekaran "Fundamentals of Algorithms", Galgotia publications.*

*3. Jon Kleinberg and Tremblay and Eva Tardos, "Algorithm Design", Addison Wesley.*

*4. Jean-Paul Tremblay and Paul-G Sorenson, An introduction to data structures with applications, Mc Graw Hill.*

*5. Adam Drozdek, "Data Structures and Algorithms in C++", Cengage Learning, 2012. 6. Michael McMillan, "Data Structures and Algorithms Using C#", Cambridge University Press, 2007.*

*7. Weiss, Weiss Mark Allen, "Data Structures and Algorithm Analysis in C++", Pearson Education India, 2007.*

*8. Akepogu Ananda Rao, "Data Structures and Algorithms Using C+", Pearson Education India, 2010.*

*9. Peter Brass, "Advanced Data Structures", Cambridge University Press, 2008.*

*10. J.A. Storer, "An Introduction to Data Structures and Algorithms", Springer Science & Business Media, 2012.*

***Name of the Module: Cryptography and Internet Security Laboratory***
***Module Code: MCSE – 505***
***Semester: M. Tech 1st***
***Credit Value: 1 [L=0, T=0, P=2]***
***Module Leader:***

Laboratory is mainly based on the materials taught i.e. development of code for Classical Cryptosystems, DES, AES, IDEA, RSA, MD5, SHA, DSA etc. and do experimentation. Mini projects may be given in small groups.

Few List of practicals are:

1) Finding GCD of two integer numbers: Euclidian and Extended Euclidian Algorithm, Finding the inverse: Additive and multiplicative
2) Traditional Symmetric Cipher techniques:
    a) Mono alphabetic Cipher: Additive, Multiplicative, Affine
    b) Poly alphabetic Cipher: Autokey cipher, Playfair cipher, Hill cipher, Vigenere cipher.
    c) Transposition cipher
3) Modern Symmetric Encryption: Data Encryption (DES), Advance Encryption Standard (AES).
4) Asymmetric Cipher: RSA, Elgamal, Rabin, Elliptic Curve Cryptosystem.
5) Digital Signatures: RSA digital signature scheme, Elgamal digital signature, etc.
6) Entity Authentication: Challenge response, Zero knowledge, etc
7) Key management: Diffie- Hellman, etc.

***Name of the Module: Internet Technology Laboratory***
***Module Code: MCSE - 506***
***Semester:***
***Credit Value: 1 [L=0, T=0, P=2]***
***Module Leader:***

**List of practical's':**

1. Experimental study of application protocols such as HTTP, FTP, SMTP, using network packet sniffers and analyzers such as Ethereal. Small exercises in socket programming in C/C++/Java.
2. Experiments with packet sniffers to study the TCP protocol. Using OS (netstat, etc) tools to understand TCP protocol FSM, retransmission timer behaviour congestion control behavior.
3. Introduction to ns2 (network simulator) - small simulation exercises to study TCP behaviour under different scenarios.
4. Setting up a small IP network - configure interfaces, IP addresses and routing protocols to set up a small IP network. Study dynamic behaviour using packet sniffers.
5. Experiments with ns2 to study behaviour (especially performance of) link layer protocols such as Ethernet and 802.11 wireless LAN.
6. Practical on Server Configuration Example, Web Server, Mail Server, FTP Server etc.
7. Practice on Cisco Packet Tracer simulator.
8. Basic use of HTML tag, linking image table, frame, form design.
9. DHTML- inline styles, creating style sheets with the style element, linking external style sheet, positioning elements, user style sheet.
10. Creating event handler that responds to mouse and keyboard event: Onload, onmouseover, onmouse out, onfocus, onblur, onsubmit, onresult, onclick, onchange.
11. Structuring data with xml, xml parser, extensible style language (xsl); customising markup language.
12. Configuring apache-tomcat server. 6. Building simple jsp: Declaring variables and methods in jsp, inserting java expression in jsp, processing request from user, generating a dynamic response for the user. Accessing database from jsp, inserting applet into jsp

## *Proposed Courses for Second Semester*

| Sl No | Code | Course Title | L-T-P | Credit |
|---|---|---|---|---|
| 1 | MCSE - 507 | Virtualization and Cloud Computing | 3-0-0 | 3 |
| 2 | MCSE - 508 | Distributed Operating System | 3-0-0 | 3 |
| 3 | MCSE - 509 | Distributed Operating System Laboratory | 0-0-2 | 2 |
| 4 | MCSE – 510X | Elective-I | 3-0-0 | 3 |
| 5 | MCSE – 511X | Elective-II | 3-0-0 | 3 |
| | | **TOTAL** | **15-0-2** | **14** |

***Name of the Module: Virtualization and Cloud Computing***
***Module Code: MCSE - 507***
***Semester: 2nd***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**Objectives:**

The course is design to meet the objectives of:

The student will learn about the cloud environment, building software systems and components that scale to millions of users in modern internet, cloud concepts capabilities across the various cloud service models including Iaas, Paas, Saas, and developing cloud based software applications on top of cloud platforms

**Course Outcomes**

After completion of course, students would be able:

- To learn how to use Cloud Services.
- To implement Virtualization
- To implement Task Scheduling algorithms.
- Apply Map-Reduce concept to applications.
- To build Private Cloud.

**Introduction**

Definitions, Characteristics of cloud computing, Advantages and disadvantages of cloud computing, Cloud computing Vs Grid computing, Cloud computing Vs Distributed computing, Cloud computing Vs Cluster Computing.

**Virtualization**

Basic concept– Hypervisor- Types of virtualization- hardware, operating system, server, storage- Features of virtualization- Advantages and disadvantages of different types of virtualization.

**Cloud Architecture**

Types of deployment models-Private, Public , Hybrid, Community, Types of service models-Iaas, PaaS, SaaS.

**Cloud storage architecture**

Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system, Apache Hadoop, BigTable, Megastore, Amazon Simple Storage Service(S3).

**Cloud Security**

Cloud vulnerabilities-Threats to cloud confidentiality-VM cross attack, Malicious Sys Admin-Defense mechanism-Coresidency detection, NoHype-Threats to cloud integrity-data loss/manipulation, dishonest computation- Defense Mechanism-Provable Data Possession (PDP), Proof of Retrievability, Dynamic PDP.

Text Books:


1. Distributed and Cloud Computing, Kai Hwang, Geoffry C. Fox, Jack J. Dongarra MK Elsevier.
2. Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier.
3. Cloud Computing, A Hands on approach, Arshadeep Bahga, Vijay Madisetti, University Press

References:

1. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH
2. Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammarai selvi, TMH

***Name of the Module: Distributed Operating System***
***Module Code: MCSE - 508***
***Semester: 2nd***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet the objectives of:

1. Study of basic structure of Operating System.
2. Difference between OS and Distributed Operating Systems.
3. Study of Memory Management, Synchronization, Fault Tolerance, Deadlock.
4. Study of Multiprocessor Operating System, its Architecture and Management.

**B. Subject matter:**

1. Students will be able to work in threats programming.
2. Student will able to understand and work in Distributed File System.
3. Student will able to work in UNIX base Operating Systems.
4. Student will understand Fault Tolerance under UNIX.

**C. Subject matters:**

**Unit I:**

**Introduction:** Function of an operating system, Design approaches, concepts of processes, threats, Critical Section problem, Other synchronization problem, Communicating sequential processes. **Process Deadlocks:** Introduction, Preliminaries, Models of Deadlocks, Models of resources, A graph theoretic models of System State, Necessary and sufficient conditions for a Deadlocks. Detection, Prevention and Avoidance.

**Distributed Operating Systems:** Introduction, System Architectures, issues in Distributed Operating Systems, Communication Networks, and Limitations of Distributed OS.

**Unit II**

**Distributed Mutual Exclusion:** Classifications of Mutual Exclusion, Preliminaries, Solutions of Mutual Exclusions- Non token based algorithm, Lamport's Algorithm, Maekawa's Algorithm, Token Based Algorithm etc.

**Distributed Deadlock Detection:** Introduction, Preliminaries, Deadlock handing strategies in Distributed OS, Control organizations for Distributed Deadlock Detection, Central Deadlock Detection Algorithms, Distributed Deadlock Detection Algorithm.

**Agreement Protocol**: System model, Classification of agreement problems, Application of Agreement Protocol.

**Unit III:**

**Distributed File Systems:** Mechanisms for building Distributed File Systems, Design Issues, Case Studies- Sun Network File System, The Sprite File Systems, Apollo Domain Distributed File System, Coda, Log Structure File Systems, and Disk Space Management.

**Distributed Shared Memory:** Architecture and Motivation, Algorithm for Implementing of DMS,Memory Coherence, Coherence Protocol, Case Studies- IVY, Mirage, Clouds.

**Distributed Scheduling:** Issues in load Distributing, Components of Load Distributing Algorithm, Stability, Load Distributing Algorithm, Performance Comparison, Selecting a Suitable Load Sharing Algorithm, Load Sharing Policies.

**Unit IV:**

**Failure Recovery:** Classification of Failures, Backward and Forward Error recovery, Recovery in concurrent systems, Check points.

**Fault Tolerance:** Atomic Action and Committing, Commit Protocols, Non-Blocking Commit Protocols, Voting Protocols, Dynamic Voting Protocols, Case studies-Fault Tolerance under UNIX. **Multiprocessor System Architecture:** Motivations, Basic Architecture, Caching, Hypercube Architecture,

**Multiprocessor Operating Systems:** Structure, Multiprocessor Design issues, Threats, Process, Synchronization, Processor Scheduling, Memory Management, Reliability/Fault Tolerance.

**D. Reading lists:**


1. *Singhal, "Advanced Concepts In Operating Systems", Tata McGraw-Hill Education, 2001.*
2. *W. Richard Stevens, Stephen A. Rago, "Advanced Programming in the UNIX Environment, Addison-Wesley Professional Computing Series", Addison-Wesley, 2013.*
3. *Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson Education India, 1995.*
4. *Wiseman, Yair, "Advanced Operating Systems and Kernel Applications: Techniques and Technologies: Techniques and Technologies", IGI Global, 2009*
5. *Pramod Chandra P. Bhatt, "An Introduction to Operating Systems: Concepts and Practice",*

*PHI Learning Pvt. Ltd., 2010.*

6. *Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating System Concepts, 9th Edition", Addison-Wesley, 2013.*

7. *Sibsankar Haldar, Alex Alagarsamy Aravind, "Operating Systems", Pearson Education India, 2010.*
8. *Chow, "Distributed Operating Systems And Algorithm Analysis", Pearson Education India, 2009*

9. *Pradeep K. Sinha, "Distributed Operating Systems: Concepts And Design", Phi Learning Pvt. Ltd., 1998.*

10. *Thomas W. Doeppner, "Operating Systems In Depth: Design And Programming", John Wiley & Sons, 2011.*

***Name of the Module: Distributed Operating System Laboratory***
***Module Code: MCSE - 509***
***Semester: 2nd***
***Credit Value: 1 (L=0, T=0, P=2)***
***Module Leader:***

Programs related to all related topics covered in theory.

## List of Elective Subjects

| ELECTIVE – I | | ELECTIVE – II | |
|---|---|---|---|
| **L-T-P** | **Name of the Subject** | **L-T-P** | **Name of the Subject** |
| 3-0-0 | Quantum Computing | | NPTEL Online Course * |
| 3-0-0 | Image Processing | | |
| 3-0-0 | Soft Computing | | |
| 3-0-0 | Advanced Software Engineering | | |
| 3-0-0 | Green Computing | | |
| 3-0-0 | Parallel Algorithm | | |
| 3-0-0 | Mobile Ad-hoc Network | | |
| 3-0-0 | Natural Language Processing | | |

*** Student can enroll in 1st year (1st or 2nd semester). However the courses will be credited in 2nd semester only.**

*** Courses will be of completely student's choice and should contain at least 20 video lectures including tutorials which will be considered as 3 credit course.**

# Elective Courses

***Name of the Module:*** *Quantum Computing*
***Module Code:*** *MCSE*
***Semester:*** *2nd*
***Credit Value:*** *3 [L=0, T=0, P=0]*
***Module Leader:***

**A. Objectives:**

The course is design to meet the objectives of:

1. why to be interested in quantum computing,
2. the prehistory of quantum computing,
3. the specific properties of quantum computing in comparison with randomized computing,
4. the basic experiments and principles of quantum physics,
5. the basics of Hilbert space theory,
6. the elements of classical reversible computing.

**B. Learning outcomes:**

Upon Completion of the subjects:

1. Understand and explain the basic notions of Quantum Computing-including Quantum Bits and registers, Quantum Evolution, Quantum Circuits, Quantum Teleportation and the basic Quantum Algorithms known at the present time.

2. Identify the essential difference between the classical paradigm and the quantum paradigm of computation and appreciate why quantum computers can solve currently intractable problems.

3. Work with Quantum Simulator like Revkit 1.3, JQuantum etc to design and verify different quantum circuits.

**C. Subject matter:**

**Unit I:**

**Fundamental Concepts:** Global Perspectives, Quantum Bits, Quantum Computation, Quantum Algorithms, Quantum Information, Postulates of Quantum Mechanisms.

**Quantum Computation:** Quantum Circuits – Quantum algorithms, Single Orbit operations, Control Operations, Measurement, Universal Quantum Gates, Simulation of Quantum Systems, Quantum Fourier transform, Phase estimation, Applications, Quantum search algorithms – Quantum counting – Speeding up the solution of NP – complete problems – Quantum Search for an unstructured database

**Unit II:**

**Quantum Computers**: Guiding Principles, Conditions for Quantum Computation, Harmonic Oscillator Quantum Computer, Optical Photon Quantum Computer – Optical cavity Quantum electrodynamics, Ion traps, Nuclear Magnetic resonance.

**Unit III:**

**Quantum Information:** Quantum noise and Quantum Operations – Classical Noise and Markov Processes, Quantum Operations, Examples of Quantum noise and Quantum Operations – Applications of Quantum operations, Limitations of the Quantum operations formalism, Distance Measures for Quantum information.

**Unit IV:**

**Quantum Error Correction:** Introduction, Short code, Theory of Quantum Error –Correction, Constructing Quantum Codes, Stabilizer codes, Fault – Tolerant Quantum Computation, Entropy and information – Shannon Entropy, Basic properties of Entropy, Von Neumann, Strong Sub Additivity, Data Compression, Entanglement as a physical resource.

**D. Reading lists:**


1. *C. T.Bhunia ,"Introduction To Quantum Computing" , Publisher New Age International Pvt Ltd Publishers, ISBN 9788122430752*
2. *Micheal A. Nielsen. & Issac L. Chiang, "Quantum Computation and Quantum Information", Cambridge University Press, Fint South Asian edition, 2002*
3. *David McMahon, "Quantum Computing Explained", Wiley.*
4. *Eleanor G. Rieffel , Wolfgang H. Polak, "Quantum Computing: A Gentle Introduction (Scientific and Engineering Computation)", The MIT Press.*
5. *Susan Shannon , "Trends in Quantum Computing Research", Nova Publishers, 2006*
6. *Julian Brown, "Quest for the Quantum Computer", Simon & Schuste.*
7. *Marco Lanzagorta, Jeffrey Uhlmann, "Quantum Computer Scienc", Morgan & Claypool Publishers,2009*
8. *Phillip Kaye , Raymond Laflamme , Michele Mosca , "An Introduction to Quantum Computing", Oxford.*
9. *Sahni, "Quantum Computing", Tata McGraw-Hill Education, 2007.*

6. *Quantum Information and Computation, ISSN: 1533-7146.*
7. *Journal of Optics B: Quantum and Semiclassical Optics, Online ISSN: 1741-3575 Print ISSN: 1464-4266*

8. *Reviews of Modern Physics, 0034-6861 (print), 1539-0756 (online)*
9. *Information and Computation, Elsevier, ISSN:0890-5401*
10. *The Future of Quantum Information Processing, Science (Special Issue).*

***Name of the Module: Image Processing***
***Module Code: MCSE-***
***Semester:***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet the objectives of:

1. give the students a general understanding of the fundamentals of digital image processing,
2. introduce the student to analytical tools which are currently used in digital image processing as applied to image information for human viewing,
3. develop the students ability to apply these tools in the laboratory in image restoration, enhancement and compression,
4. understand differences between computer vision and image processing,
5. know the basic components of an image processing system.

**B. Learning outcomes:**

1. Understand the basics of the human visual system as they relate to image processing; including spatial frequency resolution and brightness adaption.
2. Understand how images are represented; including optical images, analog images, and digital images. Understand image types such as binary images, gray-scale images, color and multi-spectral images.
3. Know the key concepts in image file formats.
4. Understand the model for an image analysis process.
5. Understand why preprocessing is performed and know about image geometry, convolution masks, image algebra and basic spatial filters.
6. Understand image quantization in both the spatial and brightness domains.
7. Know about the 2-D Fourier, discrete cosine, Walsh-Hadamard and wavelet transforms; including implied symmetry, phase, circular convolution, vector inner and outer products and filtering.
8. Know why log remapping is necessary for viewing spectral image data.
9. Understand lowpass, highpass, bandpass, notch filters; including ideal and non-ideal filters such as the Butterworth.

**C. Subject matter:**

**Unit I:**

**Digital image fundamentals:** Introduction: Digital Image- Steps of Digital Image Processing Systems-Elements of Visual Perception -Connectivity and Relations between Pixels. Simple

Operations- Arithmetic, Logical, Geometric Operations. Mathematical Preliminaries - 2D Linear Space Invariant Systems - 2D Convolution - Correlation 2D Random, Sequence - 2D Spectrum

**Unit II:**

**Image transforms and enhancement**

Image Transforms: 2D Orthogonal and Unitary Transforms-Properties and Examples. 2D DFT-FFT ‑ DCT -Hadamard Transform - Haar Transform - Slant Transform - KL Transform -Properties And Examples. Image Enhancement:- Histogram Equalization Technique- Point Processing-Spatial Filtering-In Space And Frequency - Nonlinear Filtering-Use Of Different Masks.

**Unit III:**

**Image restoration and construction:** Image Restoration: Image Observation And Degradation Model, Circulant And Block Circulant Matrices and Its Application In Degradation Model - Algebraic Approach to Restoration- Inverse By Wiener Filtering – Generalized Inverse-SVD And Interactive Methods - Blind Deconvolution-Image Reconstruction From Projections.
**Color and multispectral image processing:** Color Image-Processing Fundamentals, RGB Models, HSI Models, Relationship Between Different Models.Multispectral Image Analysis - Color Image Processing Three Dimensional Image Processing-Computerized Axial Tomography-Stereometry-Stereoscopic Image Display-Shaded Surface Display.

**Unit IV:**
**Image compression & segmentation**
Image Compression: Redundancy And Compression Models -Loss Less And Lossy.
Loss Less- Variable-Length, Huffman, Arithmetic Coding - Bit-Plane Coding, Loss Less Predictive Coding, Lossy Transform (DCT) Based Coding, JPEG Standard - Sub Band Coding.
Image Segmentation: Edge Detection - Line Detection - Curve Detection - Edge Linking And Boundary Extraction,

Boundary Representation, Region Representation And Segmentation, Morphology-Dilation, Erosion, Opening And Closing. Hit And Miss Algorithms Feature Analysis.

**Books:**


1. *Gonzalez, "Digital Image Processing,2/e", Pearson Education India.*
2. *Jayaraman, "Digital Image Processing", Tata McGraw-Hill Education, 2011*
3. *Stéphane Marchand-Maillet, Yazid M. Sharaiha, "Binary Digital Image Processing: A Discrete Approach", Academic Press.*
4. *Edward Dougherty, "Mathematical Morphology in Image Processing", CRC Press*
5. *Wilhelm Burger, Mark J. Burge, "Digital Image Processing: An Algorithmic Introduction Using Java Texts in Computer Science", Springer Science & Business Media, 2009.*
6. *Linda Shapiro, "Computer Vision and Image Processing", Academic Press.*
7. *Thomas Klinger, "Image Processing with LabVIEW and IMAQ Vision- National Instrument virtual instrumentation series Virtual Instrumentation Series", Prentice Hall Professional.*

8. *Tinku Acharya, Ajoy K. Ray, "Image Processing: Principles and Applications", John Wiley & Sons, 2005.*

9. *J. R. Parker, "Algorithms for Image Processing and Computer Vision", John Wiley & Sons, 2010*

10. *Maher A. Sid Ahmed, "Image Processing: Theory, Algorithms, and Architectures", McGraw-Hill*

11. *Sanjit Kumar Mitra, Giovanni L. Sicuranza, "Nonlinear Image Processing", Academic Press, 2001.*

12. *Tinku Achary, Ajoy K. Ray, "Image Processing: Principles and Applications", John Wiley & Sons, 2005*

13. *J. R. Parker, "Algorithms for Image Processing and Computer Vision", John Wiley & Sons, 2010*

***Name of the Module:*** *Soft Computing*
***Module Code:*** *MCSE-*
***Semester:***
***Credit Value:*** *3 [L=3, T=0, P=0]*
***Module Leader*:**

**A. Objectives:**

The course is designed to meet with the objectives of:

1. introducing the fundamental concepts of Soft Computing;
2. equip with the knowledge and skills in logic programming;
3. exploring the different paradigms in knowledge representation and reasoning;
4. understanding the contemporary techniques in machine learning;
5. evaluating the effectiveness of hybridization of different artificial intelligence techniques.

6. fundamentals of non-traditional technologies and approaches to solving hard real-world problems, namely of fundamentals of artificial neural networks, fuzzy sets and fuzzy logic and genetic algorithms

**B. Learning outcomes:**

1. understand the history, development and various applications of Soft Computing.
2. familiarize with propositional and predicate logic and their roles in logic programming;

3. learn the knowledge representation and reasoning techniques in rule-based systems, case-based systems, and model-based systems;

4. appreciate how uncertainty is being tackled in the knowledge representation and reasoning process, in particular, techniques based on probability theory and possibility theory (fuzzy logic);

6. master the skills and techniques in machine learning, such as decision tree induction, artificial neural networks, and genetic algorithm;

7. understand neural network(NN) paradigms, fuzzy logic, genetic algorithm(GA), evolutionary programming, classifier systems, genetic programming parse trees, mathematical foundation of GA variants of GA

**C. Subject matter:**
**Unit I:**

**Artificial Neural Network:** Basic concept of Soft Computing; Basic concept of neural networks, Mathematical model, Properties of neural network, Typical architectures: single layer, multilayer, competitive layer; Different learning methods: Supervised, Unsupervised & reinforced; Common activation functions; Feed forward, Feedback & recurrent N.N; Application of N.N; Neuron.

**Unit II:**

**Pattern Recognition:** Pattern Classification, Pattern Association, Clustering, Simple Clustering algorithm, k-means & k-medoid based algorithm.

**Models Of Neural Network:** Architecture, Algorithm & Application of -- McCulloh-Pitts, Hebb Net, Perceptron ( with limitations & Perceptron learning rule Convergence theorem), Backpropagation NN, ADALINE, MADALINE, Discrete Hopfield net, BAM, Maxnet , Kohonen Self Organizing Maps, ART1,ART2.

**Unit III:**

**Fuzzy Sets & Logic:** Fuzzy versus Crisp; Fuzzy sets—membership function, linguistic variable, basic operators, properties; Fuzzy relations—Cartesian product, Operations on relations; Crisp logic—Laws of propositional logic, Inference; Predicate logic— Interpretations, Inference; Fuzzy logic—Quantifiers, Inference; Fuzzy Rule based system; De-fuzzification methods; FAM;

**Unit IV:**

**Genetic Algorithm:** Basic concept; role of GA in optimization, Fitness function, Selection of initial population, Cross over(different types), Mutation, Inversion, Deletion, Constraints Handling; Evolutionary Computation; Genetic Programming; Schema theorem; Multiobjective & Multimodal optimization in GA; Application— Travelling Salesman Problem, Graph Coloring problem;

**Hybrid Systems:** Hybrid systems, GA based BPNN(Weight determination, Application); Neuro Fuzzy Systems—Fuzzy BPNN--fuzzy Neuron, architecture, learning, application; Fuzzy Logic controlled G.A;

**D. Books**


1. *Elaine Rich and Kevin Knight, "Artificial Intelligence", (2006), McGraw Hill Companies Inc.*
2. *Stuart Russell and Peter Norving, "Artificial Intelligence: A Modern Approach", Prentice Hall.*
3. *Davin Poole, Alan Mackworth, and Randy Goebel, "Computational Intelligence: A logical Approach" , Oxford University Press.*
4. *George F. Luger, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Addison-Wesley, 2005.*
5. *Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann, 1998.*
6. *Thomas Dean, "Artificial Intelligence: Theory and Practice", Addision- Wesley.*
7. *Mike Sharples, et al, "Computers and Thought: A practical Introduction to Artificial Intelligence", A Bradford Book , 1989*
8. *Xin-Xing Tang, "Virtual Reality: Human Computer Interaction", InTech , 2012.*
9. *Ray Kurzweil, "The Age of Intelligent Machines", The MIT Press , 1992.*

10. *David Poole, Alan Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press , 2010*

***Name of the Module: Advanced Software Engineering***
***Module Code: MCSE -***
***Semester:***
***Credit Value: 3[L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet with the objectives of:

1. to solve the software crisis where software is delivered late, with faults, and over budget. Software engineering aims to deliver fault free software, on time and within budget, meeting the requirements and needs of the client. The software is developed keeping in mind the future maintenance that is involved,

2. to design, implement, and modify software that is high quality, affordable, and maintainable. It's applying the engineering discipline to software such that consistently high quality software can be built within a calculated time and budget.

**B. Learning outcomes:**

1. Identify the scope and necessity of software engineering.
2. Identify the causes of and solutions for software crisis.
3. Differentiate a piece of program from a software product.

**C. Subject matter:**

**Unit I:**

**Overview of System Analysis & Design**: , Business System Concept, System Development Life Cycle, Waterfall Model , Spiral Model, Feasibility Analysis, Technical Feasibility, Cost-Benefit Analysis, COCOMO model.

**System Requirement Specification:** DFD, Data Dictionary, ER diagram, Process Organization & Interactions.

**System Design**: Problem Partitioning, Top-Down and Bottom-Up design; Decision tree, decision table and structured English; Functional vs. Object- Oriented approach.

**Unit II:**

**Coding & Documentation:** Structured Programming, OO Programming, Information Hiding, Reuse, System Documentation.

**Testing:** Levels of Testing, Integration Testing, Test case Specification, Reliability Assessment, Validation & Verification Metrics, Monitoring & Control.

**Unit III:**

**Technical Issues And Object Oriented Software Engineering:**

**Software Requirements:** Functional and Non-Functional Requirements**,** IEEE Standard for Software Requirements document

**UML 2.0 and the Unified Process:** Overview of UML 2.0**,** Unified Process

**Inception:** Use cases**,** Supplementary specification, Glossary and Vision

**Elaboration Iteration 1 – Domain Model:** System Sequence Diagrams**,** Domain Model**,** Contracts for System Operations

**Elaboration Iteration 1 –Design Patterns,** Design patterns

**Elaboration – Iteration 1 Design Model: Use Case Realization,** Use case realizations
**Elaboration – Iteration 1 Design Model: Design Class Diagram,** Design class diagram
**Elaboration Iteration 1 – Implementation Model,** Mapping design to code
**Elaboration Iterations 2 and 3,** Iteration 2 and its requirements, Iteration 3 and its requirements, Package structures

**Design With Layers,** Logical Architecture and Software Architecture, Applying UML: Package Diagrams, Design with Layers

**N+1 Views**

**Formal Specifications**: Specification Qualities, Classification of Specification Styles,

Descriptive Specifications: Logic and Algebraic Specifications, Operational Specifications:

DFD, FSM, Petri Nets, Introduction to Z

**Unit IV:**

**Software Project Management:** Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring.

**Software modelling:** with Unified Modelling Language.

**CASE TOOLS:** Concepts, use and application.

**F. Reading lists:**


1. *Larman, "Applying UML and Patterns, Third Edition",* Prentice Hall, 2005.
2. *Roger S Pressman, "Software Engineering – A practitioner"s approach", McGraw-Hill Higher Education*
3. *Rajiv Mall, "Software Engineering", PHI.*
4. *Ghezzi, jazayeri, Mandrioli, "Fundamentals of Software Engineering", Prentice Hall PTR*
5. *Sommerville, "Software Engineering", Pearson Education*
6. *Behforooz, "Software Engineering Fundamentals", OUP*
7. *Ghezzi, "Software Engineering", PHI*
8. *PankajJalote, "An Integrated Approach to Software Engineering", NAROSA.*
9. *SCHACH, "Object Oriented & Classical Software Engineering(Fifth Edition)", TMH*
10. *Vans Vlet, "Software Engineering", SPD*
11. *Uma, "Essentials of Software Engineering", Jaico*
12. *Benmenachen, "Software Quality", Vikas*
13. *"IEEE Standards on Software Engineering",* IEEE *Computer Society Press*

***Name of the Module: Green Computing***
***Module Code: MCSE-956***
***Semester:***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet the objectives of:

1. effects of IT and Networking devices in environments point of views,
2. green Computing approach for propose more energy efficient devices and construct a framework for green architecture in different areas eg. Data enters, wired & wireless networking, Wireless sensor networks, Smart Grid etc,
3. measuring and Analysis techniques of existing & proposed systems and find out the greenness.

**B. Learning outcomes:**

Upon Completion of the subjects:

1. Explore and understand different research areas of green computing to minimize energy consumption, reducing Green House Gases.
2. Different tools and simulators for measuring power usages efficiencies,
3. Changing existing networking protocols, result analysis, comparison of both existing and new proposed approach etc.

**C. Subject matter:**

**Unit I:**

Origins, Regulations and industry initiatives- Government, Industry.

Approaches to green computing- Product longevity, Algorithmic efficiency, Resource allocation.

**Virtualization**: Green Maturity model for Virtualization, Virtualization level : Level0, Level 1, Level 2, Level 3.

**Unit II:**

Terminal servers, Power management, Operating system support, Power supply, Storage, Video card, Display.

Web, Temporal and Spatial Data Mining Materials recycling, Telecommputing.

Thin Clients: Introduction of thin clients, Characteristics of thin clients, Thin Clients variants. Dynamic Voltage/Frequency Scaling - DVFS, DVF, DVS in microprocessor and small handheld gazettes.

**Unit III:**

Middleware Support for green computing, Tools for monitoring, HPC computing, Green Mobile, embedded computing and networking, Management Frameworks Standards and metrics for computing green

**Environmentally Sustainable Infrastructure Design:** Sustainable Technology, Sustainable Intelligence, Decomposing Infrastructure Environment.

**Profiling Energy Usages for Efficient Consumption:** Profiling Energy Usages for the Application, Profiling Energy Usages for the operating System and Extra Energy usages profile.

**Unit IV:**

**Green Networking:** Where to save energy in Wired Networking, Taxonomy of Green Networking research: Adaptive Link rate, Interface Proxying, Energy ware Infrastructure, Energy ware Application.

**Efficient-Efficient Data Canters:** Reason for over power consumption in data centers, Data Center Management Architecture in greener perspective.

**Green Cellular Networking:** Survey, Measuring Greenness matrics, Energy Saving in Base Stations, Research Issues, Challenges, Future Generation Wireless Systems, Wireless Sensor Network for Green Networking

**Books:**


1. *Bud E. Smith, "Green Computing: Tools and Techniques for Saving Energy, Money, and Resources", Auerbach Publications.*
2. *Toby Velte, Anthony Velte, Robert Elsenpeter, "Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line", MC-Grow Hill*
3. *Jason Harris , "Green Computing and Green IT Best Practices on Regulations and Industry Initiatives, Virtualization, Power Management, Materials Recycling and Telecommuting",*

   *Emereo Publishing*
4. *John Lamb , "The Greening of IT-How Companies Can Make a Difference for the Environment", Pearson Education*
5. *Greg Schulz , "The Green and Virtual Data Center", CRC Press*
6. *F. Richard Yu, Xi Zhang, Victor C.M. Leung, "Green Communications and Networking", CRC Press.*
7. *Daniel Minoli, "Designing Green Networks and Network Operations: Saving Run-the-Engine Costs", CRC Press.*

8. *Gary Moore, "The Dark Side of Green: The Unintended Consequences of the Climate Change Movement", CRC Press, April 2011.*

9. *Bhuvan Unhelkar. "Handbook of Research on Green ICT: Technology, Business and Social Perspectives", IGI-Global, 2010.*

10. *Bhuvan Unhelkar, "Green IT Strategies and Applications: Using Environmental Intelligence", CRC Press, March 2011*

11. *Wu-chun Feng, "Green Computing: Large-Scale Energy Efficiency", CRC Press. January 2011*

***Name of the Module: Parallel Algorithms***
***Module Code: MCSE -***
***Semester:***
***Credit Value: 3[L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet with the objectives of:

1. basics of parallel and distributed computing,
2. study different aspects of Parallel Models,
3. study different aspects of Interconnection Architecture,
4. analyse a number of fundamental parallel algorithms from various application domains,
5. principles of parallel and distributed algorithms and their time complexity.

**B. Learning outcomes:**

1. Understand the role of computation models in parallel computation.
2. Understand the circuit and comparison network models.
3. Understand the basics of merging and sorting networks.
4. Understand the relationship in parallel algorithm and High Performance Computing.

**C. Subject matter:**

**Unit I:**

**Parallel Models** (SIMD, MIMD, PRAMs, Interconnection Networks);
Performance Measures (Time, Processors, Space, Work);

Sequential model, need of alternative model, parallel computational models such as PRAM, LMCC, Hypercube, Cube Connected Cycle, Butterfly, Perfect Shuffle Computers, Tree model, Pyramid model, Fully Connected model, PRAM-CREW, EREW models, simulation of one model from another one.

**Unit II:**

Performance Measures of Parallel Algorithms, speed-up and efficiency of PA, Costoptimality, An example of illustrate Cost-optimal algorithms- such as summation, Min/Max on various models. Techniques (Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Pipelining, Systolic Computation, Acccelerated Cascading, Prefix Computation, List Ranking, Euler Tour, Tree Contraction);

**Unit III:**

Parallel Sorting Networks, Parallel Merging Algorithms on CREW/EREW/MCC/, Parallel Sorting Networks on CREW/EREW/MCC/, linear array

**Unit IV:**

Parallel Searching Algorithm, Kth element, Kth element in X+Y on PRAM, Parallel Matrix Transportation and Multiplication Algorithm on PRAM, MCC, Vector-Matrix Multiplication, Solution of Linear Equation, Root finding. Graph Algorithms - Connected Graphs, search and traversal, Combinatorial Algorithms- Permutation, Combinations, Derrangements, Complexity (Lower bounds, NC Class and P-Completeness).

**Reading lists:**


1. *M.J. Quinn, "Designing Efficient Algorithms for Parallel Computer", Mc GrawHill.*
2. *S.G. Akl, "Design and Analysis of Parallel Algorithms", Prentice Hall of India.*
3. *S.G. Akl, "Parallel Sorting Algorithm", Academic Press*
4. *R. Greenlaw, H.J. Hoover, W.L. Ruzzo, "Limits to Parallel Computation: P-Completeness Theory", Oxford University Press, New York, 1995.*
5. *V. Kumar, A. Grama, A. Gupta, G. Karypis, "Introduction to Parallel Computing", The Benjamin/ Cummings Publishing Company, Redwood City, California, 1994.*
6. *T. Cormen, C. Leiserson, R. Rivest, "Introduction to Algorithms", The MIT Press, Cambridge, 1992.*
7. *M. J. Quinn, "Parallel Computing", McGraw Hill, 1994.*
8. *F.T. Leighton, "Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes", Morgan Kaufmann Publishers, San Mateo, California, 1992.*
9. *D.P. Bovet, P. Crescenzi, "Introduction to The Theory of Complexity", Prentice Hall, N.Y., 1994.*
10. *S. Lakshmivarahan and S. K. Dhall, "Analysis and Design of Parallel Algorithms - Arithmetic and Matrix Problems", McGraw Hill, 1990*

***Name of the Module: Mobile Ad-hoc Networks***
***Module Code: MCSE -958***
***Semester:***
***Credit Value: 3 [L=3, T=0, P=0]***
***Module Leader:***

**A. Objectives:**

The course is design to meet the objectives of:

1. study of Mobile Adhoc network, its applications, architecture,
2. mediam access protocol, networking protocol, routing protocol, cross layer design, integration with 4G,
3. learn different simulation tools (Eg. NS2) for proposing new protocol and their effectiveness.

**B. Learning outcomes:**

1. Explore Mobile Adhoc network field for research purpose.
2. Learn Simulators for implementation and changes in different routing protocol like AODV, DSR.

**C. Subject matter:**

**Unit I:**

**Introduction**
Introduction to Adhoc networks – definition, characteristics features, Application, Characteristics of Wireless channel, Adhoc Mobility Models: - Indoor and outdoor models, WLAN, Bluetooth, Short range ADHOC networks- Body area network, Wireless Personal area network.

**Medium Access Protcols**

MAC protocols: design issues, goals and classification. Contention based protocols –with reservation, scheduling algorithms, protocols using direction antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.

**Unit II:**

**Network Protocols**

Routing protocols: Decentralized Routing Algorithm, Global routing algorithm, Proactive vs. reactive routing, uncast routing algorithms, Multicast routing hierarchical routing, Link state

routing, distance vector routing, QoS aware routing, Routing and mobile management in mobile wireless network

**Unit III:**

**End-End Delivery and Security**

Transports layer: Issues in desiging- transport layer classification, adhoc transport protocols. Security issues in adhoc network: issues and challenges, network security attacks, secure routing protocols.

**Unit IV:**

**Cross Layer Design And Integration Of Adhoc For 4G**

Cross layer design: need for cross layer design, cross layer optimization, parameter optimizations, techniques, cross layer cautionary perspective. Integration of adhoc with mobile IP networks. Mesh networks, vehicular area networks.

**Books:**


*1. C K Toh, "Ad-hoc mobile wireless network – protocols and systems", prentice hall.*

*2. Siva Ram Murthy, "Ad-hoc wireless networks – architecture and protocols", Addison-Wesley.*

*3. Stefano Basagni, Marco Conti, Silvia Giordano, Ivan Stojmenovic , "Mobile Ad Hoc Networking", Wiley-Interscience.*

*4. Edgar H. Callaway, "Wireless sensor networks: architecture and protocols", Auerbach publications.*

*5. Azzedine Boukerche, "Algorithms and Protocols for Wireless, Mobile Ad Hoc Networks", Wiley.*

*6. Yi Pan, Yang Xiao,"Ad Hoc and Sensor Networks", Nova Science Publishers.*

*7. Hai Liu, Xiaowen Chu, Yiu-Wing Leung, "Ad Hoc and Sensor Wireless Networks: Architectures, Algorithms and Protocols", Bentham Science.*

*8. Pedro Cuenca, Carlos Guerrero, Ramon Puigjaner, Bartomeu Serra, "Advances in AdHoc Networking", Springer*

*9. Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, "Mobile Ad Hoc Networks: Current Status and Future Trends", CRC Pres.*

*10. Aggelou, "Mobile Ad Hoc Networks", Tata McGraw-Hill Education*