

## Advanced Database Management System

### Teaching Scheme:

Theory Hours: 04 Hrs/Week  
Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	<b>Parallel and Distributed Databases :</b> Architectures for parallel database, Parallel query Evaluation, Parallelizing individual operation, Parallel Query Optimization, Distributed DBMS Architecture, Storing data in distributed DBMS, Distributed Catalog Management, Distributed query processing, Updating distributed data, Distributed concurrence control, Distributed recovery.	[ 08 Hrs]
<b>Unit II</b>	<b>Web databases :</b> Web search engines, web search architecture, Inverted indexes the IR way, Inverted indexes for web search engines, web crawling, web search statistics.	[ 08 Hrs]
<b>Unit III</b>	<b>Data Warehousing:</b> Introduction Data Warehousing OLAP, Implementation Techniques for OLAP, Views and decision support. <b>Data Mining:</b> Introduction, Counting Co-occurrences, Mining for rules, Tree structured rules, Clustering, Similarity search over sequences, Additional data mining tasks.	[ 08 Hrs]
<b>Unit IV</b>	<b>Object Database Systems:</b> User defined abstract data types, Structured types, Objects, Objects Identity and Reference types, Inheritance, database design for an ORDBMS, Comparing RDBMS with OODBMS and ORDBMS. <b>XML:</b> Introduction, Structure of XML Data, XML Document Schema, Querying and Transformation, API to XML, Storage of XML Data, XML Applications.	[ 08 Hrs]
<b>Unit V</b>	<b>Spatial Data Management :</b> Types of Spatial Data and Queries Application involving Spatial data, Introduction to spatial Indexes, Indexing based on space filling Curves, Grid files, R trees, High command Indexing.	[ 08 Hrs]
<b>Unit VI</b>	<b>Deductive Databases:</b> Recursive Queries, Theoretical foundation, Recursive Queries with Negation, Efficient evaluation of Recursive Queries, Additional Transaction Processing, Advance transaction processing Integrated access to Multiply data sources, Mobile database, multiplying database, Geographic Information systems, Temporal and Sequence database, Information Visualization. <b>Advanced Transaction Processing:</b> Transact ion-Processing Monitors, Transactional Workflows, Main- Memory Databases, Real-Time Transaction Systems, Long-Duration Transactions and Transaction Management in Multi-databases.	[ 08 Hrs]

#### References:

- [1] Rob & Colonel, "Database System Design Implementation & Management", Thomson Learning
- [2] Date, "An Introduction to database system", Addison Wesley Pub.
- [3] Desai "Principles of Repagination database", Galgotia Publications
- [4] Mallach, "Decision Support and Data Warehouse Systems", TMH
- [5] Raghu Ram Krishnan, "Database Management Systems", IInd edition
- [6] Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", 5th Edition , McGraw Hill International Edition.
- [7] Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Systems", Morgan Kaufmann publishers

#### Syllabus for Unit Test

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Advanced Software Engineering

### Teaching Scheme:

Theory Hours: 04 Hrs/Week  
Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	Software Development Process: Software Processes, SDLC Models, Waterfall Model, The V Model, Prototyping Model, Iterative Model, Spiral Model. Agile Development, Agile Principles, XP, Scrum, AUP, Kanban, ASD, DSDM, FDD, Agile practices, Empirical Model in Software engineering.	[ 08 Hrs]
<b>Unit II</b>	Requirement Engineering: Requirements phase and its importance, Requirement Elicitation and Analysis, Process models (DFD), Data models (ERD), Software, Requirement Specification Standard and Preparation, Characteristics of good SRS Documents, traceability matrix and its importance, CASE tool, and its basic features. Black box testing: Test case design and implementation, Automated testing and limitations, debugging methods, Black box testing methods.	[ 08 Hrs]
<b>Unit III</b>	Process Improvement and Verification: Process and product quality, Process classification, Process Measurement, Process Analysis and Modelling, Process change, The CMMI process improvement framework, Configuration Management Planning, Change management, Version and release management, System building, CASE tools for configuration management.	[ 08 Hrs]
<b>Unit IV</b>	User interface Design, Maintenance and reengineering: User interface design issues: The UI design process, User analysis, User interface prototyping, Interface Evaluation. Software Maintenance: Reengineering, Business process reengineering, software reengineering, reverse engineering, restructuring, Forward engineering, The economics of reengineering.	[ 08 Hrs]
<b>Unit V</b>	Software Reuse, CBSE: The reuse landscape, Design patterns, Frameworks, Generator based reuse, Application frameworks, Application system reuse, components and component models, The CBSE process, component composition, service oriented software engineering - services as reusable components, service engineering, software development with services.	[ 08 Hrs]
<b>Unit VI</b>	Quality Management - Quality Concepts, Software Quality, The review technique, cost impact of software defects, defect amplification and removal, Review metrics and their use, Reviews: A formal spectrum, Informal spectrum, Formal technical reviews, SQA: Background issues, Elements of SQA: SQA tasks, goals and metrics, Formal approaches to SQA: statistical SQA, Software reliability. The ISO 9126 quality factors, Mc Call's quality factors, The SQA plan.	[ 08 Hrs]

### References:

- [1] Ian Sommerville, "Software Engineering: Update", 8th Edition
- [2] Roger S. Pressman and Roger, "Software Engineering: A Practitioner's Approach"
- [3] Shari Lawrence Pfleeger and Joanne M Atlee, "Software Engineering", 3rd Edition

### **Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Mobile Operating Systems

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Total Credits: 4

<b>Unit I</b>	Brief History of Mobile Operating Systems: OS- Interfaces, Multilevel Views of OS, Categories, Small and Specialized OS, 64-Bit OS, Processes and Threads, System Performance and Models: Performance of Computer Systems, Performance Metrics, Workload and System Parameters, Simulation Models: Types, Discrete-Event Model, Stochastic Model.	[ 08 Hrs]
<b>Unit II</b>	System with Multiprogramming, Processor Scheduling, Synchronization, Deadlocks, File Management, Memory Management: Process Address Space, Contiguous Memory Allocation, Non Contiguous Memory Allocation, Virtual Memory, Paging with Virtual Memory.	[ 08 Hrs]
<b>Unit III</b>	Security and Protection Components for Security and Protection, Physical Security, User Authentication, Protection, Secure Communications, Digital Certificates, System Vulnerabilities, Invasive and Malicious Software, Defending the System and User, Intrusion Detection Management.	[ 08 Hrs]
<b>Unit IV</b>	Mobile Ecosystems: Application Framework, Developing a Mobile Strategy, Mobile Information Architecture, Mobile Design: Elements of Mobile Design, Ubiquity in the Mobile Web, Mobile Web Development.	[ 08 Hrs]
<b>Unit V</b>	Introduction to Using Linux Command Line Interface, Files and Directories, Shell Variables, Script Files, Connecting a Remote Linux Server. Java Modeling Framework, Java and Posix Threads.	[ 08 Hrs]
<b>Unit VI</b>	Case Study: Android SDK, iOS, Windows, Mobile Web Apps vs. Mobile Applications.	[ 08 Hrs]

### References:

- [1] Jose M Garrido, Richard Schlesinger, Kenneth Hoganson, Principles of Modern Operating Systems.
- [2] By Brian Fling, Mobile Design and Development: Practical concepts and techniques for Creating Mobile Sites and Web Apps, O'Reilly Publications
- [3] Brian Fling, Mobile Design and Development, O'Reilly Publications

### Syllabus for Unit Test

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Distributed Computing

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Total Credits: 4

<b>Unit I</b>	Distributed System Concepts: Distributed Computing Models, Software Concepts, Issues in Designing Distributed Systems Client-Server Model. Case Studies. Network Communication: LAN and WAN Technologies, Protocols for Network Systems, Asynchronous Transfer Mode, Protocols for Distributed Systems.	[ 08 Hrs]
<b>Unit II</b>	Interprocess Communication Message Passing, Advantages and Features of Message Passing Systems, IPC Message Format, IPC Synchronization, Message Buffering Strategies, Multidatagram Messaging, Process Addressing Techniques, Failure Handling Mechanism. Case Study: IPC in Mach	[ 08 Hrs]
<b>Unit III</b>	Remote Communication: Introduction, Remote Procedural Call, RPC Implementation, RPC Implementation, Parameter Passing Semantics, Server Management, RPC Call Semantics, Communication Protocols, Client Server Binding, Exception Handling and Security, RPC in Heterogeneous Environment, Failure Handling, RPC Optimization, Case Study: Sun RPC, Java RMI.	[ 08 Hrs]
<b>Unit IV</b>	Synchronization: Clock Synchronization, Physical Clocks, Clock Synchronization Algorithms, Logical Clocks, Global State, Mutual Exclusion, Election Algorithms, Deadlocks: Prevention, Detection Recovery, Deadlocks in Message Communication.	[ 08 Hrs]
<b>Unit V</b>	Distributed System Management: Resource Management, Task Assignment Approach, Load Balancing Approach, Load Sharing Approach, Process Management in Distributed Environment, Process Migration, Threads, Fault Tolerance, Component Faults, System Failures and Use of Redundancy.	[ 08 Hrs]
<b>Unit VI</b>	Distributed Shared Memory: Architecture, Types of DSM, Hardware DSM, and Design Issues in DSM Systems. Distributed File Systems, Naming, Security in Distributed Systems, Real Time Distributed Operating System, Distributed Database Management System, Emerging Trends in Distributed Computing.	[ 08 Hrs]

### References:

- [1] H. Attiya, J. Welch Distributed Computing - Fundamentals, Simulation and Advanced Topics, Wiley Publications.
- [2] Vijay Garg, Elements of Distributed Computing, Wiley Publications.
- [3] S. Mahajan, S. Shan, Distributed Computing, Oxford Publications.

### Syllabus for Unit Test

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## High Performance Computing

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	Computer organization: Memory, Registers, Instruction set architecture, Instruction processing, Pipelined processors: Pipelining, Structural, data and control hazards, Impact on programming. Cache memory: Organization, impact on programming, virtual caches, Operating systems: Processes and system calls, Process management, Program profiling.	[ 08 Hrs]
<b>Unit II</b>	Modern Computer Architectures - Memory, Floating-Point Numbers, Programming and Tuning Software - What a Compiler Does, Timing and Profiling, Eliminating Clutter, Loop Optimizations, Program execution, Program, Compilation, Object files, Function call and return, Address space, Data and its representation. Parallel Processing Concepts - Levels of parallelism instruction, transaction, task, thread, memory, and function, Models SIMD, MIMD, SIMT, SPMD, Dataflow Models, and Demand-driven Computation etc. Case Study: Cluster Computing network.	[ 08 Hrs]
<b>Unit III</b>	Parallel Algorithms: Parallel models: ideal and real frameworks, Basic Techniques: Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Regular Algorithms: Matrix operations and Linear Algebra, Irregular Algorithms: Lists, Trees, Graphs, Randomization: Parallel Pseudo-Random Number Generators, Sorting, Monte Carlo techniques	[ 08 Hrs]
<b>Unit IV</b>	Parallel Programming: Revealing concurrency in applications, Task and Functional Parallelism, Task Scheduling, Synchronization Methods, Parallel Primitives (collective operations), SPMD Programming (threads, OpenMP, MPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, Star-P, Matlab MPI), Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays).	[ 08 Hrs]
<b>Unit V</b>	High-End Computer Systems: Memory Hierarchies, Multi-core Processors: Homogeneous and Heterogeneous, Shared-memory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Supercomputers and Petascale Systems, Application Accelerators / Reconfigurable Computing, Novel computers: Stream, multithreaded, and purpose-built, Architectures: N-wide superscalar architectures, multi-core, multi-threaded.	[ 08 Hrs]
<b>Unit VI</b>	Achieving Performance: Performance metrics and measurements, Measuring performance, Identifying performance bottlenecks, Restructuring applications for deep memory hierarchies, Partitioning applications for heterogeneous resources, Using existing libraries, tools, and frameworks, CASE tools.	[ 08 Hrs]

### References:

- [1] "Highly Parallel Computing", by George S. Almasi and Alan Gottlieb
- [2] "Advanced Computer Architecture: Parallelism, Scalability, Programmability", by Kai Hwang, McGraw Hill 1993
- [3] "Parallel Computer Architecture: A hardware/Software Approach", by David Culler Jaswinder Pal Singh, Morgan Kaufmann, 1999.
- [4] "Scalable Parallel Computing", by Kai Hwang, McGraw Hill 1998.

- [5] "Principles and Practices on Interconnection Networks", by William James Dally and Brian Towles, Morgan Kaufman 2004.
- [6] GPU Gems 3 --- by Hubert Nguyen (Chapter 29 to Chapter 41)
- [7] Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Wesley, © 2003.
- [8] Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, © 2007.
- [9] J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
- [10] Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, John Wiley.
- [11] R. E. Bryant and D. R. O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall.
- [12] John Levesque (Author), Gene Wagenbreth (Author), High Performance Computing: Programming and Applications (Chapman & Hall/CRC Computational Science)

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI



## Advanced Computer Algorithms

### Teaching Scheme:

Theory Hours: 04 Hrs/Week  
Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	<b>Introduction :</b> Asymptotic notation, Models of Computation, Algorithm & their complexity, Random Analysis machines, Computational complexity of RAM programs, A stored program model, Abstractions of the RAM, A primitive model of computation(Turing Machines),Relational between Turing machine & RAM model ,Pidgin ALGOL A high level lang.	[ 08 Hrs]
<b>Unit II</b>	<b>Algorithm Analysis:</b> Analyzing Algorithm, Designing Algorithm, Time & Space Complexity, Average & Worst case analysis, Lower Bounds. <b>Algorithm Design techniques:</b> Divide & Conquer, Search Traversals, Dynamic Programming, Backtracking, Branch & Bound, Greedy Algorithm.	[ 08 Hrs]
<b>Unit III</b>	<b>Sorting and Searching Algorithm :</b> The Sorting problem, Radix Sorting, Sorting by comparison, Heap sort-an $O(n \log n)$ comparison sort, Quick Sort-an $O(n \log n)$ expected time sort, Expected time for Order statistics, Binary Search, binary search trees, optimal binary search tree, B-Trees Algorithms on graph: Elementary graph Algorithm, Minimum spanning tree, Single Source shortest Path, All pairs shortest path	[ 08 Hrs]
<b>Unit IV</b>	<b>String Processing Algorithm:</b> The naïve string matching, The Robin-Karp algorithm, String matching with Finite Automata, Knuth Morris Pratt Algorithm <b>Divide and conquer method:</b> Binary search, Mergesort, Quick sort, Strassen's matrix multiplication. <b>The Greedy method:</b> Knapsack problem, job sequencing, optimal merge patterns, minimal spanning trees.	[ 08 Hrs]
<b>Unit V</b>	<b>Dynamic Programming:</b> Multistage graphs, OBST, 0/1 Knapsack, traveling sales man problem. <b>Back Tracking:</b> Eight Queens problem, graph coloring, Hamiltonian cycles, Knapsack problem, Maze problem. <b>Branch &amp; Bound:</b> 0/1 Knapsack, Traveling salesman problem lower bound theory-comparisons trees for sorting/searching, lower bound on parallel computation.	[ 08 Hrs]
<b>Unit VI</b>	<b>NP-hard and Np-complete problems-</b> Algorithms, Complexity- intractability, Non-Deterministic Polynomial time ( NP) Decision problems, cooks Theorem, NP-Complete problems- statisfiability problem, vertex cover problem. NP-Hard problems-graph, scheduling, code generation problems, Simplified NP Hard Problems, Approximation Algorithm for NP Hard Problem.	[ 08 Hrs]

### References:

- [1] Bressard, "Fundamental of Algorithm"
- [2] Horowitz, Sahani, "Fundamentals of Computer Algorithms", Galgotia
- [3] Thomas H. Cormen and Charles E. L. Leiserson, "Introduction to Algorithm", PHI
- [4] V. Aho and J. D. Ullman, "Design and Analysis of Algorithms", Addison Wesley
- [5] E. V. Krishna Murthy, "Introduction to Theory of Computer"

### Syllabus for Unit Test

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Web Technologies

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks

Internal Assessment: 40 Marks

Total Credits: 4

<b>Unit I</b>	<b>Web Environment:</b> WWW, HTTP, Web Server and its deployment, N-Tier Arch., Services of Web Server – Mail server, News server, Proxy server, Multimedia server. <b>XML Primer :</b> Mark-up languages, XML, Uses of XML. WELL-FORMED XML: Parsing XML, Tags, text, elements, attributes, comments and empty elements. XML Declaration, Processing, Instructions, Errors in XML XML NAMESPACES: Need for namespaces, How XML namespaces work, URIs, When to use, namespace. <b>VALIDATION:</b> Document type definitions (DTD), Sharing vocabularies, Anatomy of DTD, Developing DTDs, DTD Limitations. <b>XML SCHEMAS:</b> Benefit of XML schemas, Elements of XML Schema Definition, Creating a Schema from multiple documents. XPATH, XSLT, Xquery	[ 08 Hrs]
<b>Unit II</b>	<b>JSP :</b> JSP overview, JSP language basics, JSP translation and compilation directives, Standard java objects from JSP, JSP configuration and deployment, actions and tags of JSP; Java servlets – Arch, servlet interface, applications of servlets.	[ 08 Hrs]
<b>Unit III</b>	<b>ASP :</b> Objects and Components, Handling databases, Data Retrieval from Databases, applications of ASP, session management, ASP with .NET	[ 08 Hrs]
<b>Unit IV</b>	<b>Web Technologies :</b> Server side programs. CGI programs. Client side scripts. The Applet Concept. Search Engine Optimization: Strategies, Optimizing Search strategies, Robots, Spiders and Crawlers, Mobile Search Engine Optimization.	[ 08 Hrs]
<b>Unit V</b>	<b>The Web as an example of client server computing :</b> Characteristics of web servers: handling permissions. File Management Capabilities of common server architectures .Role of client Computer. Nature of Client server relationship. Web protocols Support tools for website creation and management. Developing Internet Information servers. Publishing information and application.	[ 08 Hrs]
<b>Unit VI</b>	<b>Building Web applications :</b> Protocols at the application layer. Principles of Web engineering. Database driven websites. RPC. Lightweight distributed objects. The role of the middleware. Support tools. Security issues in Distributed object systems. Enterprise- wide web base.	[ 08 Hrs]

### References:

- [1] Information Architecture for the World Wide Web, Peter Morville and Louis Rosenfield, O'REILLY, 2007
- [2] Internet and World Wide Web: How to Program, Deitel and Deitel, 4th Edition, Prentice Hall, 2009
- [3] Beginning XML, David Hunter et al, 4th Edition, Wrox/John Wiley, 2007
- [4] Herbert Schildt, "Complete Reference JAVA 2", TMH

[5] Jerri L. Ledford, "Search Engine Optimization", 2<sup>nd</sup> Edition, Wiley Publication,

**Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## WIRELESS COMMUNICATION AND SECURITY

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Total Credits: 5

<b>Unit I</b>	<b>Introduction :</b> A Short history of wireless communication. A market for mobile communication. Some research topics. A simplified reference model. Wireless Transmission. <b>Frequencies for Radio Transmission:</b> Signal antennas, signal propagation. Multiplicity, modulation, spread spectrum, cellular systems.	[ 08 Hrs]
<b>Unit II</b>	<b>Medium Access Control :</b> Motivation for a specialized MAC. SDMA, FDMA, TDMA, CDMA, Comparison of S/T/F/CDMA. <b>Telecommunication Systems :</b> GSM, DECT, TETRA, UMTS.	[ 08 Hrs]
<b>Unit III</b>	<b>Satellite Systems :</b> Basics, Routing, Localization, Handover. <b>Broadcast Systems :</b> Cyclic repetition of data, digital audio broadcasting, digital video broadcasting.	[ 08 Hrs]
<b>Unit IV</b>	<b>Wireless LAN:</b> Infrared vs. radio transmission, Ad-Hoc networks, IEEE802.11, Bluetooth, Case Study on WLAN. <b>Wireless ATM :</b> Motivation for WATM, WATM services reference model, functions, radio access layer, handover, location management, addressing, mobile quality of service, access point control protocol, Case Study on WATM.	[ 08 Hrs]
<b>Unit V</b>	<b>Mobile Network Layer :</b> Mobile IP, Dynamic host configuration protocol, Ad-hoc Networks. <b>Mobile Transport Layer :</b> Traditional TCP, Indirect TCP, Mobile TCP.	[ 08 Hrs]
<b>Unit VI</b>	<b>Performance Issues :</b> QOS issues, Security issues, Non line of sight issues, Power control issues. <b>Security</b> Encryption and Authentication, Key pre-distribution and management, Secure Ad-Hoc Networks, Denial-of-Service Attacks, Energy-aware Security Mechanisms	[ 08 Hrs]

### References:

- [1] Jochen Schiller, "Mobile Communication", Pearson Education, Asia
- [2] Mallick, "Mobile and Wireless Design Essentials", Wiley computer publication
- [3] Andy Dornan, "The Essential Guide of Wireless Communications Applications", Pearson Education Asia
- [4] Weisman, "The Essential guide to RF and wireless", Pearson Education Asia
- [5] Lee, "Mobile Cellular Telecommunications", MGH

### **Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Elective I : E-Commerce and ERP

### Teaching Scheme:

Theory Hours: 04 Hrs/Week  
Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	Ecommerce business models and concepts, EC infrastructure, Ecommerce -Frame work, anatomy of E-Commerce applications  E-Commerce Consumer applications, E-Commerce organization. Applications. Consumer Oriented Electronic commerce - Mercantile Process models	[ 08 Hrs]
<b>Unit II</b>	ESecurity and payment systems, Electronic payment systems - Digital Token-Based, Smart Cards, Credit Cards, Risks in Electronic Payment systems. Inter Organizational Commerce - EDI, EDI Implementation, Value added networks.	[ 08 Hrs]
<b>Unit III</b>	Concepts and communications, ethical, social and political EC issues, Intra Organizational Commerce - work Flow, Automation Customization and internal Commerce, Supply chain Management. Corporate Digital Library - Document Library, digital Document types, corporate Data Warehouses. Advertising and Marketing - Information based marketing, Advertising on Internet, on-line marketing process, market research. Marketing, online retailing, services, content and media, social networks.	[ 08 Hrs]
<b>Unit IV</b>	Introduction To ERP: Evolution of ERP, What is ERP? Reasons for the growth of ERP, Scenario and Justification of ERP in India, Evaluation of ERP, Various Modules of ERP, Advantage of ERP.	[ 08 Hrs]
<b>Unit V</b>	An overview of Enterprise, Integrated Management Information, Business Modeling, ERP for Small Business, ERP for make to order companies, business Process Mapping for ERP Module Design, Customized ERP,Hardware Environment and its Selection for ERP Implementation.	[ 08 Hrs]
<b>Unit VI</b>	ERP Market: Introduction, SAP AG, Baan Company, Oracle Corporation, People Soft, JD Edwards World Solutions Company, System Software Associates, Inc. (SSA) QAD, A Comparative Assessment and Selection of ERP Packages and Modules.ERP implementation lifecycle, issues in implementing Vendors, Consultants and users, In-House Implementation - pros and cons, vendors, consultants, end user.	[ 08 Hrs]

### References:

1. Laudon K., C. G. Traver, E-Commerce Prentice Hall, 2010
2. William S. Davis, John Benamati, E-Commerce Basics: Technology Foundations and E-Business Applications, Prentice Hall
3. Enterprise Resource Planning – Alexis Leon
4. ERP Ware: ERP Implementation Framework – V.K. Garg & N.K. Venkitakrishnan

### **Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI



## Elective I : Information Storage and Management

### Teaching Scheme:

Theory Hours: 04 Hrs/Week  
Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	<b>Introduction to Storage Technology</b> Data proliferation and the varying value of data with time & usage, Sources of data and states of data creation, Data center requirements and evolution to accommodate storage needs, Overview of basic storage management skills and activities, Traditional file storage and its pitfalls. The five pillars of technology, Overview of 12 storage infrastructure components, Evolution of storage, Information Lifecycle Management concept, Data categorization within an enterprise, Storage and Regulations.	[ 08 Hrs]
<b>Unit II</b>	<b>Storage Systems Architecture</b> Intelligent disk subsystems overview, Contrast of integrated vs. modular arrays, Component architecture of intelligent disk subsystems, Disk physical structure components, properties, performance, and specifications, Logical partitioning of disks, RAID & parity algorithms, hot sparing, Physical vs. logical disk organization, protection, and back end management, Array caching properties and algorithms, Front end connectivity and queuing properties, Front end to host storage provisioning, mapping, and operation, Interaction of file systems with storage, Storage system connectivity protocols.	[ 08 Hrs]
<b>Unit III</b>	<b>Introduction to Networked Storage</b> JBOD, DAS, SAN, NAS, & CAS evolution, Direct Attached Storage (DAS) environments: elements, connectivity, & management, Storage Area Networks (SAN): elements & connectivity, Fibre Channel principles, standards, & network management principles, SAN management principles, Network Attached Storage (NAS): elements, connectivity options, connectivity protocols (NFS, CIFS, ftp), & management principles IP SAN elements, standards (SCSI, FCIP, FCP), connectivity principles, security, and management principles, Content Addressable Storage (CAS): elements, connectivity options, standards, and management principles, Hybrid Storage solutions overview including technologies like virtualization & appliances.	[ 08 Hrs]
<b>Unit IV</b>	<b>Introduction to Information Availability</b> Business Continuity and Disaster Recovery Basics, Local business continuity techniques, Remote business continuity techniques, Disaster Recovery principles & techniques. Case study: Storage Network for Business Continuity.	[ 08 Hrs]
<b>Unit V</b>	<b>Managing &amp; Monitoring:</b> Management philosophies (holistic vs. system & component), Industry management standards (SNMP, SMI-S, CIM), Standard framework applications, Key management metrics (thresholds, availability, capacity, security, performance), Metric analysis methodologies & trend analysis, Reactive and pro-active management best practices, Provisioning & configuration change, Problem reporting, prioritization, and handling techniques, Management tools overview	[ 08 Hrs]
<b>Unit VI</b>	<b>Information storage on cloud</b> :Concept of Cloud, Cloud Computing, storage on Cloud, Cloud Vocabulary, Architectural Framework, Cloud benefits, Cloud computing Evolution, Applications & services on cloud, Cloud service providers and Models, Essential characteristics of cloud computing, Cloud Security and integration. (08 hours)	[ 08 Hrs]

### References:

- 1) Information Storage and Management Storing, Managing, and Protecting Digital Information , by EMC, Hopkinton and Massachusetts, Wiley, ISBN:9788126521470
- 2) G. Somasundaram & Alok Shrivastava (EMC Education Services) editors; Information Storage and Management: Storing, Managing, and Protecting Digital Information; Wiley India.
- 3) Ulf Troppens, Wolfgang Mueller-Friedt, Rainer Erkens, Rainer Wolafka, Nils Haustein; Storage Network explained: Basic and application of fiber channels, SAN, NAS, iSES, INFINIBAND and FCOE, Wiley India.
- 4) John W. Rittinghouse and James F. Ransome; Cloud Computing : Implementation , Management and Security, CRC Press, Taylor Frances Pub.

**Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Elective I : Cyber Security

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

Practical: 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks

Internal Assessment: 40 Marks

Term Work : 25 Marks

Oral: 25 Marks

Total Credits: 5

<b>Unit I</b>	<b>Cyber Security Fundamentals</b> Network and Security Concepts, Authentication, Authorization, Non repudiation, Confidentiality, Integrity, Availability, Basic Cryptography, Symmetric Encryption, Public Key Encryption, The Domain Name System, Firewalls, Virtualization, Microsoft Windows Security Principles	[ 08 Hrs]
<b>Unit II</b>	<b>Attacker's Techniques</b> Types of Proxies, Tunneling Techniques, Phishing, Smishing, Vishing, and Mobile Malicious Code Threat Infrastructure.	[ 08 Hrs]
<b>Unit III</b>	<b>Exploitation</b> Shell code, Stack-Based Buffer Overflows, Format String Vulnerabilities, Malicious PDF Files, Race Web Exploit Tools, Brute Force and Dictionary Attacks, Misdirection, Reconnaissance, and Disrupt Cross-Site Scripting, DNS Amplification Attacks.	[ 08 Hrs]
<b>Unit IV</b>	<b>Malicious Code</b> Self-Replicating Malicious Code, Virtual Machine Obfuscation, Persistent Software Techniques, H Privileged User Accounts and Escalation of Privileges, Token Kidnapping, Man-in-the-Middle Att	[ 08 Hrs]
<b>Unit V</b>	<b>Defense and Analysis Techniques</b> Memory Forensics, Capabilities of Memory Forensics, Memory Analysis Frameworks, Installing and Using Volatility, Honey pots, Malicious Code Naming, Automated Malicious Code Analysis Sy	[ 08 Hrs]
<b>Unit VI</b>	<b>Cyber Security Real World Impact:-</b> Cyber security and internal political security, International conflict in cyberspace, Nation-state cyber attack mitigation strategies, IP V6 address space, Improved security, privacy concerns, uneven world wide deployment. Case study	[ 08 Hrs]

### References:

[1] Cyber security essentials by James Graham, Richard Howard, Ryan Olson

[2] Strategic Cyber Security by Kenneth Geers.

### Syllabus for Unit Test

Unit Test I	Unit I, II, III
Unit Test II	Unit IV, V, VI

## Elective I : BIG DATA ANALYTICS

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks

Internal Assessment: 40 Marks

Term Work : 25 Marks

Oral: 25 Marks

Total Credits: 5

<b>Unit I</b>	Introduction to Big data, Data Exposition, Types of data, Need for big data, Big data & its sources, Three Characteristics of big data, Challenges of Conventional Systems – Big data Problem, Traditional IT Analytics Approach, Big data use cases, Handling limitations of Big data, big data platform. Evolution of Analytic Scalability.	[ 08 Hrs]
<b>Unit II</b>	Big Data Storage and Computing Platforms: Traditional RDBMS, NoSQL, NewSQL, and Hadoop, Parallel computing systems, Programming models for batch, interactive, and streaming applications, Trade-offs between programming models, Survey of new emerging database and storage systems for Big Data, Tradeoffs between reduced consistency, performance, and availability, MangoDB: Introduction, overview, Design Goals for MangoDB, MangoDB shell, MangoDB applications, Multimedia database application.	[ 08 Hrs]
<b>Unit III</b>	Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear Systems Analysis - Nonlinear Dynamics - Rule Induction - Neural Networks: Learning And Generalization - Competitive Learning - Principal Component Analysis and Neural Networks - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees - Stochastic Search Methods.	[ 08 Hrs]
<b>Unit IV</b>	Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.	[ 08 Hrs]
<b>Unit V</b>	Mining Frequent Itemsets - Market Based Model – Apriori Algorithm – Handling Large Data Sets in Main Memory – Limited Pass Algorithm – Counting Frequent Itemsets in a Stream – Clustering Techniques – Hierarchical – K-Means – Clustering High Dimensional Data – CLIQUE And PROCLUS – Frequent Pattern based Clustering Methods – Clustering in Non-Euclidean Space – Clustering for Streams and Parallelism.	[ 08 Hrs]
<b>Unit VI</b>	MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Visualizations - Visual Data Analysis Techniques - Interaction Techniques; Systems and Analytics Applications - Analytics using Statistical packages-Approaches to modeling in Analytics – correlation, regression, decision trees, classification, association-Intelligence from unstructured information-Text analytics-Understanding of emerging trends and technologies-Industry challenges and application of Analytics.	[ 08 Hrs]

**TEXT BOOKS:**

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Ohlhorst, Frank J. Big Data Analytics: Turning Big Data into Big Money. Copyright © 2012 SAS Institute Inc., Cary, North Carolina, USA.
3. AnandRajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
4. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley & sons, 2012.
5. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007
6. Pete Warden, "Big Data Glossary", O'Reilly, 2011.
7. Jiawei Han, MichelineKamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.

**Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Elective II : Cryptography and Network Security

### Teaching Scheme:

Theory Hours: 04 Hrs/Week  
Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	Introduction: Services, Mechanisms and Attacks, The OSI Security Architecture, A Model for Network Security. Symmetric Ciphers: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography. Block Ciphers and the Data Encryption Standard: Simplified DES, Block Cipher Principles, The Data Encryption Standard, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of Operation.	[ 08 Hrs]
<b>Unit II</b>	Introduction to Finite Fields: Groups, Rings, Fields, Modular Arithmetic, Euclid's Algorithm, Finite Fields of the Form GF, Polynomial Arithmetic, Finite Fields of the Form GF. Advanced Encryption Standard: Evaluation Criteria for AES, The AES Cipher. Contemporary Symmetric Ciphers: Triple DES, Blowfish, RC5, Characteristics of Advanced Symmetric Block Ciphers, RC4 Stream Cipher. Confidentiality Using Symmetric Encryption: Placement of Encryption Function, Traffic Confidentiality, Key Distribution, Random Number Generation.	[ 08 Hrs]
<b>Unit III</b>	Public-Key Encryption and Hash Functions: Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms. Public-Key Cryptography and RSA, Principles, The RSA Algorithm, Key Management, Diffie Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography	[ 08 Hrs]
<b>Unit IV</b>	Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions. Hash Algorithms: MD5 Message Digest Algorithm, Secure Hash Algorithm, RIPEMD-160, HMAC, Digital Signatures, Authentication Protocols, Digital Signature Standard.	[ 08 Hrs]
<b>Unit V</b>	Authentication Applications: Kerberos, X.509 Authentication Service, E-mail Security, Pretty Good Privacy, S/MIME, IP Security, Architecture, Authentication Header, Encapsulation Security Payload, Combining Security Associations, Key Management Web Security: Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction.	[ 08 Hrs]
<b>Unit VI</b>	System Security: Intruders, Intrusion Detection, Password Management. Malicious Software, Firewalls: Firewall Design Principles, Trusted Systems.	[ 08 Hrs]

**References:**

[1] William Stallings, "Cryptography and Network Security", Principles and Practices, Pearson Education, Sixth Edition.

[2] Behrouz A. Forouzan, "Cryptography and Network Security", McGraw Hill Publication

[3] Atul Kahate, "Cryptography and Network Security", McGraw Hill(India)Publication, Third Edition.

**Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Elective II : PARALLEL COMPUTING

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

<b>Unit I</b>	<b>Introduction to Parallel Programming Paradigms</b>	[ 08 Hrs]
	Types of Parallelism , Parallel Computation Models, Memory less Parallel Computers, Parallel Computers with Memory, Flynn's Taxonomy, The Data-Parallel Model, Networked Computers, The Performance of Parallel Algorithms, Amdahl's Law, Gustafson Barsis's Law, Karp-Flatt Metric, Multidimensional Meshes, Hypercube-Based Machines, Routing in Networks, The PRAM Model.	
<b>Unit II</b>	<b>Convergence of Parallel Architecture</b>	[ 08 Hrs]
	Communication Architecture, Shared Address Space, Message Passing, Convergence, Data parallel processing, Other Parallel Architectures, A Generic parallel architectures, shared memory systems and cache coherence, distributed-memory systems, interconnection networks and routing, Architectural Trends, Application Trends, Technology Trends, Supercomputers case study: Param.	
<b>Unit III</b>	<b>Programming scalable systems</b>	[ 08 Hrs]
	The message-passing model, the message-passing interface, MPI standard basic concepts of MPI: MPI_Init, MPI_Comm_size, MPI_Comm_rank, MPI_Send, MPI_Recv, MPI_Finalize, timing the MPI programs: MPI_Wtime, MPI_Wtick, collective communication: MPI_Reduce, MPI_Barrier, MPI_Bcast, MPI_Gather, MPI_Scatter, case studies: the sieve of Eratosthenes, Floyd's algorithm, Matrix-vector multiplication.	
<b>Unit V</b>	<b>Implications for Programming Models and Case Study</b>	[ 08 Hrs]
	Naming, Replication, Overhead and granularity of communication, Block Data transfer, Synchronization, Hardware Cost and Design Complexity, Case Study: Ocean, Ray trace, Data mining.	
<b>Unit VI</b>	<b>Fundamental Design issues</b> Partitioning of data, Mapping of data onto the processors, Reproducibility of results, Synchronization, Scalability and Predictability of performance, Performance & Scalability, Performance Requirements, Types of performance requirements, Performance Metrics of Parallel Systems, Communication Abstraction, Programming model requirements, Communication and Replication, Starssen's Matrix multiplication to compute complexity less than $O(n^3)$ .	[ 08 Hrs]

References:



- [1] Parallel Programming – Techniques and applications Using Networked Workstations and Parallel Computers, Barry Wilkinson and Michael Allen, Prentice Hall, 1999.
- [2] Multi-Core Programming - Increasing Performance through Software MultiThreading, Shameem Akhter and Jason Roberts, Intel Press 2006.
- [3] Parallel Programming in C with MPI and OpenMP, Michael J. Quinn, McGraw Hill 2003.
- [4] Introduction to Parallel Computing by AnanthGrama, George Karypis, Vipin Kumar, and Anshul Gupta.
- [5] Programming Massively Parallel Processors by D.Kirk and W. Hwu

**Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Elective II : WIRELESS SENSOR NETWORKS

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

Practical : 02 Hrs/Week

### Examination Scheme:

Theory: 60 Marks

Internal Assessment: 40 Marks

Term Work : 25 Marks

Oral: 25 Marks

Total Credits: 5

<b>Unit I</b>	<b>Introduction &amp; Characteristics of Wireless Sensor Networks :</b> Introduction, Brief Historical Survey of Sensor Networks. Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.	[ 08 Hrs]
<b>Unit II</b>	<b>Medium Access Control Protocols:</b> Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol, <b>Case Study:</b> IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling, ZigBee.	[ 08 Hrs]
<b>Unit III</b>	<b>Routing And Data Gathering Protocols:</b> Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Point-to-Point VPN Tunneling Protocol and Challenges-Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GAF, GPSR – Real Time routing Protocols – APTEEN, SPEED, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB,	[ 08 Hrs]
<b>Unit IV</b>	<b>Embedded Operating Systems:</b> Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS –OSPM - EYES OS. Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components - Programming in Tiny OS using NesC, Emulator TOSSIM.	[ 08 Hrs]
<b>Unit V</b>	<b>Transport Control Protocols and Middlewares for Wireless Sensor Networks</b> Traditional Transport Control Protocols: TCP (RFC 793), UDP (RFC 768), MobileIP, Introduction, WSN Middleware Principles, Middleware Architecture: Existing Middleware: MiLAN (Middleware Linking Applications and Networks), IrisNet (Internet-Scale Resource-Intensive Sensor Networks Services)	[ 08 Hrs]
<b>Unit VI</b>	<b>Applications of WSN:</b> WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications.	[ 08 Hrs]

### References:

- [1] Kazem Sohraby, Daniel Minoli and Taieb Znati, “ Wireless Sensor Networks Technology, Protocols, and Applications”, John Wiley & Sons, 2007.
- [2] Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley & Sons, Ltd, 2005.
- [3] K. Akkaya and M. Younis, “A survey of routing protocols in wireless sensor networks”, Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325—349.
- [4] Philip Levis, “ TinyOS Programming” .
- [5] Anna Ha’c, “Wireless Sensor Network Designs”, John Wiley & Sons Ltd.
- [6] Wireless sensor networks Edited by C. S. Raghavendra Pub: Springer.
- [7] Fundamentals of Sensor Network Programming: Applications and Technology By Sridhar S. Iyengar, NandanParameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley.
- [8] Ad Hoc Wireless Networks: Architectures And Protocols By Murthy Pub: Pearson Education.

**Syllabus for Unit Test**

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI

## Elective II : STORAGE AREA NETWORK

### Teaching Scheme:

Theory Hours: 04 Hrs/Week

### Examination Scheme:

Theory: 60 Marks  
Internal Assessment: 40 Marks  
Term Work : 25 Marks  
Oral: 25 Marks  
Total Credits: 5

- Unit I Information Storage and Data Centre Environment:** Information Storage, Evolution of Storage [ 08 Hrs]  
Architecture, Data Center Infrastructure, Virtualization and Cloud Computing, Application, Database Management System (DBMS), Host (Compute), Connectivity, Storage, Disk Drive Components, Disk Drive Performance, Disk I/O Controller Utilization, Host Access to Data, Direct-Attached Storage, Storage Design Based on Application Requirements and Disk Performance, Data Protection: RAID.
- Unit II Data and Information in SAN:** Data organization: File vs. Block, Object, Data store, Searchable [ 08 Hrs]  
models, File Systems, Volume Managers, Caches, Prefetching, Storage Networking Technologies, What Storage Networking Is, What to Expect from SANs, Leading up to SANs, Killer Apps for SANs
- Unit III SAN Hardware Ecosystem:** Components of an Intelligent Storage System, Front End, Cache, [ 08 Hrs]  
Back End, Physical Disk, Storage Provisioning, Virtual Storage Provisioning, Types of Intelligent Storage Systems – DAS, SAN, NAS, Comparing DAS, SAN & NAS, Host Bus Adapters, SFPs, FC Cables and Connectors, SCSI/SATA/SAS Cables and Connectors, JBODs, RAID Arrays, RAID Controllers, External Storage Boxes, Tape Drive, Tape Library, NAS Device, NAS Head, Fiber Channel Switches, Bridges, FC Appliances.
- Unit IV Storage Virtualization:** Storage Virtualization, Disk Virtualization, Block Virtualization, File [ 08 Hrs]  
Virtualization, File system Virtualization, Tape Virtualization, Tape Library Virtualization, Host Based Virtualization, Network Based Virtualization, Storage Device Virtualization.
- Unit V Protocols in SAN:** ATA and SATA, SPI – Parallel SCSI, SAS – Serial Attached SCSI, SAS Topology, [ 08 Hrs]  
SAS Devices, FC Topologies, FC Ports, FC Protocol Layers, FC WWNs, FC Addresses, FC Frame, FC Flow Control, Zoning, Lun Masking, iSCSI Topology, iSCSI Initiators and Targets, iSCSI Names and Addresses, Speeding Up iSCSI, iSCSI Advantages, iSCSI Limitation, Comparing Storage Protocols.
- Unit VI SAN Managements and Storage Systems:** Storage Management, Storage Vs. Data [ 08 Hrs]  
Classification, Information Lifecycle Management, Hierarchical Storage Management, RTO and RPO, Backup and Restore, Snapshot & CDP, De-duplication, Storage Provisioning, Storage Migration, SRM, Case study - Google FS/BigTable, Programming models: Hadoop, NAS.

### References:

- [1] Storage Area Network Essentials: A complete Guide to Understanding and Implementing SANs (Hard Cover) By Richard Barker, Paul Massigliar By Wiley 2001.
- [2] Storage Networks Explained: Basics and Application of Fibre Channel SAN, NAS iSCSI and InfiniBand By Ulf Troppens, Rainer Erkens, Wolfgang Müller Wiley 2004.
- [3] Using SANs and NAS By W. Curtis Preston, Mike Loukides.
- [4] Information Storage and Management, 2nd Edition, Edited by Somasundaram Gnanasundaram, Alok Shrivastava

Unit Test I	Unit I, II , III
Unit Test II	Unit IV, V, VI