115MCT01 ADVANCED DATA STRUCTURES

L	T	P	C
3	0	0	3

Course Objectives (Cos):

- To understand the implementation and use of advanced data structures
- To design efficient algorithms using algorithmic technics
- To learn how to analysis space and time requirements of a given algorithm

UNIT I List, Stack, Queue **9**

Algorithm Analysis – ADT - List: Linked List (Singly, Doubly and Circular) - Array-Stack-Queue-Implementation and Applications.

UNIT II Tree Structures **9**

Trees – Tree Traversals with an Application, Binary, Binary Search, AVL Tree, **Splay Tree** and **B^+ Tree-**, Red-Black-Tree,2-3 Trees,2-3-4-Trees,**AA-Tree,K-d Tree**

UNIT III Searching and Sorting **9**

Hashing: Linear-Static-Dynamic-Application: **Bloom Filters** Heap: Min-Max **Sorting: Internal Sorting – Insertion Sorting – Shell Sorting – Merge Sorting – Quick Sorting, External Sorting**.

UNIT IV Graph Structures **9**

Graphs – Directed Graphs – Shortest Path Problem-Dijkstra's Algorithm- Undirected Graph - Spanning Trees-Prim's Algorithm, Kruskal's Algorithm,**Sollin's Algorithm** – Graph Traversals-DFS, BFS, Applications of graphs

UNIT V Dynamic Programming and Memory Management **9**

Divide and Conquer: Closest Point-Convex Hull-Stassen's Matrix Multiplication- Greedy Algorithm:-Scheduling Problem, Huffman Codes, **Bin Packing** – Backtracking-Turnpike Reconstruction, and **Dynamic Memory Management**.

Total 45 hours

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REFERENCES

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education, 2002.
2. "Fundamentals of Data Structures", Second Edition. Horowitz, Sahni, Anderson, Freed, 2011.
3. Tanenbaum A.S., Langram Y, Augestien M.J., "Data Structures using C & C++", Prentice Hall of India, 2002.

Course Outcomes:

- Understand the properties of various data structures
- Analyze different algorithm techniques
- Design and Employ different appropriate Data Structure for Real Time Applications

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115MCT02 ADVANCED OPERATING SYSTEM

L	T	P	C
3	0	0	3

Course Objectives (COs)

To know the components of the operating systems.
To have thorough knowledge of process management, storage management , Input / Output and file systems.
To have thorough knowledge of distributed operating systems concepts.

UNIT I Fundamentals of operating systems **9**

Overview – Synchronization Mechanisms – Processes and Threads - Process Scheduling – Deadlocks: Detection, Prevention and Recovery – Models of Resources

Unit II Memory Management and File Management **9**

Memory management- Paging- Segmentation-Virtual memory- Demand paging – Page replacement algorithms- **Modeling Page Replacement Algorithm ,Design Issues for Paging systems –Files-Directories-File System implementation- Example File System.**

Unit III Distributed Operating System **9**

Client/Server Computing,- Remote procedure call – Message passing – Clusters- sun clusters Process Migration – Global States- Distributed mutual exclusion- Distributed Dead Lock. Distributed Synchronization: Atomicity- Concurrency Control- Election Algorithm.

Unit IV Distributed File System **9**

Distributed file systems –File Models-File accessing models- File Sharing Semantics-File Caching Schemes-Coherence Protocols- Design issues.

UNIT V Case Studies **9**

Linux System: Design Principles - Kernel Modules - Process Management Scheduling – Memory Management - Input-Output Management - File System – Inter process Communication

Total: 45 Hours

Course Outcomes (COs)

Analyze the requirements of operating system.
Demonstrate the scheduling mechanisms.
Design the algorithm for memory management techniques.

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References

1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, *Operating System Concepts*. New Delhi: Addison Wesley Publishing Company, 9th Edition 2013(I, V)

2. Pradeep K. Sinha , " Distributed Operating Systems Concepts and Design "PHI New Delhi, India, Fifth Edition.2002.(IV)

3. William Stallings, *Operating Systems Internals and Design Principles.* New Delhi: Pearson Education, 5th edition 2007(III)

4. Andrew S Tanenbaum, " *Modern Operating System*" Pearson Fourth Edition,2014.(II)

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115MCT03 COMPILER CONSTRUCTION AND OPTIMIZATION

L	T	P	C
3	1	0	4

Course Objectives (COs)

To understand, the concepts of compiler design.
To design and implement a parser.
To understand Intermediate Code Generation.
To understand code generation schemes.
To develop a idea on code optimization and optimization techniques.

Unit I Introduction to Compiler and Lexical Analysis **9**

Language Processors – The Structure of a compiler - Lexical analysis - Role of the lexical analyzer - Input buffering -Specification and recognition of tokens. The Lexical Analyzer – LEX.- Finite automata – Regular expression to finite automata.

Unit II Syntax Analysis **10**

Role of a parser –-Context-free grammars - Top-down parsing – Non recursive predictive parser - Bottom-up parsing - Shift Reduce Parser-Operator precedence parsers- LR parsers – SLR -CLR – LALR. – Parser Generator - YACC.

Unit III Intermediate Code Generation **8**

Intermediate languages - Declarations - Assignment statements - Boolean expressions-- Case statements- Back patching.

Unit IV Code Generation **9**

Issues in the design of a code generator –Target Machine -Basic blocks and flow graphs –Next Use Information- Register allocation and assignment –The DAG Representation of Basic blocks- A Simple code generator .

Unit V Code Optimization **9**

Importance of Code optimization– Structure of Optimizing compilers- placement of optimizations in optimizing compilers – ICAN - Optimization Techniques – Early optimization – redundancy elimination -Procedure optimization – Procedural analysis.

Case Study: Sun Compilers for SPARC- Compiler testing tools – SPIM

Total 45 hours

References

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D.Ullman, "Compilers:Principles, Techniques and Tools", Second Edition, Pearson,2013.
2. Steven S. Muchnick, "Advanced Compiler Design and Implementation",Morgan Kaufmann Publishers - Elsevier Science, India, Indian Reprint 2010
3. Keith D Cooper and Linda Torczon, *Engineering a Compiler*, Elsevier Science, 2011
4. Kenneth C Louden: Compiler Construction Principles & Practice, 1st edition, Cengage Learning, 2011.
5. Allen Holub "Compiler Design in C", Prentice Hall of India 2003.
   Charles N. Fischer, Richard J. Leblanc, "Crafting a compiler with C", Benjamin Cummings, 1991.

Course Outcomes (COs)

This course helps the students to
Design lexical and syntax analysis phases of compiler.
Demonstrate the basic notions and techniques for programming language translation
Demonstrate the basic notions and techniques for intermediate code generation.
Apply the principles of compiler design in designing a compiler.

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115MCT04 SOFTWARE ENGINEERING METHODOLOGIES

L T P C
3 0 0 3

Course Objectives:

- Ability to design, synthesizes, and analyzes, software systems of increasing size and complexity at various abstraction levels, from the individual component to the entire system architecture.
- To be aware of different life cycle models, requirement dictation process, analysis modeling and specification, architectural and detailed design methods, implementation and testing strategies, verification and validation techniques project planning and management, use of CASE tools.

UNIT I SOFTWARE PRODUCT AND PROCESS 9

Software Process models – process iteration – process activities – rational unified process – computer aided software engineering. Management activities – project planning – project scheduling – risk management. Enterprise applications – introduction to skills required to build an enterprise application – types - software engineering methodology - life cycle - key determinants - measuring the success of enterprise applications.

UNIT II REQUIREMENT ANALYSIS 9

Functional and Non – functional requirements – user requirements – system requirements – interface specifications – software requirements document. Requirements engineering processes – feasibility studies – elicitation and analysis – validations – management. System Models – Context – Behavioral – Data – Object – Structured.

UNIT III ANALYSIS, DESIGN CONCEPTS AND PRINCIPLES 9

The Design concepts-The Design model-Architectural design-Designing Class Based Components -User interface design: user analysis and design, Interface analysis, Interface design steps-Requirements modeling: Flow oriented modeling-Software risk management, Case Studies. Structured System Analysis and Design - Distributed System Architectures – Application Architectures – Object Oriented Design – Real-time Software Design.

UNIT IV SOFTWARE TESTING 9

Software testing fundamentals – Test Case Design – White Box – Basis Path Testing – Structural Testing - Functional Testing - Object Oriented Testing - Control Structure Testing – Black Box – Testing for Specialized environments, Architectures and Applications - Software Testing Strategies – Approach – issues – testing – unit – integration – validation – system – art of debugging.

UNIT V SOFTWARE QUALITY ASSURANCE 9

Software Quality Concepts – Quality Assurance – Software Technical Reviews – Formal Approach to Software Quality Assurance – Reliability – Quality Standards – Software Quality Assurance Plan – Software Maintenance – Software Configuration Management – configuration item – process – objects in the software configuration – version control – change control – configuration audit – status reporting – SCM Standards – Case study : Martha Stockton Greengage (MSG) foundations.

Total 45 hours

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REFERENCES

1. Roger S. Pressman, Software Engineering: A Practitioner Approach Seventh Edition , McGraw-Hill, 2010
2. Fairley, Software Engineering Concepts, McGraw-Hill, 2009
3. I. Summerville, Software Engineering, Addison Wesley, Eighth Edition,2006
4. David Gustafson, Software Engineering, Schaums outlines, Tata McGraw-Hill, 2003
5. Raising Enterprise Applications – Published by John Wiley, authored by Anubhav Pradhan, Satheesha B. Nanjappa, Senthil K. Nallasamy, Veerakumar Esakimuthu

Course Outcomes:

- Ability to define, assess, and tailor software quality practices, and software processes and methodologies for appropriate application on software development projects in a variety of domain areas.

- Ability to be an effective member of a multi-disciplinary software-intensive product development with an awareness of individual professional and ethical responsibilities.

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115MCT05 MATHEMATICAL FOUNDATIONS FOR COMPUTER SCIENCE

L	T	P	C
3	1	0	4

Course Objectives:

- To introduce most of the basic terminologies used in computer science courses
- To understand the concept of logic and hence to construct valid mathematical arguments.
- To master combinatorics which deals with the counting principles .
- To analyze the various grammars thro modeling computation,
- To learn probability distributions occurring in natural phenomena and acquire the skills to analyze queueing models.

UNIT – I FUNDAMENTAL STRUCTURES **9+3**

Set theory- Relationships between sets – Operations on sets – Set identities – Principle of inclusion and exclusion – Minsets- Relations- Binary relations – Partial orderings – Equivalence relations-Functions-Properties of functions – Composition of functions – Inverse functions – Permutation functions.

UNIT – II LOGIC **9+3**

Propositional logic – Logical connectives – Truth tables – Normal forms (conjunctive and disjunctive) – Predicate logic – Universal and existential quantifiers – Proof techniques – direct and indirect – Proof by contradiction – Mathematical Induction.

UNIT – III COMBINATORICS **9+3**

Basics of counting – Counting arguments – Pigeonhole principle – Permutations and Combinations – Recursion and Recurrence relations – Generating functions.

UNIT – IV MODELING COMPUTATION AND LANGUAGES **9+3**

Finite state machines – Deterministic and Non- deterministic finite state machines – Formal Languages – Classes of Grammars – Type 0 – Context sensitive – Context Free – Regular Grammars – Ambiguity.

UNIT – V QUEUEING THEORY **9+3**

Introduction - Characteristics of Queueing Models - Little's Formula- Markovian Single server and Multi server queuing models: Model I: **(M/M/1)**: **(∞/FIFO)** , Model II: **(M/M/s)**: **(∞/FIFO)** , Model III: **(M/M/1)**: **(k/FIFO)** , Model IV: **(M/M/s)**: **(k/FIFO)** – **(M/G/1)** Queuing System – Pollaczek Khinchin formula.

TOTAL: 45+15= 60 PERIODS

Reference Books

1. Judith L.Gersting, "Mathematical Structures for Computer Science", W.H.Freeman and Company, NY, 2012.
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications",seventhth edition, TMH, 2013.
3. M.K. Venkataraman, N. Sridharan and N.Chandrasekaran," Discrete Maths.",The National Publishing Company, 2012.
4. Kishore S Trivedi, "Probability and statistics with reliability, Queueing and computer science applications", PHI, 2012.

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115MCP07 **ADVANCED DATA STRUCTURES LAB (Using C++)**

L	T	P	C
0	0	4	2

Course Objectives

- To develop programming skills in design and implementation of data structures and their applications.
- To understand the linked list concepts.
- To understand the Tree concepts

1. Implement Singly, Doubly and Circular Linked Lists with Primitive Operations.
2. Implement STACK and QUEUE ADT using Array and Linked List .
3. Implement Hash Technique of Separate Chaining.
4. Implement Max Heap and Min Heap with necessary Operations.
5. Implement B Tree and **B+ Tree** with the fundamental Operations.
6. Implement AVL Trees with the fundamental (Single, Double Rotation) Operations.
7. Implement Breadth First, Depth First Search Techniques for Traversing Graph.
8. Implement Shortest Path Technique using Dijkstra's Algorithm.
9. Implement Prim's, Kruskal's Algorithm to find Minimum Spanning Tree.
10. Simulate the Process of **Bin Packing** using Dynamic programming.

Course Outcomes

- Demonstrate the concepts of Basic Data structures Algorithms
- Demonstrate the concepts of Tree Structures.
- Demonstrate the concepts of Graph and Dynamic Programming.

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115MCP08 OPERATING SYSTEMS AND COMPILER LABORATORY

L	T	P	C
0	0	4	2

Course Objectives (COs)

Implementation of scheduling Algorithms & Memory Management Techniques
Perform lexical analysis and use lexical analyzer generators
Perform parsing and intermediate representation
Implementation Lexical Analyzer using LEX tool

List of Experiments

Operating Systems

1. Write a programme for CPU Scheduling Algorithms
o First Come First Serve
o Shortest Job First Serve
o Priority scheduling
o Round Robin scheduling
2. Write a program for Best fit, First Fit Algorithm for Memory Management.
3. Write a program for Memory Allocation with Pages.
4. Write a program to implement Banker's algorithm.
5. Write a program for Deadlock Handling operations.

Compiler Programs

1. Construction of NFA for a regular expression.
2. Implementation of Shift reduce parsers.
3. Implementation of a predictive parser.
4. Generation of code for a given Intermediate code
5. Program for lexical analyzer using LEX tool

Course Learning Outcomes (CLOs)

Demonstrate the concepts of operating system
Demonstrate the importance of implementing parser.
Design of applications for generating intermediate code.

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15MCE01 ADVANCED COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

Course Objectives (COs)

- ✓ To Learn the wired, wireless LANs and backbone networks
- ✓ To gain knowledge about the routing protocols
- ✓ To focus on congestion control and traffic management

Unit I Introduction 9

Requirements – Network architecture – Implementing network software – Performance - Reliable transmission –Ethernet and Multiple access network (802.3) – Wireless - 802.11/Wi-Fi - Bluetooth/802.15.1 - Cell phone Technologies .

Unit II Inter networking and End to End Protocol 9

Switching and bridging – Data grams - Virtual circuit switching - Source routing - Bridges and LAN switches – Basic Internetworking (IP) - Service model - Global addresses - Datagram forwarding in IP - Subnetting and classless addressing - Address translation - Host configuration - Error reporting - Virtual networks and Tunnels – Simple de-multiplexer (UDP) - Reliable byte stream (TCP) – Remote Procedure Call (RPC).

Unit III High-Speed Networks 9

LAN Ethernet, fast Ethernet, gigabit Ethernet, FDDI, DSL, ADSL. **Connection Oriented Networks**. Frame relay, B-ISDN, ATM protocol stack, ATM switching, internetworking with ATM Networks, traffic management in ATM

Unit IV Wireless communication 9

Wireless networks, wireless channels, channel access, network architecture, IEEE 802.11, Bluetooth. **Congestion and Traffic Management** Effects of congestion – Traffic management - Congestion control in packet - Switching networks – Frame relay congestion control – Need for flow and error control – Link control mechanisms ARQ performance – TCP flow and congestion control – Performance of TCP over ATM – Requirements for ATM traffic and congestion control –ATM traffic - Related attributes – Traffic management framework – Traffic control.

Unit V Internet Routing 9

Overview of graph theory and Least-cost paths – Interior routing protocols – Internet routing principles – Distance Vector and Link state protocol – Exterior routing protocols: BGP and IDRP - Multicasting.

Total : 45 Hours

References

1. Larry L. Peterson and Bruce S. Davie, *Computer Networks: A Systems Approach*, Morgan Kaufmann,2012.
2. William Stallings, *High-Speed Networks and Internets: Performance and Quality of Service*, Pearson Education, 2010.
3. James F. Kurose and Keith W. Ross, *Computer Networking: A Top-Down Approach*, Pearson Education,2013.
4. Andrew S. Tanenbaum and David J. Wetherall, *Computer Networks*, Pearson Education, 2011.

5. Behrouz Forouzan, *Data communications and Networking*, Tata Mc Graw Hill Education, 2009.
6. High performance communication networks by: J. Walrand & Pravin Varaiya , Morgan Kaufman, 1999.
8. ATM networks: Concepts, Protocols, Applications by: Handel, Addision Wesseley
9. Computer networks: Tanenbaum, Andrew S, Prentice Hall

Course Outcomes (COs)

- ✓ Identify the type of networks and protocols for a given network scenario
- ✓ Estimate the performance and throughput of a given network
- ✓ Design a network aimed at optimum performance

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115MCE02 TRENDS IN COMPUTING

L	T	P	C
3	0	0	3

Course Objectives (COs)

- To have thorough knowledge in various Computing Techniques
- To know the emerging trends in Android operating system
- To have systematic knowledge of cloud computing
- To have thorough knowledge of big data analytics
- To know the Impact of Green Computing in the Industry

UNIT I Computing Techniques **9**

Grid Computing - Introduction Grid Computing, Grid Architecture, Overview of Resource Managers, Overview of Grid Systems, Application Management **Cluster Computing -** Overview of Cluster Computing, the Role of Clusters, Definition and Taxonomy, Distributed Computing - Cluster Planning, Architecture and Cluster Software, Protocols, Distributed File Systems, Virtualization technologies

UNIT II Android Operating System **9**

Introduction-Getting started with Android programming- Activities, fragments, and intents - Getting to know the Android user interface-Designing your user interface with views-Displaying pictures and menus with views, Android Application Development

UNIT III Cloud Computing **10**

Introduction to cloud computing-Fundamentals of cloud computing -Cloud for the business- Managing the cloud resources -Advantages of highly scaled data centre - Scaling computer system -Cloud's workload strategy. Massively scaled applications and business process-Managing and securing cloud services -Governing the cloud- **Virtualization** and the cloud.

UNIT IV Big Data Analytics **9**

Data Analytics-Introduction to big data – Importance of big data- Industry examples for big data - Big data technology- Information management- Business analytics. Predictive Analytics, Social Analytics

UNIT V Green Computing **9**

The Role of Computer Consultants in Propagating Green Computing - The Impact of Green Computing in the Industry, The Business Impact of Green Computing, Green Computing for Environmental Impact Management - Green Computing Strategies That Companies Should Be Aware of (CSCI - The Climate Savers Computing Initiative) Top Ten Strategies - Improving Organization Performance through Green Computing Process Organization.

Total: 45 Hours

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References

1. Joshy Joseph & Craig Fellenstein, "Grid Computing", Pearson Education 2004.
2. Fran Berman, Geoffrey Fox, Anthony J.G. Hey, "Grid Computing: Making the Global Infrastructure a reality", John Wiley and sons, 2000 UNIT III
3. Wei-Meng Lee, Beginning Android 4 Application Development, New Delhi: Wiley Publications 2012
4. Judith Hurwitz, Cloud computing for dummies. New Delhi: Wiley Publishing Inc.2010.
5. Michael Minelli, Big Data Big Analytics, New Delhi, John Wiley publications 2013.
6. Aravind Sethi, Big data analytics Disruptive Technologies changing the Game, IBM Corporation MC Press 2012.
7. Green Computing and Green IT Best Practices on Regulations and Industry Initiatives, Virtualization, Power Management, Materials Recycling and Telecommuting by Jason Harris

Course Outcomes (COs)

- Familiar with the basic concepts of Android operating system
- Demonstrate the process of cloud computing
- Comprehend the importance of big data analysis

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115MCE03 **ADVANCED COMPUTER ARCHITECTURE** **L T P C**
3 0 0 3

Course Objectives (COs)

- To introduce the fundamental techniques based on parallel processing.
- To develop the foundations for analyzing the benefits of design options in computer architecture.
- To give experience of the application of the various computing techniques.

Unit I - Pipelining and ILP **9**

Fundamentals of computer design: Defining Computer Architecture - Measuring and reporting performance – Quantitative principles of computer design - Instruction level parallelism and its Exploitation: Concepts and challenges – Reducing Branch costs with prediction - Overcoming data hazards with dynamic scheduling – Tomasulo's algorithm

Unit II - Advanced Techniques for Exploiting ILP **9**

Compiler Techniques for Exposing ILP - Studies of the Limitations of ILP - Limitations on ILP for realizable processors - Hardware versus Software Speculation - Multithreading: Using ILP support to exploit Thread - level parallelism - Performance of advanced multiple issue processors - Efficiency in advanced multiple issue processors.

Unit III – Multiprocessors **9**

Multiprocessor System Interconnects – Cache coherence and Synchronization mechanisms – Symmetric shared memory architectures – Performance Issues – Synchronization issues – Models of memory consistency.

Unit IV - Memory Hierarchy **9**

Introduction - Optimizations of cache performance - Memory technology and optimizations - Protection: Virtual memory and virtual machines-Design of memory hierarchies.

Unit V - Storage Systems **9**

Advanced topics in disk storage - Definition and examples of real faults and failures - I/O performance, reliability measures and benchmarks - A Little queuing theory.

Total: 45 Hours

References

1. John L. Hennessey and David A. Patterson, "Computer Architecture: A Quantitative Approach", Morgan Kaufmann, 5th Edition, 2012.

2. Kai Hwang, Naresh Jotwani "Advanced Computer Architecture: Parallelism, Scalability, Programmability" Tata McGraw Hill Edition, 2nd Edition, 2011.

Course Outcomes (COs)

- Analyze the working principle of different ILP and TLP techniques.
- Demonstrate the concepts of multiprocessor architecture.
- Identify the need of memory concepts.

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115MCE04 NETWORK ENGINEERING AND MANAGEMENT

L	T	P	C
3	0	0	3

Course Objectives (COs)

- To understand the concepts of computer networks and to study the functions of different layers.
- To make the students to get familiarized with different protocols and network components.
- To understand how the network management protocol are actually implemented.

Unit I Foundations of Networking **9**

Data communication networks – Protocols and standards –OSI model – Layers in OSI –TCP/IP protocol suite – Error detection and correction – Flow control – Error control.

Unit II Data link Layer and Network layer **9**

SONET architecture –Layers – Frames – STS multiplexing –SONET networks – Frame relay-ATM-ATM LAN – AAL- IPv4 Address – IPv6 address –Internetworking – Transition from IPv4 to IPv6 –Address mapping – ICMP– IGMP – ICMPv6 –Congestion control.

Unit III SNMP and Network Management **9**

Network management standards – Network management models – Organization model-Information model- Communication model-Abstract syntax notation-Encoding structure-Internet organization and standards.

Unit IV SNMPv1, SNMPv2 and SNMPv3 **9**

SNMPv1 Communication model-Functional model-SNMPv2 system architecture-Structure of management information-Management information base -SNMP v2 protocol -Compatibility with SNMPv1-SNMPv3 key features-Documentation architecture-Applications-MIB-Security-User based security model.

Unit V RMON and Telecommunication Network Management **9**

Remote monitoring - RMON SMI and MIB - RMON1 - RMON2-ATM Remote monitoring - TMN –TMN conceptual model-TMN architecture - TMN management service architecture - TMN integrated view.

Total: 45 Hours

References:

1. Behrouz A. Forouzan, *Data Communication and Networking.*, Tata Mcgraw-hill Education Pvt ltd-New Delhi 32nd reprint 2012.
2. Mani Subramanium , *Network Management Principles and practices*. New Delhi: Pearson Education,2010
3. Larry L. Peterson and Bruce S. Davie, *Computer Networks: A Systems Approach*. Noida: Morgan Kaufman Publishers, 2007.
4. William Stallings, *SNMP, SNMPv2, SNMPv3 and RMON1 and RMON2.* New Delhi: Pearson Education,2010.

Course Learning Outcomes (CLOs):

- Analyze the requirements of modern communication network.
- Demonstrate the process of network management.
- Design the procedure remote monitoring.

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115MCE05 **PROGRAMMING PARADIGMS** **L T P C**
3 0 0 3

Course Objectives (COs)

- To understand the concepts of object-oriented, event driven, and concurrent programming paradigms
- To develop skills in using these paradigms using Java.

UNIT I OBJECT-ORIENTED PROGRAMMING – FUNDAMENTALS **9**

Review of OOP - Objects and classes in Java – defining classes – methods - access specifiers – static members – constructors – finalize method – Arrays – Strings - Packages – JavaDoc comments

UNIT II OBJECT-ORIENTED PROGRAMMING – INHERITANCE **10**

Inheritance – class hierarchy – polymorphism – dynamic binding – final keyword – abstract classes – the Object class – Reflection – interfaces – object cloning – inner classes – proxies

UNIT III EVENT-DRIVEN PROGRAMMING **10**

Graphics programming – Frame – Components – working with 2D shapes – Using color, fonts, and images - Basics of event handling – event handlers – adapter classes – actions – mouse events – AWT event hierarchy – introduction to Swing – Model-View- Controller design pattern – buttons – layout management – Swing Components

UNIT IV GENERIC PROGRAMMING **8**

Motivation for generic programming – generic classes – generic methods – generic code and virtual machine – inheritance and generics – reflection and generics – exceptions – exception hierarchy – throwing and catching exceptions – Stack Trace Elements - assertions - logging

UNIT V CONCURRENT PROGRAMMING **8**

Multi-threaded programming – interrupting threads – thread states – thread properties – thread synchronization – thread-safe Collections – Executors – synchronizers – threads and event-driven programming

TOTAL:45 hours

Course Outcomes

- Understanding the concepts of Object Oreinted Programming
- Develop programming Skill in Java

References

1. Cay S. Horstmann and Gary Cornell, "Core Java: Volume I – Fundamentals", Eighth Edition, Sun Microsystems Press, 2008.
2. K. Arnold and J. Gosling, "The JAVA programming language", Third edition, Pearson
3. Education, 2000.
4. Timothy Budd, "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, 2000.
5. C. Thomas Wu, "An introduction to Object-oriented programming with Java", Fourth Edition, Tata McGraw-Hill Publishing company Ltd., 2006.

115MCE06 **MOBILE AND WIRELESS NETWORKS**

L	T	P	C
3	0	0	3

Course Objectives (COs)

- To be familiar with the wireless/mobile market and the future needs and challenges.
- Ability to analyze improved data services in cellular communication
- To strengthen knowledge in mobile/wireless communication systems.

UNIT I Mobile Communication System **9**

Evolution of Mobile Radio Communication Systems – Mobile Radio Telephony – Mobile Radio Systems Around the World – Examples of Wireless Communications Systems – Trends in Cellular Radio - Modern Wireless Communication Systems: Second Generation (2G) Cellular Networks – Third Generation (3G) Wireless Networks – Wireless Local Loop (WLL) and LMDS – Wireless Local Area Networks (WLANS) – Bluetooth and Personal Area Networks (PAN).

Unit II Cellular Networks **9**

Introduction – Frequency Reuse – Channel Assignment Strategies – Handoff Strategies – Interference and System Capacity: Co-channel interference and system capacity – Channel planning for wireless systems – Adjacent channel interference – Power control for reducing interference - Trunking and Grade of service – Improving Coverage and Capacity in cellular Network .

Unit III Wireless Communication Techniques **9**

Digital Modulation Techniques – Linear Modulation Techniques – Spread Spectrum Modulation Techniques – Multiple Access Techniques – Packet Radio Protocols – Reservation Protocols – Reservation ALOHA – Packet Reservation Multiple Access (PRMA) – Capacity of Cellular systems.

UNIT IV Wireless Networks **9**

Introduction to Wireless Networks – Differences between Wireless and Fixed Telephone Networks – Development of Wireless Networks – Fixed Network Transmission Hierarchy – Traffic Routing In wireless Networks – Wireless Data Services – Common Channel Signaling (CCS) – Integrated Services digital Network (ISDN) – Signaling System No 7 (SS7) – Personal Communication Services/Networks (PCS/PCNS) – Protocols for Network Access – UMTS.

UNIT V Wireless Systems and Standards **9**

AMPS and ETACS – United States Digital Cellular (IS-54 and IS136) – GSM – CDMA Digital Cellular Standards (IS-95) – CT2 Standard for Cordless Telephones – DECT – PACS – PDC – PHS –US PCS and ISM Bands – US Wireless Cable Television.

Total: 45 Hours

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Reference

1. Theodore S Rappaport: Wireless Communications, Principles and Practice, 2nd Edition, Pearson Education Asia, 2011.

2. Jochen Schiller, "Mobile Communications", PHI/Pearson Education, Second Edition, 2003.

3. William Stallings: Wireless Communications and Networks, 2nd edition, Pearson Education Asia, 2009.

Course Learning Outcomes (CLOs)

Upon Completion of the course, the students should be able to:

- Discuss the various generations of the Mobile Communication systems.
- Demonstrate the concept of Cellular systems with Handoff and Interference Techniques.
- Understand the new trends in mobile/Wireless communication systems
- Gain information on Various Standards on the Wireless Systems.

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115MCE07 **PERFORMANCE EVALUATION OF COMPUTER SYSTEMS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the mathematical foundations needed for performance evaluation of computer
- systems
- To understand the metrics used for performance evaluation
- To understand the analytical modeling of computer systems
- To enable the students to develop new queueing analysis for both simple and complex systems
- To appreciate the use of smart scheduling and introduce the students to analytical techniques
- for evaluating scheduling policies

UNIT I OVERVIEW OF PERFORMANCE EVALUATION **9+3**

Need for Performance Evaluation in Computer Systems – Overview of Performance Evaluation Methods – Introduction to Queueing – Probability Review – Generating Random Variables for Simulation – Sample Paths, Convergence and Averages – Little's Law and other Operational Laws –Modification for Closed Systems.

UNIT II MARKOV CHAINS AND SIMPLE QUEUES **9+3**

Discrete-Time Markov Chains – Ergodicity Theory – Real World Examples – Google, Aloha –Transition to Continuous-Time Markov Chain – M/M/1 and PASTA.

UNIT III MULTI-SERVER AND MULTI-QUEUE SYSTEMS **9+3**

Server Farms: M/M/k and M/M/k/k – Capacity Provisioning for Server Farms – Time Reversibility and Burke's Theorem – Networks of Queues and Jackson Product Form – Classed and Closed Networks of Queues.

UNIT IV REAL-WORLD WORKLOADS **9+3**

Case Study of Real-world Workloads – Phase-Type Distributions and Matrix-Alalytic Methods –Networks with Time-Sharing Servers – M/G/1 Queue and the Inspection Paradox – Task Assignment Policies for Server Farms.

UNIT V SMART SCHEDULING IN THE M/G/1 **9+3**

Performance Metrics – Scheduling Non-Preemptive and Preemptive Non-Size-Based Policies - Scheduling Non-Preemptive and Preemptive Size-Based Policies – Scheduling - SRPT and Fairness.

TOTAL : 45+15 =60 PERIODS

REFERENCES:

1. Mor Harchol - Balter, "Performance Modeling and Design of Computer Systems – Queueing Theory in Action", Cambridge University Press, 2013.
2. Raj Jain: The Art of Computer Systems Performance Analysis, 1st edition, John Wiley and Sons, 2012.
3. Lieven Eeckhout, "Computer Architecture Performance Evaluation Methods", Morgan and Claypool Publishers, 2010.
4. Paul J. Fortier and Howard E. Michel, "Computer Systems Performance Evaluation and Prediction", Elsevier, 2003.
5. David J. Lilja, "Measuring Computer Performance: A Practitioner's Guide", Cambridge University Press, 2000.

6. Krishna Kant, "Introduction to Computer System Performance Evaluation", McGraw-Hill, 1992.
7. K. S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 1st edition, PHI, 2011.

OUTCOMES:

Upon completion of the course, the students will be able to

- Identify the need for performance evaluation and the metrics used for it
- Discuss open and closed queueing networks
- Define Little'e law and other operational laws
- Apply the operational laws to open and closed systems
- Use discrete-time and continuous-time Markov chains to model real world systems
- Develop analytical techniques for evaluating scheduling policies

215MCT01 **ADVANCED DATABASE TECHNOLOGY** **L T P C**
3 0 0 3

Course Objectives:

- To acquire knowledge on parallel and distributed databases and its applications.
- To study the usage and applications of Object Oriented database
- To learn emerging databases such as XML, Cloud and Big Data
- To acquire inquisitive attitude towards research topics in databases

UNIT – I **INTRODUCTION TO DATABASES** **9**

Data Models, Schemas, and Instances - Three-Schema Architecture and Data Independence - Database Languages and Interfaces - The Database System Environment - Centralized and Client/Server Architectures for DBMSs- Classification of Database Management Systems.

UNIT –II **PARALLEL AND DISTRIBUTED DATABASES** **9**

Parallel Databases : Introduction, I/O Parallelism, Inter query Parallelism, Intra query Parallelism, Intra operation parallelism, Inter operation parallelism, Design of Parallel Systems.

Distributed Databases : Homogeneous and Heterogeneous databases, Distributed data storage, Distributed Transactions, Commit protocols, concurrency control in Distributed databases, Availability, Distributed query processing, Heterogeneous Distributed Databases.

UNIT –III **OBJECT, OBJECT-RELATIONAL DATABASES** **9**

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.

UNIT –IV XML DATABASES **9**

Open database Connectivity -XML Databases –XML Data Model –DTD-XML Schema-XML Querying –Web databases

UNIT – V EMERGING TECHNOLOGIES **9**

Spatial and Geographic Databases, Multimedia Databases, Mobility and personal Databases, Cloud based Databases: Data storage systems on the cloud- Cloud storage Architectures-Cloud Data Models-Introduction-Big Data.

Total: 45 PERIODS

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REFERENCES:

1. Ramez Elmasri, shamkant B. Navathe, "Fundamentals of Database Systems",5th Edition & 6th Edition. Pearson Education, 2011.

2. Abraham Silberschatz, Henfy F.Korth, S.Sudarshan, "Database System Concepts", 5th Edition, Tata McGraw Hill, 2006.

3. C.J.Date, "An introduction to Database Systems", 7th Edition, Pearson Education, 2003.

4.V.S. Subramanian,"Principles of Multimedia Dtabase systems", Harcourt India Pvt Ltd.,2001

5.Raghu Ramakrishnan,Johannes Gehrke,"Database Management Systems",McGrawHill, Third Edition 2004.

Course Outcomes:

On Successful completion of this course ,the student will be able to :

- Design and implement distributed databases, XML databases and multimedia databases.
- Represent the data using XML database for better interoperability
- Implement the concept of database connectivity with the applications
- To solve the issues related to the data storage and retrieval

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215MCT02 NETWORK PROTOCOLS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the existing network architecture models and analyze the their performance
- To understand the high speed network protocols and design issues.
- To learn network security technologies and protocols
- To study various protocols in wireless LAN, MAN.

UNIT I FUNDAMENTALS OF NETWORKING STANDARDS AND PROTOCOLS 9

Network Communication Architecture and Protocols - OSI Network Architecture seven Layers Model - Definition and Overview of TCP/IP Protocols -TCP/IP Four Layers Architecture Model - Other Network Architecture Models: IBM SNA.

UNIT II ROUTED AND ROUTING PROTOCOLS 9

Application Layer Protocols-Presentation Layer Protocols- Session Layer Protocols - Transport Layer Protocols - Network Layer Protocols - Data Link Layer Protocols - Routing Protocols – Multicasting Protocols - MPLS.

UNIT III ISDN AND NETWORK MANAGEMENT PROTOCOLS 9

Overview of ISDN – Channels – User access – Protocols Network management requirements – Network monitoring – Network control – SNMP V1, V2 and V3 – Concepts, MIBs – Implementation issues-RMON.

UNIT IV SECURITY PROTOCOLS 9

IP Security -Network Security Technologies and Protocols - AAA Protocols - Tunneling Protocols - Secured Routing Protocols – IP telephony -Voice over IP and VOIP Protocols –Signaling Protocols-Media/CODEC

UNIT V NETWORK ENVIRONMENTS AND PROTOCOLS 9

Wide Area Network and WAN Protocols - Frame relay - ATM - Broadband Access Protocols –PPP Protocols - Local Area Network and LAN Protocols - Ethernet Protocols - Virtual LAN Protocols - Wireless LAN Protocols - Metropolitan Area Network and MAN Protocol - Storage Area Network and SAN Protocols.

TOTAL: 45 PERIODS

REFERENCES:

1. Javvin, "Network Protocols" , Javvin Technologies Inc , second edition, 2005
2. Mani Subramanian, "Network Management–Principles and Practices", Addison Wesley, 2nd edition pearson Education 2010.
3. William Stallings, "SNMP, SNMPV2, SNMPV3 and RMON1 and 2", 3rd Edition, Addison Wesley, 1999.

4. William Stallings, "Data and Computer Communications" 5th Edition, PHI, 1997.

COURSE OUTCOME:

- Ability to study, analyze and design seven layers of protocols of wired and wireless networks.

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215MCT03	INTERNET TECHNOLOGY	L T P C 3 0 0 3

COURSE OBJECTIVE

- To understand the Internet Protocols, CGI and XHTML as well as how information is displayed by browser using CSS Technology.
- Presents basic information about Client side programming and Host Objects.
- Focus on Server side programming, Study about ASP and JSP applications. Focus on Database connectivity, XML schema, DTD and Simple API for XML(SAX)
- Illustrates how the various web service technologies interact.

UNIT I INTRODUCTION TO INTERNET TECHNOLOGY **9**

Introduction to web - Web essentials - protocols governing the web - Web development strategies - Clients/Servers communication - markup languages – CGI - XHTML - simple XHTML pages style sheets - CSS

UNIT II CLIENT SIDE SCRIPTING AND AJAX **9**

Client side programming - Java script language - java script objects - Host Objects: Browsers and the DOM - Introduction to AJAX, VB Script

UNIT III SERVER SIDE PROGRAMMING **9**

Server side programming - Java Servlets - basics - simple program - separating programming and presentation - Sessions-Cookies - ASP/JSP - JSP basics ASP/JSP objects - simple ASP/JSP pages.

UNIT IV DATABASE AND XML **9**

Representing Web data - Database connectivity - JDBC - Dynamic Web pages XML - DTD - XML schema - Basics of namespace, Xlink, Xpointer, Xpath, XQuery, Extensible style sheet language transformations - XML and databases - SAX.

UNIT V MOBILE WEB TOOLS AND APPLICATION FRAMEWORK **9**

Building Web applications for mobile devices - CSS Mobile - SVG Tiny - XHTML For Mobile - Mobile Web programming tools, ChocolateChip-UI, Mobl, jQuery Mobile, The-M-Project, Touchqode -Web App Framework - case studies.

TOTAL: 45 PERIODS

REFERENCES:

1. Deitel, Deitel, Goldberg, "Internet & World Wide Web How to Program", Third Edition, Pearson Education' 2006.
2. Isrd Group, " Internet Technology and Web Design", Tata McGraw-Hill Education, 2011
3. Xavier, C, " Web Technology and Design" , New Age International, June 2013
4. Jeffrey C Jackson, "Web Technology – A computer Science perspective", Persoon Education, 2007.

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5. Chris Bates, "Web Programming – Building Internet Applications, "Wiley India, 2006.
6. Harold and Means, "XML in a Nutshell", O'Reilly Publishers, Orlando, 2004.
7. Ron Schmelzer et al., "XML and Web Services", Pearson Education, New Delhi, 2002.
8. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services: An Architect's Guide", Prentice Hall, New Delhi, 2004.
9. Robert. W. Sebesta, "Programming the World Wide Web", Fourth Edition, Pearson Education, 2007.
10. Marty Hall and Larry Brown,"Core Web Programming" Second Edition, Volume I and II, Pearson Education, 2001.
11. Phillip Hanna, "JSP 2.0 - The Complete Reference", McGraw-Hill, 2003.
12. Mathew Eernisse, "Build Your Own AJAX Web Applications", Site Point, 2006.
13. Steven Holzner, "PHP: The Complete Reference", 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2009.
14. Express.js: Node.js Framework for Web Application Development (Web App Development) [Kindle Edition] Daniel Green

COURSE OUTCOME:

- Able to understand Internet Protocols, CGI and XHTML as well as how information is displayed by browser using CSS Technology
- Able to understand the Client side programming and Server side programming.
- Design and implement Programs using Internet Programming languages like HTML, DHTML, XML, JSP, and ASP.
- Able to understand the open source environment like PHP and MYSQL, and also understand Web Service technologies

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215MCT04 **SECURITY IN COMPUTING** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the basics of cryptography
- To comprehend the mathematical foundations of security principles
- To analyze the different aspects of encryption techniques
- To gain and awareness about current securities in network
- To learn about the database and standards in security.

UNIT I SYMMETRIC CIPHERS 9

Introduction - Security Attacks - Security Services - Security Mechanisms – Symmetric Ciphers Classical Encryption Techniques – Block Ciphers and the Data Encryption Standard – Advanced Encryption Standard.

UNIT II NUMBER THEORY 9

Divisibility and the Division Algorithm-The Euclidean Algorithm-Modular Arithmetic-Groups-Rings and Fields- Finite Fields of the Form GF(p)-Polynomial Arithmetic-Finite Field of the Form GF(2^m).

UNIT III PUBLIC KEY ENCRYPTION AND HASH FUNCTIONS 9

Asymmetric Ciphers: Mathematical concepts – Public Key Cryptography and RSA – Other Public-Key Cryptosystems – Messages Authentication and Hash Functions: Authentication Requirements- Authentication Functions- Authentication Codes- Hash Functions- Security of Hash Functions and MACs.

UNIT IV SECURITY IN NETWORKS 9

Networks Concepts- Threats in Networks- Wireless Network Security– Firewalls- Intrusion Detection and prevention Systems- Network Management

UNIT V SECURITY IN DATABASE AND STANDARDS 9

Introduction to Database- Security Requirements of Databases- reliability and Integrity-database disclosure-Big data- Security Standards- ISO 27000 family of standards-NIST.

TOTAL: 45 PERIODS

REFERENCES:

1. W. Stallings, "Cryptography and Network Security", Fifth Edition, Prentice Hall, 2011.
2. Charles P. Pfleeger , Shari Lawrence Pfleeger and Jonathan Margulies, "Security in Computing", Fifth Edition, Pearson Education , 2013
3. Behrouz A Forouzan & Debdeep Mukhopadhyay, " Cryptography and Network Security", Second Edition, Tata McGraw Hill Education Pvt Ltd Publication , 2010.
4. Bernard L. Menezes, "Network Security and Cryptography", First Edition, Cengage Learning India 2010.
5. Whitman and Mattord, Principles of Information Security, 4th Edition, Engage Learning, 2011

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COURSE OUTCOMES:

- Apply cryptographic algorithms for encrypting and decryption for secure data transmission
- Identify the features of encryption and authentication with mathematical aspects.
- Understand the importance of Firewall and Intrusion and detection.
- Understand the role of threats and database in network security
- Gain the knowledge of security models and standards

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215MCP07 **DATABASE AND INTERNET TECHNOLOGY LABORATORY**

L	T	P	C
0	0	4	2

COURSE OBJECTIVE:

- To explore the features of a Database Management Systems
- To interface a database with front end tools
- Development and design of static and dynamic web sites using HTML,DHTML,CSS.,.
- To understand and development of the Client side Programming and the Server side Applications.
- To understand and development of Servlet and XML Schema.
- Parsing an XML document using DOM and SAX Parsers

LIST OF EXERCISES

1. Basic SQL, Intermediate SQL, Advanced SQL
2. ER Modelling
3. Implementation of Normalization concepts
4. Develop a java interface to the database
5. Building Web Applications using PHP & MySQL
6. Indexing and Query Processing
7. Creation of HTML pages with frames, links, tables and other tags
8. Usage of internal and external CSS along with HTML pages
9. Client side Programming
   i. Java script for displaying date and comparing two dates
   ii. Form Validation including text field, radio buttons, check boxes, list box and other controls
10. Usage of ASP/JSP objects response, Request, Application, Session, Server, ADO etc
    i. Writing online applications such as shopping, railway/air/bus ticket reservation system with set of ASP/JSP pages
    ii. Using sessions and cookies as part of the web application
11. Writing Servlet Program using HTTP Servlet
12. Any online application with database access
13. Creation of XML document for a specific domain
14. Writing DTD or XML schema for the domain specific XML document
15. Parsing an XML document using DOM and SAX Parsers
16. Sample web application development in the open source environment

COURSE OUTCOME:

- Ability to use databases for building web applications.
- Gaining knowledge about the internals of a database system.
- Able to design and create web pages using HTML, XML and DHTML.
- Able to Develop server side programming using the Servlets and ASP/JSP
- Able to design and create web pages and also make database connectivity with MySQL using open source programming languages like PHP,Python and PERL

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215MCE01 **DATA WAREHOUSING AND DATA MINING**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To expose the students to the concepts of Data warehousing Architecture and Implementation
- To Understand Data mining principles and techniques and Introduce DM as a cutting edge
- business intelligence
- To learn to use association rule mining for handling large data
- To understand the concept of classification for the retrieval purposes
- To know the clustering techniques in details for better organization and retrieval of data
- To study the overview of developing areas – web mining, text mining and ethical aspects of data mining

UNIT I INTRODUCTION TO DATA WAREHOUSING **9**

Introduction to Data Warehousing - Data warehousing Components – Building a Data warehouse, Data Warehouse and DBMS, Data marts, Metadata, Multidimensional data model, OLAP vs OLTP, OLAP operations, Data cubes, Schemas for Multidimensional Database: Stars, Snowflakes and Fact constellations– Data Warehouse Architecture – Data warehouse implementation – **Trends in Data Warehousing.**

UNIT II INTRODUCTION TO DATA MINING **9**

Data mining-KDD versus data mining, Stages of the Data Mining Process-task primitives, Data Mining Techniques -Data mining knowledge representation – Data mining query languages, Integration of a Data Mining System with a Data Warehouse – Issues, Data preprocessing – Data cleaning, Data transformation, Feature selection, Dimensionality reduction, Data Discretization Concept Hierarchy Generation - Mining frequent patterns-association-correlation.

UNIT III CLASSIFICATION AND PREDICTION **9**

Classifications – Basic Concepts – Decision Tree induction – Bayesian Classification – Rule Based Classification –Classification by Back Propagation – Support Vector Machines - Associative Classification – Lazy Learners – Other Classification Methods – **Prediction - Model Evaluation and Selection – Techniques to Improve Classification Accuracy.**

UNIT IV CLUSTER ANALYSIS **9**

Cluster Analysis: Basic concepts and Methods – Cluster Analysis – Partitioning methods –Hierarchical methods – Density Based Methods – Grid Based Methods – Model Based Clustering Methods – Advanced Cluster Analysis: Model Based Clustering – Clustering High–Dimensional Data Constraint-Based Cluster Analysis – Outlier Analysis.

UNIT V PREDICTIVE MODELING OF BIG DATA AND TRENDS IN DATAMINING **9**

Statistics and Data Analysis – EDA – Small and Big Data –Logistic Regression Model - Ordinary Regression Model-Mining complex data objects – Spatial databases – Temporal databases – Multimedia databases –

Time series and sequence data – Text mining – Web mining – Applications in Data mining - **Case Study: WEKA.**

TOTAL: 45 PERIODS

REFERENCES

1. Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann, Third edition, 2011.
2. Alex Berson, Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw Hill, Tenth Reprint, 2007.
3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, Third Edition, 2014.
4. Ian.H.Witten, Eibe Frank and Mark.A.Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Third edition, 2011.
5. Bruce Ratner, "Statistical and Machine - Learning Data Mining: Techniques for Better Predictive Modeling and Analysis of Big Data", CRC Press, Second Edition, 2012.
6. Mehmed kantardzic, "Data mining: Concepts, Models, Methods, and Algorithms", Wiley-Blackwell, Second Edition, 2011.
7. Ian Witten, Eibe Frank, "Data Mining: Practical Machine Learning Tools and Techniques", Third Edition, Morgan Kaufmann, 2011.
8. George M Marakas, "Modern Data Warehousing, Mining and Visualization: Core Concepts", Prentice Hall, 2002.

COURSE OUTCOMES:

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

- Evolve multidimensional intelligent model from typical system
- Discover the knowledge imbibed in the high dimensional system
- Evaluate various mining techniques on complex data objects

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215MCE02 **PERVASIVE COMPUTING** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the characteristics and principles of Pervasive computing and the solutions that are in use.
- To design and implement pervasive applications.
- To give an introduction to the enabling technologies of pervasive computing.

UNIT I Introduction to Pervasive Computing 9

Pervasive Computing- Principles, Characteristics and its significances – Research trends in pervasive computing and networking. Architecture for pervasive computing - Pervasive devices - embedded controls.

UNIT II Tools and Techniques for Dynamic Reconfiguration and Interoperability of Pervasive Systems 9

Introduction – Mobile Agent Technology – Sensor Networks - Collaboration and interoperability among sensor networks. Service oriented architecture – Research initiatives in service discovery for pervasive systems.

UNIT III Service Management in Pervasive Computing Environments 9

Techniques for Service Management in PvCE - Service Composition - Device Technology- Context aware computing - Device Connectivity - Integration of real world practice and experience with pervasive learning.

UNIT IV Wireless Sensor Cooperation for a Sustainable Quality of Information 9

Introduction - Sensing the Real World - Inter-Sensor Cooperation - Mobile Sensor Cooperation - Cooperation across Mobile Entities - Inter-WSN Cooperation

UNIT V Data Management and Security in Pervasive Networks 9

Data dissemination and Management – Approaches and solutions: deployment, routing, energy efficiency, fault tolerance and reliability - Security classics and privacy in pervasive networks.

TOTAL: 45 PERIODS

REFERENCES:

1. Mohammad S., Obaidat, Mieso Denko, Isaac Woungang, Pervasive Computing and Networking, John Wiley & Sons ltd, first edition, 2011.
2. Jochen Burkhardt, Stefan Hepper, Klaus Rindtorff, Thomas Schaeck,"Pervasive Computing-Technology and Architecture of Mobile Internet Application", Pearson Education, sixth Edition, 2009.
3. Frank Adelstein, Sandeep Gupta, Golden Richard III, Loren Schwiebert, Fundamentals of Mobile and Pervasive Computing, Tata McGraw Hill, 2005

COURSE OUTCOMES:

Upon the completion of this course given in the curriculum, students should be able to

- Outline the basic problems, performance requirements of pervasive computing applications, and the trends of pervasive computing and its impacts on future computing applications and society.
- Analyze and compare the performance of different data dissemination techniques and algorithms for pervasive oriented real-time applications.
- Analyze the performance of different sensor data management for sensor networks.
- Develop an attitude to propose solutions with comparisons for problems related to pervasive computing system through investigation

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215MCE03 COMPUTATIONAL INTELLIGENCE TOOLS **L T P C**
3 0 0 3

Course Objective

The subject aims to introduce students to

- Fundamentals of key intelligent systems technologies
- To be familiar with knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation
- Practice in integration of intelligent systems technologies for engineering applications.

UNIT – I COMPUTATIONAL INTELLIGENCE PARADIGM **9**

Introduction – Computational Intelligence paradigms- Artificial Neural Networks-Evolutionary Computation-Swarm Intelligence - Artificial Immune Systems - Fuzzy Systems

UNIT – II ARTIFICIAL NEURAL NETWORKS **9**

The Artificial Neuron - Supervised Learning Neural Networks - Unsupervised Learning Neural Networks - Radial Basis Function Networks –Reinforcement Learning - Performance Issues (Supervised Learning)

UNIT – III EVOLUTIONARY COMPUTATION **9**

Introduction to Evolutionary Computation - Genetic Algorithms - Genetic Programming - Evolutionary Programming - Evolution Strategies - Differential Evolution - Cultural Algorithms

UNIT – IV COMPUTATIONAL SWARM INTELLIGENCE **9**

Particle Swarm Optimization - Basic Particle Swarm Optimization- Social Network Structures- Basic Variations- Basic PSO Parameters- Single-Solution Particle Swarm Optimization- Applications Ant Algorithms - Ant Colony Optimization Meta-Heuristic- Cemetery Organization and Brood Care - Division of Labor - Continuous Ant Colony Optimization - Multi-Objective Optimization - Dynamic Environments- Applications

UNIT – V ARTIFICIAL IMMUNE SYSTEMS & Fuzzy Systems **9**

Natural Immune System - Artificial Immune Models - FUZZY SYSTEMS - Fuzzy Logic and Reasoning - Fuzzy Controllers - Rough Sets

Total: 45 PERIODS

References:

1. A.P. Engelbrecht, Computational Intelligence: An Introduction, 2nd Edition, John Wiley & Sons, 2012.
2. A.P. Engelbrecht, Computational Intelligence: An Introduction, 2nd Edition, John

Wiley & Sons, 2012

3. M. Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Pearson/Addison Wesley, 2011.
4. H.K. Lam, S.S.H. Ling, and H.T. Nguyen, Computational Intelligence and Its Applications: Evolutionary Computation, Fuzzy Logic, Neural Network and Support Vector Machine, Imperial College Press, 2011.

Outcomes

Upon completion of the course, students shall be able to

a. Gain a working knowledge of knowledge-based systems, neural networks, fuzzy systems, and evolutionary computation;

b. Apply intelligent systems technologies in a variety of engineering applications;

c. Implement typical computational intelligence algorithms

d. Present ideas and findings effectively

e. Think critically and learn independently.

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215MCE04 SERVICE ORIENTED ARCHITECTURE AND WEB SERVICES

L T P C
3 0 0 3

COURSE OBJECTIVES:

- Understand the concepts of Service Oriented Architecture along with the evolution of SOA.
- Be aware of the key issues facing many organizations, especially dealing with integration among systems and providing architectural abstractions to them.
- Integrate SOA technologies with Web Services paradigms.
- Know related technologies and implementation basics of SOA

UNIT I-INTRODUCTION **10**

Business Computing – Globalization and development of enterprise computing. Inventory of Distributed computing - Service Orientation – Loose Coupling – Granularity - Scope variance. Software Architectures – Service oriented architecture – benefits – Obstacles and roadmap for SOA. Service orientation, Object and Component orientation - Comparison -Basic SOA Architecture concepts- Key Service characteristics-Technical and Business Benefits.

UNIT II-COMBINING SOA AND WEB SERVICES **15**

XML Technologies– XML – DTD – XSD. Web Services Basis - Web Services versus SOA. Service Discoverability - Universal Description Discovery and Integration – Programming UDDI – UDDI Data Model – UDDI SOAP APIs – Inquiry APIs – Publisher APIs. Service Description and Look up - Web Service Definition Language – Defining Message data types – Defining Operations on Messages –WSDL documents usage Scenarios. Service Interactions– Simple Object Access Protocol – SOAP Specification – SOAP Message processing – SOAP use of Namespaces – SOAP Multipart MIME attachments. SOAP binding. State management and Security in Web Services. Web Service standards and extensions.

UNIT-III BUSINESS PROCESS MANAGEMENT AND MULTI CHANNEL ACCESS **8**

Basic Business process management Concepts – examples – Business modeling – options - Basis of workflow - atomic services and composite services Service orchestration and Choreography – Business Process Execution Language. –Business process reengineering and management- Combining BPM – SOA – Web Services.. Web Service Composition-BPEL-RESTFUL Services-comparison of BPEL and RESTFUL Services. SOA for Multi-Channel Access-Business Benefits-Tiers.

UNIT IV-WEB SERVICES SECURITY AND TRANSACTION **7**

Meta Data Management-Advanced Messaging- Addressing – Reliable Messaging– Policies-WS-Policy– Security- WS-Security–Transaction Management

UNIT V -CASE STUDIES **5**

Inter-Enterprise applications like Insurance Claim processing - Credit Card based online transaction – Direct to Home Services. SOA and Web services in J2EE and .Net Platform.

Total : 45 PERIODS

REFERENCES:

1. Eric Newcomer and Lomow, "Understanding SOA with Web Services", Pearson Education, 2009.
2. Dirk Krafzig, Karl Banke and Dirk Slama, "Enterprise SOA, Service oriented architectures best practices", Prentice Hall, 2008.

3. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services", Pearson Education, 2007.
4. Thomas Erl, "Service Oriented Architecture (SOA): Concepts, Technology and Design", Prentice Hall, 2005.
5. Dan Woods and Thomas Mattern, "Enterprise SOA Designing IT for Business Innovation" O'REILLY, 2006.

COURSE OUTCOMES:

- Understand primary concepts of SOA
- Know the integration of SOA technological points with Web Services.
- Implement of SOA in development cycle of Web Services.

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215MCE05 **SOFTWARE MANAGEMENT**

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COURSE OBJECTIVES:

- To understand the various software processes.
- To learn format process models.
- To gain knowledge of the overall project activities.
- To analyses the various issues in each phase of project management and people management.

UNIT I STRATEGIC MANAGEMENT AND PROJECT SELECTION 9

Project selection models- Project portfolio process- Analysis under uncertainty- Project organization-Matrix organization. Software Project Management -Formal Technical Reviews-Software Quality Assurance-Software Configuration Management-Re-usability Management-Risk analysis and Management-Measurement and Metrics-Document Preparation and Production

UNIT II ENGINEERING AND PEOPLE ISSUES IN PROJECT 9

Phases (Requirements, Design, Development, Testing, maintenance, deployment) - engineering activities and management issues in each phase-Difficulties in people management- Role of Project manager ,Special considerations in project management for India and geographic distribution issues.

UNIT III CONFIGURATION AND QUALITY MANAGEMENT 9

Identifying artifacts to be configured – naming conventions and version control – configuration Control – quality assurance techniques – peer reviews – Fegan inspection – unit, integration, System, and acceptance testing – test data and test cases – bug tracking – causal analysis-Tutorial: version control exercises, development of test cases, and causal analysis of defects.

UNIT IV SOFTWARE QUALITY MANAGEMENT COMPONENTS 9

Project Progress Control- Components, Internal & External Participants, Progress- control regimes, Computerized tools, Software Quality Metrics – Objective, Classification, Process & Product Metrics, Implementation & Limitation of Software Metrics - Software Quality Costs – Objective, Classification Model of cost, Extended Model and Applications

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UNIT V STANDARDS, CERTIFICATION AND ASSESSMENT 9

SQA Standards – ISO 9001 Certification - Software Process Assessment. Organizing for Quality Assurance -Management and its Role in Quality Assurance- The Software Quality Assurance Unit - SQA Trustees and Committees.

Total:45 PERIODS

REFERENCES:

1. Daniel Galin, "Software Quality Assurance: From Theory to Implementation", Pearson Addison-Wesley, 2012.
2. Roger S. Pressman, "Software Engineering-A Practitioner's Approach", McGraw Hill pub.2010.
3. Allen Gilles "Software quality: Theory and management", International Thomson, Computer press 1997.
4. Stephen H.Kan, "Metrics and models in software quality Engineering", Addison –Wesley 2003.
5. Ramesh, " Gopalaswamy: Managing Global Projects ", Tata McGraw Hill, 2001.
6. Humphrey, Watts: "Managing the software process ", Addison Wesley, 1986.
7. Roger S. Pressman, "Software Engineering – A Practitioner's Approach", Seventh Edition,McGraw Hill, 2010.
8. Wheelwright and Clark: "Revolutionising product development ", The Free Press, 1993.
9. Watts Humphrey, "Managing the Software Process ", Pearson Education, New Delhi, 2000.
10. PankajJalote, "Software Project Management in practice", Pearson Education, New Delhi, 2002.

COURSE OUTCOMES:

- Get the basic knowledge about various processes.
- Emphasize the use of format process models.
- Knowledge gained in usage and application of umbrella activities for project management.
- Execute the project development in a systematic manner using tools and techniques.
- Issues are analysed in various phases of project management and people management.

215MCE06 **OPEN SOURCE SYSTEMS**

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COURSE OBJECTIVES:

- To introduce the basic concepts of OSS and open source operating system and Web Servers.
- To give strong foundation in recent open source databases.
- To develop good programming skills by studying various scripting languages.

UNIT I OPEN SOURCE OPERATING SYSTEM & WEBSERVERS **9**

Introduction to Open sources – FOSS licensing models – FOSS development process and basic principles – Open source operating system: Linux: Introduction – System Architecture – File System - File system Hierarchies - Process – Advanced Concepts – Scheduling – Personalities – Cloning – Signals – Development with Linux. Introduction to Apache HTTP Server -WAMP and XAMPP servers.

UNIT II OPEN SOURCE DATABASES **9**

MySQL: Introduction – Setting up account – Record selection Technology – Working with strings – Date and Time– Sorting Query Results – Generating Summary –Using sequences – MySQL and Web.
PostgreSQL: Introduction – Commonplace PSQL tasks – Working with databases, Schemas, Tables – Data types and Attributes – Views and Rules - Functions – Triggers.

UNIT III OPEN SOURCE PROGRAMMING LANGUAGES: PHP **9**

Introduction – Programming in web environment – variables – constants –data types – operators – Statements – Functions – Arrays – OOP – File handling and data storage – PHP and SQL database – Sending and receiving E-mails – Debugging and error handling – Security – Templates – Reading data in web pages – PHP Browser handling power – Handling Ajax and XML with PHP.

UNIT IV PYTHON **9**

Syntax and Style – Python Objects – Numbers – Sequences: Strings, Lists and Tuples – Mapping and Set types – Conditionals and Loops – Files and I/O – Errors and Exceptions – Functions – Modules – Classes and OOP – Execution Environment – Web Programming- Introduction to Jython and Google+.

UNIT V PERL **9**

Perl backgrounder – Perl overview – Perl parsing rules – Variables and Data – Statements and Control structures – Subroutines, Packages, and Modules- Working with Files –Data Manipulation – CGI Programming.

TOTAL: 45 PERIODS

REFERENCES:

1. Remy Card, Eric Dumas and Frank Mevel, "The Linux Kernel Book", Wiley Publications, 2013.
2. Steve Suchring, "PHP & MySQL Bible", John Wiley, Reprint 2010.
3. Vikram Vaswani, "MYSQL: The Complete Reference", 2nd Edition, Tata McGraw- Hill Publishing Company Limited, Indian Reprint 2009.
4. W. Jason Gilmore and Robert H.Treat, "Beginning PHP and PostgreSQL", Apress, First Indian Reprint 2010.
5. Steven Holzner, "PHP: The Complete Reference", 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2013.
6. Rasmus Lerdorf and Levin Tatroe, "Programming PHP", O'Reilly, 2013.
7. Wesley J. Chun, "Core Python Programming", Prentice Hall, Third edition, 2012.
8. Martin C. Brown, "Perl: The Complete Reference", 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2009.
9. WAMP server (Windows, Apache, MySQL, PHP): http://www.wampserver.com/en/

10. XAMPP server: http://sourceforge.net/projects/xampp/

COURSE OUTCOME:

- Able to understand open source operating systems, Web Servers, open source databases such as MySQL and PostgreSQL.
- Able to understand the concepts of open source Programming languages
- Able to design and develop dynamic and database backed web applications.

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215MCE07 **Digital Image Processing**

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Course objective

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

- Learn how to representation image using various transform
- Describe different techniques for Image Enhancement and restoration.
- Understand various methods for Image segmentations like Similarity, dis similarity, Edge and region based.
- Understand the different coding techniques for Image compression. Implement Image Processing Algorithm for various application

Unit I IMAGE REPRESENTATION **9**

Image representation-Image Basis Functions- Two dimensional DFT- Discrete Cosine Transform- Walsh-Hadamard transform-Wavelet transform- Principal component analysis.

Unit II IMAGE ENHANCEMENT AND RESTORATION **9**

Gray level transformation techniques- Spatial domain techniques - Half toning, Median filtering, contrast stretching, Histogram Equalization- Frequency domain techniques - Weiner filtering-Homomorphic filtering- PSFs for different forms of blur - noise models- color image processing.

Unit III IMAGE SEGMENTATION **9**

Segmentation - Similarity and dissimilarity methods- Thresholding - Edge based and Region based methods- Hough transform- Morphological operations - Clustering methods.

Unit IV IMAGE COMPRESSION **9**

Source coding techniques - Run length coding - Shannon-Fano coding- Huffman coding- Arithmetic coding- LZW coding - Transform and Predictive compression methods - Vector quantization- case studies - JPEG-MPEG.

Unit V SIMULATION **9**

Implementation of Image processing algorithms - Image Enhancement - Restoration- Segmentation- Coding techniques- Applications.

Total : 45 Hours

Reference(s) :

1. Rafael C. Gonzalez, Richard E.Woods, 'Digital Image Processing', Pearson Education, Inc., Second Edition, 2004.
2. Anil K. Jain, 'Fundamentals of Digital Image Processing', Prentice Hall of India, 2002.

3. David Salomon : Data Compression – The Complete Reference, Springer Verlag New York Inc., 2nd Edition, 2001
4. Rafael C. Gonzalez, Richard E.Woods, Steven Eddins, ' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.
5. William K.Pratt, ' Digital Image Processing', John Wiley, NewYork, 2002.
6. MilmanSonka, Vaclav Hlavac, Roger Boyle, 'Image Processing, Analysis, and Machine Vision', Brooks/Cole, Vikas Publishing House, II ed., 1999.
7. Sid Ahmed, M.A., 'Image Processing Theory, Algorithms and Architectures', McGrawHill, 1995.
8. Lim, J.S., 'Two Dimensional Signal and Image Processing', Prentice-Hall, New Jersey, 1990.

Course Outcomes

Upon Completion of this course, students will be able to :

- Represent image Mathematically using various transform
- Analyze different techniques for Image Enhancement and restoration.
- Explain various methods for Image segmentations like Similarity, dis similarity, Edge and region based.
- Compute the different coding techniques for Image compression. Design Image Processing Algorithm for various application

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215MCE08 **USER INTERFACE DESIGN** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand and design the user interface, design, menu creation and windows creation.
- To understand the concept of menus, windows, interfaces, business functions, various problems in windows design with colour, text, Non-anthropomorphic Design.
- To study the design process and evaluations.

UNIT I INTRODUCTION 8

Human–Computer Interface – Characteristics of Graphics Interface –Direct Manipulation Graphical System – Web User Interface –Popularity –Characteristic & Principles.

UNIT II HUMAN COMPUTER INTERACTION 10

User Interface Design Process – Obstacles –Usability –Human Characteristics In Design – Human Interaction Speed –Business Functions –Requirement Analysis – Direct – Indirect Methods – Basic Business Functions – Design Standards – System Timings – Human Consideration In Screen Design – Structures Of Menus – Functions Of Menus– Contents Of Menu– Formatting – Phrasing The Menu – Selecting Menu Choice– Navigating Menus– Graphical Menus.

UNIT III WINDOWS 9

Characteristics– Components– Presentation Styles– Types– Managements– Organizations– Operations– Web Systems– System Timings - Device– Based Controls Characteristics–Screen – Based Controls — Human Consideration In Screen Design – Structures Of Menus –Functions Of Menus– Contents Of Menu– Formatting – Phrasing The Menu – Selecting Menu Choice– Navigating Menus– Graphical Menus. Operate Control – Text Boxes– Selection Control– Combination Control– Custom Control– Presentation Control.

UNIT IV MULTIMEDIA 9

Text For Web Pages – Effective Feedback– Guidance & Assistance–Internationalization– Accessibility– Icons– Image– Multimedia – Coloring, Case Study: Addressing usability in ECommerce sites.

UNIT V DESIGN PROCESS AND EVALUATION 9

User Interface Design Process - Usability Testing - Usability Requirements and Specification procedures and techniques- User Interface Design Evaluation. Prototypes – Kinds Of Tests – Retest – Information Search – Visualization –Hypermedia – WWW– Software Tools.

TOTAL: 45 PERIODS

REFERENCE:

1. Wilbent. O. Galitz ,"The Essential Guide To User Interface Design", John Wiley & Sons, 2007.
2. Ben Sheiderman, "Design the User Interface", Pearson Education, 1998.
3. Alan Cooper, "The Essential of User Interface Design", Wiley – Dream Tech Ltd., 2008.
4. Deborah Mayhew, "The Usability Engineering Lifecycle", Morgan Kaufmann, 1999.
5. Alan Dix et al, "Human - Computer Interaction", Prentice Hall, 2009.

COURSE OUTCOMES:

- Knowledge on development methodologies, evaluation techniques and user interface building tools.
- Explore a representative range of design guidelines.
- Gain experience in applying design guidelines to user interface design tasks.
- Ability to design their own Human Computer.

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215MCE09 **MOBILE ADHOC NETWORKS** L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn about the issues in the design of ad hoc and wireless sensor networks
- To gain knowledge on routing and protocols in Ad Hoc and sensor networks.
- To understand the working of protocols in different layers of ad hoc and sensor networks
- To expose the students to different aspects in ad hoc and sensor networks
- To understand various standards and applications in ad hoc and sensor networks

UNIT I ADHOC NETWORKING AND ROUTING PROTOCOLS 9

Introduction to ad hoc networks- Differences between cellular and ad hoc wireless networks- Challenges and issues in ad hoc networks - Overview of routing methods – Proactive – Reactive and hybrid routing protocol – UniCast routing protocol (AODV, DSR, DSDV) – Multi-Cast routing protocol (ODMRP) – Multi clustering – Power Issues – ABR.

UNIT II TRANSPORT LAYER ISSUES 9

TCP over Ad Hoc – Ad hoc TCP - TCP with explicit link – TCP Bus -TCP Feedback - Split-TCP - Ad hoc transport protocol – Security.

UNIT III SENSOR NETWORKING 9

Unique constraints and challenges – Advantages of Sensor networks – Sensor network applications – Collaborative processing – Key Definitions of sensor networks – A racking Scenario – Problem formulation – Inference of states – Tracking Multiple Objects – Sensor Models – Performance comparison and metrics.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Key Assumptions – Medium Access Control – General Issues – Geographic – Energy Aware Routing – Attribute Base Routing. Topology Control – Clustering – Time Synchronization – Localization and localization services – algorithms.

UNIT V VEHICULAR NETWORKING 9

General Issues – Inter-vehicular networks – Mobility at the application layer – Mobility at the transport layer – Security and privacy in ubiquitous environment – Programming MANET with mobile code.

TOTAL: 45 PERIODS

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REFERENCES:

1. C.K.Toh, "Ad Hoc Mobile Wireless Systems", Prentice Hall, PTR, 2002.
2. Charles E.Perkins, "Ad Hoc Networking", Addison – Wesley, 2001.
3. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks – An Information Processing Approach", Elsevier 2004

COURSE OUTCOMES

- Understand the principles of Ad Hoc wireless and sensor networks.
- Design and simulate sensor networks and assess performance.
- Identify different issues in wireless ad hoc and sensor networks
- To analyze the protocols developed for ad hoc and sensor networks
- To identify and discuss the standards and applications of ad hoc and sensor networks

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215MCE10 **CLOUD COMPUTING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the broad perceptive of cloud architecture and model
- To understand the concept of Virtualization and server virtualization
- To be familiar with the lead players in cloud and the cloud infrastructure.
- To apply different cloud programming model as per need.
- To be able to set up a private cloud.
- To understand the design of the trusted cloud Computing System Services.

UNIT I CLOUD ARCHITECTURE AND MODEL **9**

Technologies for Network-Based System – System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture. Cloud Models:- Characteristics – Cloud Services – Cloud models (IaaS, PaaS, SaaS) – Public vs Private Cloud –Cloud Solutions - Cloud ecosystem – Service management – Computing on demand.

UNIT II VIRTUALIZATION INFRASTRUCTURE **9**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines – Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization – Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization, Case Study: Xen.

UNIT III CLOUD INFRASTRUCTURE **9**

Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture Development – Design Challenges - Inter Cloud Resource Management – Resource Provisioning and Platform Deployment – Global Exchange of Cloud Resources.

UNIT IV PROGRAMMING MODEL **9**

Parallel and Distributed Programming Paradigms – MapReduce , Twister and Iterative MapReduce – Hadoop Library from Apache – Mapping Applications - Programming Support -Google App Engine, Amazon AWS - Cloud Software Environments - OpenStack, Eucalyptus, Aneka, CloudSim, Case Study: OpenStack.

UNIT V CLOUD SECURITY INFRASTRUCTURE **9**

Security Overview – Cloud Security Challenges and Risks – Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security - Identity Management and Access Control – Autonomic Security.

TOTAL: 45 PERIODS

REFERENCES:

1. Stephen R. Smoot and Nam-Kee Tan, "Private Cloud Computing: Consolidation, Virtualization, and Service-Oriented Infrastructure", Morgan Kaufmann Publishers, 2011.
2. Sanjiva Shankar Dubey,"Cloud Computing and Beyond", I K International Publishing House Pvt. Ltd, First Edition, 2012.

3. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2013.
4. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
5. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2009.
6. Kumar Saurabh, "Cloud Computing – insights into New-Era Infrastructure", Wiley India, 2011.
7. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud", O'Reilly, 2009.
8. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.
10. Katarina Stanoevska-Slabeva, Thomas Wozniak, Santi Ristol, "Grid and Cloud Computing – A Business Perspective on Technology and Applications", Springer, 2009.
11. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010.
12. Rajkumar Buyya, Christian Vecchiola, S.Tamarai Selvi, 'Mastering Cloud Computing", TMGH, 2013.

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing
- Identify the architecture, infrastructure and delivery models of cloud computing
- Apply suitable virtualization concept to design Cloud Services for setting private cloud.
- Choose the appropriate cloud player and the appropriate Programming Models and approach
- Address the core issues of cloud computing such as security, privacy and interoperability

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215MCE11 **ONTOLOGY AND SEMANTIC WEB**

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UNIT I INTRODUCTION **8**

Components – Types – Ontological Commitments – Ontological Categories – Philosophical Background - Sample - Knowledge Representation Ontologies – Top Level Ontologies – Linguistic Ontologies – Domain Ontologies – Semantic Web – Need – Foundation – Layers – Architecture.

UNIT II LANGUAGES FOR SEMANTIC WEB AND ONTOLOGIES **12**

Web Documents in XML – RDF - Schema – Web Resource Description using RDF- RDF Properties – Topic Maps and RDF – Overview – Syntax Structure – Semantics – Pragmatics - Traditional Ontology Languages – LOOM- OKBC – OCML - Flogic Ontology Markup Languages – SHOE – OIL - DAML + OIL- OWL

UNIT III ONTOLOGY LEARNING FOR SEMANTIC WEB **12**

Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning – Importing and Processing Ontologies and Documents – Ontology Learning Algorithms - Evaluation

UNIT IV ONTOLOGY MANAGEMENT AND TOOLS **8**

Overview – need for management – development process – target ontology – ontology mapping – skills management system – ontological class – constraints – issues. Evolution – Development of Tools and Tool Suites – Ontology Merge Tools – Ontology based Annotation Tools.

UNIT V APPLICATIONS **5**

Web Services – Semantic Web Services - Case Study for specific domain – Security issues – current trends.

TOTAL: 45 PERIODS

REFERENCES:

1. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez, "Ontological Engineering: with examples from the areas of Knowledge Management, e-Commerce and the Semantic Web" Springer, 2004
2. Grigoris Antoniou, Frank van Harmelen, "A Semantic Web Primer (Cooperative Information Systems)", The MIT Press, 2004
3. Alexander Maedche, "Ontology Learning for the Semantic Web", Springer; 1 edition, 2002
4. John Davies, Dieter Fensel, Frank Van Harmelen, "Towards the Semantic Web: Ontology – Driven Knowledge Management", John Wiley & Sons Ltd., 2003.
5. John Davies (Editor), Rudi Studer (Co-Editor), Paul Warren (Co-Editor) "Semantic Web Technologies: Trends and Research in Ontology-based Systems"Wiley Publications, Jul 2006

6. Dieter Fensel (Editor), Wolfgang Wahlster, Henry Lieberman, James Hendler, "Spinning the Semantic Web: Bringing the World Wide Web to Its Full Potential", The MIT Press, 2002
7. Michael C. Daconta, Leo J. Obrst, Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Wiley, 2003
8. Steffen Staab (Editor), Rudi Studer, "Handbook on Ontologies (International Handbooks on Information Systems)", Springer 1st edition, 2004
9. Dean Allemang (Author), James Hendler (Author) "Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL" (Paperback), Morgan Kaufmann, 2008

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215MCE12 **MULTIMEDIA SYSTEMS** L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the principles of multimedia system, compression techniques and its uses in real time scenarios.
- To introduce the design issues, and multimedia networking concepts.
- To identify a range of concepts, techniques and tools for creating and editing the interactive multimedia applications

UNIT I INTRODUCTION 9

Multimedia and Multimedia Tools – Multimedia Presentation and Production – Types of Multimedia: Data, Audio, Music, Graphics, Animation, Image, Video, Haptics – Multimedia Architecture – File Formats – Multimedia Documents.

UNIT II CODING AND COMPRESSION 9

Compression Algorithm: Lossy, Lossless - Runlength, VLC, Arithmatic Coding – Transform Coding: KCT and DCT - Image Compression and Standards: JPEG – Video Compression and Standards: MPEG - 1,2,4,7-H.264 and HEVC(H.265) - Audio Compression and Standards : MPEG

UNIT III MULTIMEDIA TOOLS 9

Authoring Tools: Features and Types – Card and Page based Tools – Icon and Object based Tools – Time based Tools – Cross Platform Authoring Notes – Basic Software Tools: OCR Software – 3D Modeling and Animation Tools.

UNIT IV MULTIMEDIA NETWORKS 9

Basics of Computer and Multimedia Network – Network and Protocols for Multimedia Communication – Internet Multimedia Content Distribution – Multimedia over Wireless and Mobile Networks

UNIT V MULTIMEDIA APPLICATION DEVELOPMENT 9

Software Life Cycle – ADDIE Model – Conceptualization – Content Collection and Processing – Story – Flow Line – Script – Storyboard – Implementation – Authoring Metaphors – Testing and Feedback – Final Delivery – Report Writing/ Documentation – Case Study: Web Application – Console Application – Distributed Application – Mobile Application – Games Consoles – itv – Kiosks

TOTAL:45 PERIODS

REFERENCES

1. Ze-Nian. Li, Mark S. Drew, Jiangchuan Liu. Fundamentals of Multimedia Pearson/Prentice-Hall, 2014.
2. Ian E. Richardson. The H.264 Advanced Video Compression Standard. Second Edition, John Wiley and Sons, 2010.

3. R. Parekh, Principles of Multimedia, New Delhi: Tata McGraw-Hill, 2010.
4. Tay Vaughan, Multimedia: Making It Work, New Delhi: McGraw-Hill Professional, 2007.
5. Ralf Steinmetz and Klara Nahrstedt, Multimedia: Computing, Communications and Applications, New Delhi: Pearson Education, 2012.
6. Fred Halsall, Multimedia Communication-Application Networks, Protocols and Standard, Singapore: Addison -Wesley, 2008
7. Y. Wang, J. Ostermann, Y. Zhang. Video Processing and Communications, Prentice-Hall, 2002.
8. T. Ebrahimi, F. Pereira. The MPEG-4 Book, PRentice-Hall, 2002.

COURSE OUTCOMES:

- To acquire fundamentals of multimedia, and understand and implements various compression Algorithms.
- To gain hands-on experience in image, sound and video editing and in some aspects of multimedia authoring.
- Able to design and Develop Multimedia Networking and real time Applications.

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315MCT01 **INFORMATION SECURITY**

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PREREQUISITES: NIL

OBJECTIVES:

- To understand the basics and need for Information security
- To understand the issues , identify Risk, asses and control it in Information security
- Determine IT security guidelines for various type of industries
- To design security applications in the field of Information technology

UNIT I – INTRODUCTION & NEED FOR SECUTIRY **9**

Introduction to Information Security, Critical Characteristics of Information, CNSS Security Model, The SDLC, The SSDLC, Threats ,Attacks .

UNIT II - LEGAL, ETHICAL, AND PROFESSIONAL ISSUES IN INFORMATION SECURITY **9**

Law and Ethics in Information Security , International Laws and Legal Bodies-Ethics and Information Security, Codes of Ethics and Professional Organizations .

UNIT III- RISK MANAGEMENT & SECURITY PLANNING **9**

Risk Identification- Risk Assessment- Risk Control Strategies, Information Security Planning and Governance, Information Security Policy, Standards, and Practices, The Information Security Blueprint.

UNIT IV- PHYSICAL SECURITY **8**

Introduction- Physical Security Controls- Fire Security and Safety- Failure of Supporting Utilities and Structural Collapse- Mobile and Portable System.

UNIT V- PHYSICAL DESIGN AND IMPLEMENTATION **10**

Security Technology, IDS, Honey Pots, Honey Nets, and Padded Cell Systems, Scanning and Analysis Tools, Implementing Information Security, Project Management for Information Security, Technical Topics of Implementation, Nontechnical Aspects of Implementation.

TOTAL HOURS: 45

REFERENCES:

1. Michael E Whitman and Herbert J Mattord, "Principles of Information Security", Thomson (Cengage) Indian 4th Edition.2011
2. V k Pachghare: Cryptography and Information Security, PHE ,2013
3. Matt Bishop, "Computer Security Art and Science", Pearson/PHI, 2005.
4. Micki Krause, Harold F. Tipton, "Handbook of Information Security Management", Vol 1-3 CRC Press

Course Outcomes

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

CO1 :Analyze the vulnerabilities in any computing system and hence be able to design a security solution.

CO2:Identify the concepts ,policies associated with security.

CO3:Analyze the possible security attacks in real time systems and their effective countermeasures

CO4:Formulate research problems in the computer security field

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315MCT01 **RESEARCH METHODOLOGY**

L	T	P	C
3	0	0	3

Course Objectives

- To make students aware of how literature reviews can help in problem formulation and definition.
- To develop student skills in Research design
- To develop student skills in designing and executing hypothesis tests
- To develop the student skills in structured presentation of research findings using oral and written reports.

UNIT I: Research Problem and Methods of Data Collection 9

Research methodology – definition, mathematical tools for analysis, Types of research, exploratory research, conclusive research, modeling research, algorithmic research, Research process- steps. Data collection methods- Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data- internal sources of data, external sources of data.

UNIT II: Measurement, Scaling Techniques and Sampling 9

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

UNIT III: Hypotheses testing 9

Introduction – Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), Concerning variance – one tailed Chi-square test.

UNIT IV: Nonparametric tests 9

Introduction - One sample tests – one sample sign test, Kolmogorov- Smirnov test, run test for randomness, Two sample tests – Two sample sign test, Mann- Whitney U test, K-sample test – Kruskal Wallis test (H-Test)

UNIT V: Analysis of Data and Report Writing 9

Introduction to Disciminant analysis, Factor analysis, cluster analysis, multidimensional scaling, conjoint analysis. Report writing- Types of report, guidelines to review report, typing instructions, oral presentation

REFERENCES

1. Kothari, C.R., Research Methodology –Methods and techniques,.3/e, ,New Age International Publishers Ltd New Delhi, 2014

2. Panneerselvam, R., Research Methodology, Prentice-Hall of India, New Delhi, 2007

Course Outcomes

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

CO1: The student will be able to define a research problem and hypothesis based on literature review

CO2: The student will be able to device a suitable Research Design for data collection

CO3: The student will be able to formulate and test hypothesis

CO4: The student will be able to report the findings in a structured manner.

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315MCE02 MACHINE LEARNING

L	T	P	C
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PREREQUISITES:

- Probability and statistics
- Graph theory

OBJECTIVES:

- To understand the concepts of machine learning
- To appreciate supervised and unsupervised learning and their applications
- To understand the theoretical and practical aspects of Probabilistic Graphical Models
- To appreciate the concepts and algorithms of reinforcement learning

UNIT I INTRODUCTION **9**

Learning – Design of a Learning system - Types of machine learning –Applications Probability Theory -Probability densities Expectations and covariance -Bayesian probabilities - Gaussian distribution-Curve fitting re-visited -Bayesian curve fitting – Probability distributions -Decision Theory-Bayes Decision Theory - Information Theory

UNIT II SUPERVISED LEARNING **9**

Linear Models for Regression - Linear Basis Function Models - Predictive distribution Equivalent kernel-Bayesian Model Comparison-Evidence Approximation - Effective number of parameters - Limitations of Fixed Basis Functions - Linear Models for Classification – Naïve Bayes - Discriminate Functions - Probabilistic Generative Models -Probabilistic Discriminative Models - Bayesian Logistic Regression. Neural Networks Feed-forward Network Functions - Back- propagation.

UNIT III UNSUPERVISED LEARNING **9**

Clustering- K-means - EM Algorithm- Mixtures of Gaussians. Supervised Learning after Clustering Hierarchical Clustering Choosing the Number of Clusters The Curse of Dimensionality Reduction - Factor analysis - Principal Component Analysis - Probabilistic PCA- Independent components analysis

UNIT IV PROBABILISTIC GRAPHICAL MODELS 9

Graphical Models - Undirected graphical models - Markov Random Fields - Directed Graphical Models - Bayesian Networks - Conditional independence properties - Inference – Learning- Generalization - Hidden Markov Models - Conditional random fields(CRFs)

UNIT V REINFORCEMENT LEARNING 9

Reinforcement Learning- Introduction Single State Case: K-Armed Bandit - Elements of Reinforcement Learning - Model-Based Learning - Value Iteration - Policy Iteration - Temporal Difference Learning - Exploration Strategies - Deterministic Rewards and Actions - Nondeterministic Rewards and Actions - Eligibility Traces - Generalization Partially Observable States - The Setting - The Tiger Problem

TOTAL: 45

REFERENCES

1. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2014
2. Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2006
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.
5. Hastie, Tibshirani, Friedman, "The Elements of Statistical Learning" (2nd ed)., Springer, 2008
6. Stephen Marsland, "Machine Learning –An Algorithmic Perspective", CRC Press, 2009

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

CO1:To implement a neural network for an application of your choice using an available tool

C02:To implement probabilistic discriminative and generative algorithms for an application of your choice and analyze the results

CO3:To use a tool to implement typical clustering algorithms for different types of applications

CO4:To design and implement an HMM for a sequence model type of application

315MCE03 **Wireless Sensor Network**

L	T	P	C
3	0	0	3

PREREQUISITE: COMPUTER NETWORKS

OBJECTIVES:

- To understand the basic WSN technology.
- To study the sensor architecture and operating system.
- To learn the key routing protocols for sensor network.
- To learn to develop applications in wireless sensor network.

UNIT I INTRODUCTION AND OVERVIEW OF WIRELESS SENSOR NETWORKS 9

Background of Sensor Network Technology, Application of Sensor Networks, Challenges for Wireless Sensor Networks, Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Trends.

UNIT II OPERATING SYSTEM AND ARCHITECTURE 9

Single-node Architecture, Hardware Components & Design Constraints, Operating Systems and Execution Environments, Case study: TinyOS and nesC.
Network Architecture: Sensor Network Scenarios, Design Principles for WSNs, Service Interfaces of WSNs, Gateway Concepts.

UNIT III ROUTING PROTOCOLS AND DATA MANIPULATION 9

Issues in Designing Routing Protocols, Routing Strategies in Wireless Sensor Networks, Energy-Efficient Routing, Unicast, Broadcast and Multicast, Geographic Routing. Data Centric and Content based Routing, Storage and Retrieval in Network, Compression Technologies for WSN, Data Aggregation Technique.

UNIT IV SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level Software Platforms, Node-level Simulators, State-centric Programming.

UNIT V SECURITY AND APPLICATIONS OF WIRELESS SENSOR NETWORK 9

Overview of Wireless Sensor Network Security, Vulnerabilities and Attacks in Wireless Sensor Networks, Secure Routing in Wireless Sensor Networks, Applications: Artificial Eye Vision Using Wireless Sensor Networks, Wireless Sensor Networks: A Medical Perspective.

TOTAL HOURS: 45

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REFERENCES:

1. Ibrahiem M. M. El Emary, S. Ramakrishnan, "Wireless Sensor Networks: From Theory to Applications" CRC Press, 2013. (UNIT-V)
2. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005. (UNIT–II & III)
3. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007. (UNIT-IV)
4. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, "Wireless Sensor Network", Springer, First Ed. 2004 (ISBN: 978-4020-7883-5). (UNIT-III)
5. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks- Technology, Protocols, and Applications", John Wiley, 2007. (UNIT-I)
6. Javier Lopez, J Zhou, "Wireless Sensor Network Security", IOS press, 2008. (UNIT-V)
7. Rainer Matischek, "A TinyOS - Based Ad Hoc Wireless Sensor Network: Introduction, Versatile Application Design", Implementation, VDM Verlag, 2008. (UNIT-II)

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

- Understand sensor characteristics.
- Analyze the role of sensors in Wireless networks.
- Gain the knowledge in routing protocol for WSN.
- Understand the basic architecture for WSN based applications.

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315MCE04 **UNIX INTERNALS**

L	T	P	C
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PREREQUISITES: Operating System and C Programming

OBJECTIVES:

- To get through understanding of the kernel.
- To understand the file organization and management.
- To know the various system calls.
- To have knowledge of process architecture, process control & scheduling and memory management.

UNIT I **OVERVIEW** **9**

General Overview of the System: System structure – User perspective – Operating system services – Assumptions about hardware – Architecture of the UNIX operating system – Introduction to system concepts – The Buffer Cache: Buffer headers – Structure of the buffer pool – Scenarios for retrieval of a buffer – Reading and writing disk blocks – Advantages and disadvantages of the buffer cache.

UNIT II **FILE SYSTEM** **9**

Internal representation of files: inodes – Structure of a regular file – Distributed File System Architecture – Characteristics – Remote File Sharing Architecture– RFS Implementation –Andrew File System – AFS Implementation.

UNIT III **THE PROCESS** **9**

Process Control: Process creation – Process termination – Awaiting process termination – Invoking other programs – User id of a process – Changing the size of a process– Process states and transitions – Process Scheduling – SV4 Scheduler – Scheduling in Mach.

UNIT IV **THREADS AND SIGNALS** **9**

Thread – Kernel Thread –User Thread – Lightweight Process Design – Multithreading in Solaris and SVR4 – Signal – Signal Generation – Signal Handling – Unreliable Signal – Reliable Signal – Signal Implementation.

UNIT V **MEMORY MANAGEMENT AND I/O** **9**

Memory Management Policies: Swapping – Demand paging – Memory Management Design – Page Replacement – The I/O Subsystem – Driver Interface – Disk Driver Framework – Terminal Drivers.

TOTAL HOURS: 45

REFERENCES

1. Uresh Vahalia, "Unix Internals: The New Frontiers", Pearson Education, 2008.

2. J.Maurice Bach,"The Design of the Unix Operating System",First Edition,Pearson Education, 2006.

3. B.Goodheart and J.Cox, "The Magic Garden Explained", Prentice Hall of India, 1994.

4. S.J.Leffler, Mckusick M.K.Karels M.J and J.S Quarterman., "The Design and Implementation of the 4.3 BSD Unix Operating System", Addison Wesley, 1998.

5. Behrouz A. Forouzan, Richard Gilberg, "Unix & Shell programming", Thomson Asia, 2003.

OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Understand the basic functioning of UNIX operating systems and shell programming.

CO2: Analyze the buffer representation, kernels and system calls.

CO3: Understand the system structure, implementation of system calls.

CO4: Learn the UNIX segmentation, paging and scheduling the Drivers and IPC.

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315MCE05 BIG DATA ANALYTICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- Understand big data for business intelligence
- Learn business case studies for big data analytics
- Understand nosql big data management
- Perform map-reduce analytics using Hadoop and related tools

UNIT-I UNDERSTANDING BIGDATA 9

What is big data – why big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data and marketing – fraud and big data – risk and big data – credit risk management – big data and algorithmic trading – big data and healthcare – big data in medicine – advertising and big data – big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics

UNIT-II NOSQL DATA MANAGEMENT 9

Introduction to NoSQL – aggregate data models – aggregates – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – sharding – master-slave replication – peer-peer replication – sharding and replication – consistency – relaxing consistency – version stamps – map-reduce – partitioning and combining – composing map-reduce calculations

UNIT-III BASICS OF HADOOP 9

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures

UNIT-IV MAP REDUCE APPLICATIONS 9

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats

UNIT-V HADOOP RELATED TOOLS 9

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis.Cassandra – cassandra data model – cassandra examples – cassandra clients – Hadoop integration. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts.

TOTAL HOURS : 45

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REFERENCES:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Addison-Wesley Professional, 2012.
3. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
4. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
5. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
6. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
7. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
8. Alan Gates, "Programming Pig", O'Reilley, 2011.

COURSE OUTCOMES:

Upon Completion of the course, the students will be able to

CO1:Describe big data and use cases from selected business domains
CO2:Explain NoSQL big data management
CO3:Install, configure, and run Hadoop and HDFS
CO4:Perform map-reduce analytics using Hadoop
CO5:Use Hadoop related tools such as HBase, Cassandra, Pig, for big data analytics

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315MCE06 BIO-INFORMATICS

L	T	P	C
3	0	0	3

PREREQUISITES: NIL.

OBJECTIVES:

- To understand the basic concepts.
- To search information, visualize it.
- To learn various bioinformatics algorithms.
- To understand data mining techniques.
- To study various pattern matching techniques

UNIT I – INTRODUCTORY CONCEPTS 9

The Central Dogma – The Killer Application – Parallel Universes – Watson's Definition – Top DownVersus Bottom up – Information Flow – Convergence – Databases – Data Management – Data LifeCycle – Database Technology – Interfaces – Implementation – Networks – Geographical Scope –Communication Models – Transmissions Technology – Protocols – Bandwidth – Topology – Hardware – Contents – Security – Ownership – Implementation – Management.

UNIT II - SEARCH ENGINES, VISUALIZATION AND ALGORITHMS 9

The search process – Search Engine Technology – Searching and Information Theory – Computational methods – Search Engines and Knowledge Management – Data Visualization – sequence visualization – structure visualization – user Interface –Animation Versus simulation – General Purpose Technologies - Exhaustive search – Greedy – Dynamic programming – divide andconquer – graph algorithms

UNIT III STATISTICS AND DATA MINING 9

Statistical concepts – Microarrays – Imperfect Data – Randomness – Variability – Approximation –Interface Noise – Assumptions – Sampling and Distributions – Hypothesis Testing – QuantifyingRandomness – Data Analysis – Tool selectionstatistics of Alignment – Clustering and Classification –Data Mining – Methods – Selection and Sampling – Preprocessing and Cleaning – Transformation andReduction – Data Mining Methods – Evaluation – Visualization – Designing new queries – Pattern Recognition and Discovery – Machine Learning – Text Mining – Tools.

UNIT IV PATTERN MATCHING 9

Pairwise sequence alignment – Local versus global alignment – Multiple sequence alignment – Computational methods – Dot Matrix analysis – Substitution matrices –Dynamic Programming – Wordmethods – Bayesian methods – Multiple sequence alignment – Dynamic Programming – Progressivestrategies – Iterative strategies –Tools – Nucleotide Pattern Matching – Polypeptide pattern matching– Utilities –Sequence Databases.

UNIT V MODELING AND SIMULATION 9

Drug Discovery – components – process – Perspectives – Numeric considerations – Algorithms –Hardware – Issues – Protein structure – AbInitio Methods – Heuristic methods – Systems Biology –Tools – Collaboration and Communications – standards -Issues – Security – Intellectual property.

TOTAL : 45 Periods

REFERENCES:

1. Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2003.
2. T.K.Attwood and D.J. Perry Smith, "Introduction to Bio Informatics, Longman Essen,1999.
3. An Introduction to, Bioinformatics Algorithms (Computational Molecular Biology) , "Neil C.Jones,PaveA. Pevzner", MIT Press 2004.

COURSE OUTCOMES:

At the end of the course the student will be able to
CO1: Will able to have basic idea of BioInformatics.
CO2:Will able to retrieve information's using various algorithms and techniques.
CO3:Will able to sequence the databases.
CO4: Will able to do modeling and simulation

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315MCE07 SOFTWARE TESTING AND QUALITY ASSURANCE

L	T	P	C
3	0	0	3

PREREQUISITES: Software Engineering, Object oriented Analysis and Design, Object Oriented software Engineering.

OBJECTIVES:

- To introduce the basics and necessity of software testing.
- To introduce various testing techniques along with software production.
- To introduce the concepts of Software quality and its assurance.

UNIT I - INTRODUCTION 9

Basics of Software Testing – Testing Principles – Goals – Testing Life Cycle– Phases of Testing–Test Plan(IEEE format) – Importance of Testing in Software Production Cycle- Software Test Plan–Components of Plan - Types of Technical Reviews - Static and Dynamic Testing.

UNIT II - SOFTWARE TESTING METHODOLOGY & STRATEGIES 9

Software Testing in Spiral Manner - Information Gathering - Test Planning - Test Case Design - Test Development - Test Coverage - Test Evaluation -Prepare for Next Spiral - Conduct System Test - Acceptance Test - Summarize Testing Results. Testing strategies – white box and black box approach – integration testing – system and acceptance testing – performance testing – regression testing - internationalization testing – ad-hoc testing – website testing – usability testing – accessibility testing Test plan – management – execution and reporting – software test automation – automated testing tools.

UNIT III - EMERGING SPECIALIZED AREAS IN TESTING 9

Test Process Assessment – Test Automation Assessment - Test Automation Framework – Nonfunctional Testing – SOA Testing – Agile Testing – Testing Center of Excellence – Onsite/Offshore Model - Modern Software Testing Tools. Manual testing, Automated Testing Tools & Case studies, Study of Testing tools (Selenium, QTP, Rational Robot, Winrunner, Loadrunner, JMeter).

UNIT IV- SOFTWARE QUALITY 9

Hierarchical models of software quality – software quality metrics –function points -Software product quality – software maintenance quality – effect of case tools – software quality infrastructure – procedures – certifications – configuration management – documentation control. SQA Plan – Quality Standards – CMM – PCMM – CMMI – Malcolm Baldrige National Quality Award.

UNIT V- QUALITY ASSURANCE 9

Quality management -Quality assurance plan-SCM support functions-SCM Tools-Establishing standards – Guidelines-Basic inspection principles-Principles of software defect prevention-Process changes for defect prevention -Defect prevention considerations. Configuration accounting and audit.

TOTAL: 45 Hours

REFERENCES:

1. Paul C. Jorgensen: Software Testing, A Craftsman's Approach, 3rdEdition, Auerbach Publications, 2012.
2. Watts S. Humphrey, Managing the software process, Addison Wesley, 2011
3. Brian Marrick: The Craft of Software Testing, 1st edition,Pearson, 2012.
4. Srinivasan Desikan, Gopalaswamy Ramesh: Software testing Principles and Practices, 1stEdition, Pearson, 2012.
5. Kshirasagar Naik, Priyadarshi Tripathy, "Software Testing and Quality Assurance Theory and Practice", John Wiley & Sons publication, 2011.
6. Yogesh Singh, "Software Testing", Cambridge University Press, 2012.
7. William E.Lewis, "Software Testing and Continuous Quality Improvement", Third edition, Auerbach Publications, 2011.
8. Mauro Pezze, Michal Young: Software Testing and Analysis –Process, Principles and Techniques, 1st edition, John Wiley & Sons, 2011.

COURSE OUTCOMES:

At the end of the course the student will be able to
CO1: To work with various software testing strategies.
CO2: To use various testing methods for the appropriate applications.
CO3: To design and develop software quality models and implements software quality assurance.
CO4: To assess Quality Assurance standards and tools.

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315MCE08 NATURAL LANGUAGE PROCESSING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the representation and processing of Morphology and Part-of Speech Taggers
- To appreciate various techniques used for speech synthesis and recognition
- To understand different aspects of natural language syntax and the various methods used for processing syntax and disambiguating word senses
- To appreciate the various representations of semantics and discourse
- To know about various applications of natural language processing

UNIT - I MORPHOLOGY AND PART-OF SPEECH PROCESSING 9

Introduction –Regular Expressions and Automata- Non-Deterministic FSAs. Tranducers –English Morphology - Finite-State Morphological Parsing - Porter Stemmer - Tokenization- Detection and Correction of Spelling Errors. N-grams – Perplexity - Smoothing - Interpolation - Backoff . Part-of- Speech Tagging – English Word Classes - Tagsets - Rule-Based - HMM - Transformation-Based Tagging - Evaluation and Error Analysis. Hidden Markov and Maximum Entropy Models

UNIT - II SPEECH PROCESSING 9

Phonetics – Articulatory Phonetics - Phonological Categories - Acoustic Phonetics and Signals - Speech Synthesis – Text Normalization – Phonetic and Acoustic Analysis - Diphone Waveform synthesis – Evaluation- Automatic Speech Recognition –Architecture - Hidden Markov Model to Speech - MFCC vectors - Acoustic Likelihood Computation - Evaluation. Triphones – Discriminative Training - Modeling Variation. Computational Phonology-Finite-State Phonology – Computational Optimality Theory - Syllabification - Learning Phonology and Morphology

UNIT - III SYNTAX ANALYSIS 9

Formal Grammars of English – Constituency - Context-Free Grammars –Grammar Rules – Treebanks - Finite-State and Context-Free Grammars - Dependency Grammars. Syntactic Parsing – Parsing as Search - Ambiguity - Dynamic Programming Parsing Methods –CKY- Earley and Chart Parsing- Partial Parsing- Evaluation. Statistical Parsing – Probabilistic Context-Free Grammars – Probabilistic CKY Parsing of PCFGs – Probabilistic Lexicalized CFGs –Collins Parser. Language and Complexity -The Chomsky Hierarchy -The Pumping Lemma

UNIT - IV SEMANTIC AND PRAGMATIC INTERPRETATION 9

Representation of Meaning – Desirable Properties - Computational Semantics -Word Senses - Relations Between Senses – WorldNet - Event Participants- Proposition Bank -Frame Net – Metaphor. Computational Lexical Semantics – Word Sense Disambiguation- Supervised Word Sense Disambiguation – Dictionary and Thesaurus Methods- Word Similarity - Minimally Supervised WSD - Hyponymy and Other Word Relations Semantic Role Labeling -Unsupervised Sense Disambiguation. Computational Discourse - Discourse Segmentation - Unsupervised Discourse - Segmentation - Text Coherence - Reference Resolution –Phenomena – Features and algorithms - Pronominal Anaphora Resolution

UNIT - V APPLICATIONS 9

Information Extraction – Named Entity Recognition - Relation Detection and Classification –Temporal and Event Processing - Template-Filling - Biomedical Information Extraction. Question Answering and Summarization -Information Retrieval -Factoid Question Answering - Summarization - Single and Multi-Document Summarization - Focused Summarization - Evaluation. Dialog and Conversational Agents – Properties of Human Conversations - Basic Dialogue Systems - VoiceXML - Information- State and Dialogue Acts - Markov Decision Process Architecture. Machine Translation –Issues in Machine Translation - Classical MT and the Vauquois Triangle -Statistical MT - Phrase-Based Translation Model - Alignment in MT –IBM Models –Evaluation

Total Hours: 45

REFERENCES:

1.Jurafsky and Martin, "Speech and Language Processing", Pearson Prentice Hall, Second Edition, 2008.
2. Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
3. Stevan Bird, "Natural Language Processing with Python", Shroff, 2009.
4. James Allen, "Natural Language Understanding", Addison Wesley, Second Edition, 2007.
5. Nitin Indurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", (Chapman & Hall/CRC Machine Learning & Pattern Recognition), Second Edition, 2010.
6. Alexander Clark, Chris Fox, Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley-Blackwell, 2012.

COURSE OUTCOMES:

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

CO1: Identify the different linguistic components of given sentences
CO2:Design a morphological analyser for a language of your choice using finite state automata concepts
CO3:Implement the Earley algorithm for a language of your choice by providing suitable grammar and words
CO4:Use a machine learning algorithm for word sense disambiguation
CO5:Build a tagger to semantically tag words using Word Net
CO6: Design a business application that uses different aspects of language processing

315MCE09 INFORMATION RETRIEVAL

L	T	P	C
3	0	0	3

Prerequisites: Data warehousing and Data Mining.

OBJECTIVES:

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- To understand the concepts of digital libraries

UNIT I INTRODUCTION 9

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval –Retrieval Evaluation – Open Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR —IR Versus Web Search–Components of a Search engine

UNIT II MODELING 9

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing.

UNIT III INDEXING 9

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency.

UNIT IV CLASSIFICATION AND CLUSTERING 9

Text Classification and Naïve Bayes – Vector Space Classification – Support vector machines and Machine learning on documents. Flat Clustering – Hierarchical Clustering –Matrix decompositions and latent semantic indexing – Fusion and Meta learning.

UNIT V USER INTERFACE AND SEARCHING THE WEB 9

User Interface: Introduction, Human-Computer interaction, The information access process, Starting pints, Query specification, Context, Using relevance judgments, Interface support for the search process. **Searching the Web:** Introduction, Challenges, Characterizing the web, Search engines, Browsing, Metasearchers, Finding the needle in the haystack, Searching using hyperlinks.

Total:45 Periods

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REFERENCES:

1. Ricardo Baeza – Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search" (ACM Press Books), Second Edition, 2011.
2. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, First South Asian Edition, 2008.
3. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval Implementing and Evaluating Search Engines", The MIT Press, Cambridge, Massachusetts London, England, 2010.
4.David A. Grossman, Ophir Frieder: Information Retrieval Algorithms and Heuristics, 2nd Edition, Springer, 2009.
5. William B. Frakes, Ricardo Baeza-Yates (Editors): Information Retrieval Data Structures and Algorithms, 1st edition, Prentice Hall PTR, 2009.

Course Outcome: At the end of the course the student will be able to

CO 1: Build an Information Retrieval system using the available tools.
CO 2: Identify and design the various components of an Information Retrieval System.
CO 3: Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.
CO 4: Design an efficient search engine and analyze the Web content structure.

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315MCE10 Vehicular Adhoc Networks

L	T	P	C
3	0	0	3

PREREQUISITES: Wireless Sensor Network, Mobile Adhoc Networks

OBJECTIVES:

- To have a thorough understanding on the basic concepts of VANET.
- To understand VANETs to promote Traffic Safety.
- To gain knowledge on networking, localization of VANET and its simulation tools.
- To recognize VANETs in emerging application of internet, distributed gaming and the fast growing Mobile entertainment industry.

UNIT I INTRODUCTION **9**

Traffic Monitoring: Causes of congestion, Traffic Monitoring Data, Common Applications of Traffic Data, Commonly used sensor technology, Detection methods.

UNIT II TRAFFIC ENGINEERING **9**

Models for Longitudinal Vehicle Movement, Lane changes situations, simulating Vehicle-to-Vehicle, Infrastructure -to-Vehicle Communication.

UNIT III NETWORKING **9**

Mobile Ad Hoc routing in the context of Vehicular Networks: Applicability of MANET Routing to Vehicular environment, Routing protocols for VANET. Delay -Tolerant Networks: Deterministic/Stochastic Delay-Tolerant Routing, Vehicle Traffic Model, Vehicle- Roadside Data Access, Data Dissemination in VANETs.

UNIT IV LOCALIZATION AND SIMULATION **9**

Localization-Aware VANET applications, Localization Techniques for VANETs, Data Fusion in VANET Localization Systems, Vehicular Mobility Models, Vehicular Network Simulators.

UNIT V APPLICATIONS **9**

Safety related vehicular applications, Emerging vehicular applications, Use of Infrastructure in VANETs, Content delivery in Zero – Infrastructure VANETS.

TOTAL HOURS: 45

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Krishnagiri (Dt), Tamil Nadu.

REFERENCES:

1.Stephan Olariu, Michele C. Weigle, "Vehicular Networks from Theory to practice" , CRC Press.
2. Hassnaa Moustafa and Yan Zhang, " Vehicular Networks: Techniques, Standards and Applications ," Auerbach Publications, 2009.
3. C. Siva Ram Murthy and B.S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols," Prentice Hall, 2012.
4. William Stallings, " Wireless Communications and Networks ," Prentice Hall, 2015

COURSE OUTCOMES:

At the End of the Course the Students will be able to,

CO1: Understand the basic concepts of VANET.
CO2: Gain knowledge on traffic and its safety in VANET.
CO3: Get overview of networking, localization techniques and simulation tools used in VANET.
CO4: Students can work in various applications in VANET and address key research challenges.

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315MCE11 Real Time Systems

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PREREQUISITES: NIL

OBJECTIVES

- To provide good understanding of Basics concepts in real time systems.
- To provide understanding on basic multi-task scheduling algorithms for periodic, aperiodic ,and sporadic tasks as well as understand the impact of the latter two on scheduling
- Real time programming and Tools
- To expose to real time communications and databases.
- To provide good understanding of Fault tolerance, Reliability.

UNIT-I INTRODUCTION **9**

Real-time systems – Applications – Basic Model – Characteristics – Safety and Reliability – Real Time tasks – Timing Constraints – Modelling Timing Constraints.

UNIT II SCHEDULING REAL-TIME TASKS **9**

Concepts – Types of RT Tasks and their Characteristics – Task Scheduling – Clock-Driven Scheduling – Hybrid Schedulers - Event-Driven Scheduling – EDF Scheduling – RMA – Issues with RMA – Issues in Using RMA in Practical Situations.

UNIT-III PROGRAMMING LANGUAGES AND TOOLS **9**

Desired characteristics based on ADA, Data Typing, Control structures, Packages, Exception handling, Overloading Multitasking, Timing Specifications, Task scheduling, Just in time compilation, Run time Support.

UNIT-IVREAL TIME DATABASES **9**

Real time Databases, Basic Definition, Real time Vs General Purpose Databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time systems.

UNIT-V RTS DEVELOPMENT METHODOLOGIES AND EVALUATIO TECHNIQUES **9**

Introduction, Yourdon methodology, Requirements definition for Drying oven, Ward and Mellor methodology, Hatley and Pirbhai method for real time software development. **Evaluation Techniques-**Fault types, Fault detection and Containment, Reliability Evaluation Techniques, Obtaining Parameter Values, Reliability Models for Hardware Redundancy.

TOTAL HOURS: 45

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REFERENCE BOOKS:

1. Rajib Mall, "Real-Time Systems: Theory and Practice," Pearson, 2008.
2. C.M. Krishna, Kang G. Shin, "Real-Time Systems", McGraw-Hill International Editions, 1997
3. Stuart Bennett, "Real Time Computer Control-An Introduction",Second edition Perntice Hall PTR, 1994.
4. Krishna and Shin, "Real-Time Systems," Tata McGraw Hill. 1999.
5. Philip.A.Laplante "Real Time System Design and Analysis" PHI , III Edition, April 2004.
6. Jane S Liu "Real Time Systems" Pearson Education 2004
7. KVKK Prasad "Embedded Real Time Systems, Concepts, Design and Programming" Dream Teach 2003
8. R.J.A Buhur, D.L. Bailey, " An Introduction to Real-Time Systems", Prentice-Hall International, 1999.
9. S.T. Allworth and R.N. Zobel, "Introduction to real time software design", Macmillan, II Edition, 1987.

COURSE OUTCOME:

At the end of course the students will be able to

- Understand the basics and importance of real-time systems
- Understand basic multi -task scheduling algorithms for periodic, aperiodic, and sporadic tasks as well as understand the impact of the latter two on scheduling
- Generate a test plan based on requirements specification
- Expose to real time Evaluation Techniques

315MCE12 **MULTI CORE ARCHITECTURE** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the students to the recent trends in the field of Computer Architecture and identify performance related parameters.
- To understand the design of the memory hierarchy
- To understand the different multiprocessor issues
- To expose the different types of multicore architectures

UNIT - I FUNDAMENTALS OF COMPUTER DESIGN AND ILP 9

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges – Limitations of ILP – Multithreading – SMT and CMP Architectures – The Multicore era

UNIT - II MEMORY HIERARCHY DESIGN 9

Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies

UNIT - III MULTIPROCESSOR ISSUES 9

Symmetric and Distributed Shared Memory Architectures – Cache Coherence Issues – Performance Issues – Synchronization Issues – Models of Memory Consistency – Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks

UNIT - IV MULTICORE ARCHITECTURES 9

Homogeneous and Heterogeneous Multi-core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-scale computers, Cloud Computing – Architectures and Issues – Case Studies.

UNIT - V VECTOR, SIMD AND GPU ARCHITECTURES 9

Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing – Detecting and Enhancing Loop Level Parallelism.

Total Hours: 45

COURSE OUTCOMES:

At the End of the Course the Students will be able to,

CO1: Identify the limitations of ILP and the need for multicore architectures
CO2: Discuss the issues related to multiprocessing and suggest solutions
CO3:Point out the salient features of different multicore architectures and how they exploit parallelism
CO4:Critically analyze the different types of inter connection networks
CO5:Design a memory hierarchy and optimize it

REFERENCES

1. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier, 5th edition, 2012.
2. Darryl Gove, "Multicore Application Programming: For Windows, Linux, and Oracle Solaris", Pearson, 2011.
3. David B. Kirk, Wen-mei W. Hwu, "Programming Massively Parallel Processors", Morgan Kauffman, 2010.
4. Wen– mei W. Hwu, "GPU Computing Gems", Morgan Kaufmann / Elsevier, 2011

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