B

Accredited By NAAC

SHIVAJI UNIVERSITY, KOLHAPUR.

Revised Syllabus of

(M.E. (Computer Science & Engineering Sem – I & IV)

To be introduced from the academic year 2010-11

(i.e. from June 2010) Onwards

(Subject to the modifications will be made from time to time)

M.E. Sem-I

Sr. No.	Subject Name	L	T	P	Total	Theory Marks	T/W	Total Marks
1	Mathematical Foundations of Computer Science	3	1	--	4	100	25	125
2	Advanced Distributed Systems	3	1	--	4	100	25	125
3	Design & Analysis of Algorithms	3	1	--	4	100	25	125
4	Elective – I	3	1	--	4	100	25	125
5	Lab - I	--	--	2	2	--	25	25
6	Research Methodology - I	--	2	--	2	--	25	25
7	Seminar – I	--	--	1	1	--	50	50
Total		**12**	**6**	**3**	**21**	**400**	**200**	**600**

M.E. Sem-II

Sr. No.	Subject Name	L	T	P	Total	Theory Marks	T/W	Total Marks
1	Design of Database Systems	3	1	--	4	100	25	125
2	Network Core Protocols & Management	3	1	--	4	100	25	125
3	Parallel Algorithms & Design	3	1	--	4	100	25	125
4	Elective – II	3	1	--	4	100	25	125
5	Lab - II	--	--	2	2	--	25	25
6	Research Methodology - II	--	2	--	2	--	25	25
7	Seminar – II	--	--	1	1	--	50	50
Total		**12**	**6**	**3**	**21**	**400**	**200**	**600**

M.E. Sem – III

Sr. No.	Subject Name	L	T	P	Total	Theory Marks	T/W	Oral Exam	Total Marks
1.	Dissertation Phase – I	--	--	4	4	--	25	75	100
Total		**--**	**--**	**4**	**4**	**--**	**25**	**75**	**100**

M.E. Sem – IV

Sr. No.	Subject Name	L	T	P	Total	Theory Marks	T/W	Oral Exam	Total Marks
1.	Dissertation Phase – II	--	--	4	4	--	100	100	200
Total		**--**	**--**	**4**	**4**	**--**	**100**	**100**	**200**

Elective – I :

Any one of the following :

1. Unix Network Programming
2. Real Time Systems
3. Data Mining & Warehousing

Elective – II :

Any one of the following :

1. Operating System design and Evaluation
2. Artificial Neural Networks and Genetic Algorithms
3. Multicore Architecture & Programming

Note :

1. In addition to the above list of electives, any other elective based on the current developments and need may be offered with prior sanction from the University Authorities.
2. The elective offered by the department should be taught by the concerned teacher.
3. For practical batch, a single batch is treated as consisting of 9 students.
4. The work load for seminars & dissertation work is to be considered for a single student.
5. The record of the term work and attendance is to be maintained by the department.

[Note :- Examination scheme and term work marks strictly as per above structure]

M.E. (COMPUTER SCIENCE & ENGINEERING) Sem - I

1. MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term work**	**: 25 Marks**

SECTION – I

1. **Introduction :** Mathematical notions and terminology of sets, sequences and tuples, functions and relations, graphs, strings and languages, Boolean logic – properties and representation, Definition, Theorems and Types of Proofs – Formal proofs, deductive, reduction to definition, proof by construction, contradiction, induction, counter-examples. (5)
2. **Regular Languages :** Finite automata, DFA, NFA, Equivalence of DFA & NFA. An application, Regular expressions and languages, applications. (5)
3. **Context – free languages :** CFGs, Applications, Ambiguity removal, pushdown automata and Equivalence with CFGs. (4)
4. **Turing Machine :** Turing machines, variants of TMs, programming techniques for TMs, Restricted TMs, TMs and Computers. (4)

SECTION – II

5. **Decidability :** Decidable languages, decidable problems concerning Context free languages, The halting problem – Diagonalization method, halting problem is undecidable. (4)
6. **Reducibility :** Undecidable problems from language theory – Regular expressions, Turing machines, Reduction. A simple undecidable problem (PCP), mapping reducibility, and other undecidable problems. (5)
7. **Computability :** Primitive recursive functions, computable functions, examples, the recursion theorem. (4)
8. **Computational Complexity :** Tractable and Intractable problems – Growth rates of function, time complexity of TM, tractable decision problems, theory of Optimization. (5)

Books :

1. Introduction to Theory of Computation – Michael Sipser (Thomson Nrools/Cole)
2. Introduction to Automata Theory, Languages and Computations – J.E. Hopcroft, Rajeev Motwani & J.D. Ullman (Pearson Education Asia), 2nd Edition.
3. Introduction to languages and theory of computation – John C. Martin (MGH)

References :

1. Discrete Mathematical structures with application to Computer Science – J.P. Tremblay and R. Manohar
2. Theory of Computer Science – E. V. Krishnamoorthy

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

2. ADVANCED DISTRIBUTED SYSTEMS

Lectures : 3 hrs/week **Theory : 100 Marks**
Tutorial : 1hr/week **Term Work : 25 Marks**

SECTION – I

1. **Distributed Computing System Fundamentals :** Introduction to distributed computing systems, Models, Distributed operating system, Design issues of distributed operating system. (2)

2. **Message Passing :** Features of a good message-passing system, Issues in IPC by Message passing, Synchronization, Buffering, Multidatagram Messages, Encoding and Decoding of Message Data, Process Addressing, Failure handling, Group communication. (5)

3. **Remote Procedure Calls :** RPC model. Implementing RPC mechanism, Stub Generation, RPC Messages, Marshaling Arguments and Results, Server Management, Parameter-Passing Semantics, Call Semantics, Communication protocols for RPCs. (4)

4. **Distributed Shared Memory :** General Architecture of DSM systems. Design and implementation issues of DSM, Granularity, Structure of Shared Memory Space, Consistency models. (4)

5. **Resource Management :** Features of global scheduling algorithm, Task assignment approach, Load-Balancing and Load-sharing approach. (3)

SECTION - II

6. **Distributed File Systems :** Features of Good DFS, File Models, File-Accessing models, File Service Architecture, File-sharing semantics, File Caching schemes, File replications. (4)
7. **Replication :** Introduction, System Model & Group Communication, Fault Tolerant Services, Transactions with Replicated Data, Case Studies : Gossip Architecture, Bayou, Coda. (4)
8. **Peer-to-Peer Systems :** Introduction, Napster & Its Legacy, Peer-to-Peer Middleware, Routing overlays, Case Studies : Pastry, Tapestry. (4)
9. **Coordination & Agreement :** Introduction, Distributed Mutual Exclusion, Elections, Multicast Communication, Consensus & related problems. (3)
10. **Mobile & Ubiquitous Computing :** Introduction, Association, Inter operation, Sensing & Context Awareness, Security & Privacy, Adaptation, Case Study : Cooltown. (4)

Text Books :

1. Distributed Operating Systems Concepts and Design – P.K. Sinha (PHI)
2. Distributed Systems Concepts & Design by George Coulouris, Jean Dollimore & Tim Kindberg (Pearson Education)

Reference Books :

1. Distributed Systems concepts and Design – G. Coulouris, J. Dollimore & T. Kindberg – (2nd Edition, Addision Wesley)
2. Modern Operating Systems – A. S. Tanenbaum (PHI)
3. Modern Operating Systems – Singhal

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

3. DESIGN AND ANALYSIS OF ALGORITHMS

Lectures : 3 hrs/week **Theory : 100 Marks**
Tutorial : 1hr/week **Term Work : 25 Marks**

SECTION - I

1. **Divide and Conquer :** The general method, Binary search, Mergesort, Quicksort, Selection sort and analysis of these algorithms (4)

2. **Dynamic Programming :** The general method, Multistage graphs, All pair shortest paths, Optimal binary search trees, 0/1 knapsack, Reliability design, Traveling Sales person problem. (5)

3. **Basic Traversal and Search Techniques :** Game Tree; Traversal Techniques for Graphs – Breadth First Search & Traversal, Depth First Search & Traversal, AND/OR graphs; Connected components and Spanning Trees; Bi-connected components and Depth First Search. (4)

4. **Lower Bound Theory :** Comparison trees, Oracles and adversary arguments, Lower bounds through reductions**.** (6)

SECTION - II

5. **NP Hard and NP Complete Problems :** Basic Concepts, Cook's Theorem, NP Hard Graph Problems, NP Hard Scheduling Problems, NP-Hard Code Generation Problems (5)

6. **Approximation Algorithms :** Introduction, Absolute approximations, ε-approximations, Polynomial time approximation Schemes, Fully Polynomial Time Approximation Schemes, Probabilistically Good Algorithms. (5)

7. **PRAM Algorithms :** Introduction, Computational Model, Fundamental Techniques and Algorithms, Merging, Lower Bounds. (3)

8. **MESH ALGORITHMS :** Computational Model, Packet routing, Fundamental algorithms, Merging, Computing the Convex Hull. (3)

9. **HYPERCUBE ALGORITHMS :** Computational Model, PPR Routing, Fundamental Algorithms, Selection, Merging, Sorting, Computing the Convex Hull. (3)

Text Books:

1. Fundamentals of Computer Algorithms - Ellis Horowitz, Satraj Sahani, Saguthevar Rajasejaran (Universities Press) Second Edition

Reference Books :

1. Fundamentals of Computer Algorithms – Ellis Horowitz, Sartaj Sahni and Sanguthewar Rajaselaran (Galgotia publications).
2. The Design and Analysis of Computer Algorithms – Aho, Hopcraft & Ulman (Pearson Education)
3. Introduction to Algorithms – Thomas H. Cormen, Charles S. Leiserson, Ronald L. Rivest and Clifford Stein (PHI) – 2nd edition.
4. Randomized Algorithms – Rajeev Motwani and Prabhakar Raghavan (Cambridge University Press).
5. Algorithm Design – Foundations, Analysis and Internet Examples by Michael T. Goodrich, Roberto Tamassia (Wiley Student Edition)

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

4. ELECTIVE – I : A) UNIX NETWORK PROGRAMMING

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term work**	**: 25 Marks**

SECTION – I

1. **The Unix Model :** Introduction, Basic Definitions, Input and Output, Signals Process Control, Daemon Processes, listing internet daemons and their service capabilities. (4)

2. **Interprocess Communication :** Introduction, File and Record Locking, A simple Client-Server Example, Pipes, FIFOs, Streams and Messages, Name spaces, System V IPC, Message Queues, Semaphores. Shared Memory, Sockets and TLI, Differences between Unix & Windows IPC mechanisms. (6)

3. **Communications Protocols :** Introduction, TCP/IP – the Internet Protocols, XNS – Xerox Network Systems, SNA – Systems Network Architecture, NetBIOS, OSI Protocols, UUCP – Unix-to-Unix Copy, Protocol Comparisons. (4)

4. **Berkely Sockets :** Unix Domain Protocols, socket system calls and socket structure, socket addresses, socket options – uses of ioctl and fctl system calls. Asynchronous I/O, Input / Output Multiplexing, Internet Superserver, Socket Implementation. (5)

SECTION – II

5. **System V Transport Layer Interface :** Transport Endpoint Addresses, TLI Functions, Streams, TIJ Implementation, Stream Pipes. (4)

6. **Security :** Introduction, 4.3 BSD Routines, Kerberos. (2)

7. **Trivial File Transfer Protocol :** Introduction. Protocol, Security, Data Formats, Connections, Client User Interface, UDP Implementation, TCP Implementation. (4)

8. **Device Drivers :** General devices and driver architecture, Ethernet as communication device, writing device drivers for communication interface. (4)

9. **Remote Login :** Introduction, Terminal Line Disciplines, Pseudo-Terminals, Terminal Modes, Control Terminals (Again), rlogin Overview, Windowing Environments, Flow Control, Pseudo-Terminal Packet Mode, rlogin Client, rlogin Server. (5)

Reference Books :

1. Unix Network Programming – W. Rhichard Stevens Second Edition (PHI)
2. Writing Unix device drivers – George Pajari (Pearson Education Asia)
3. Illustrated TCP/IP – D. Comer (Vol. II)

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

4. ELECTIVE – I : B) REAL TIME SYSTEMS

Lectures : 3 hrs/week **Theory : 100 Marks**
Tutorials : 1 hr/week **Term Work : 25 Marks**

Pre-requisites: Basic knowledge of operating system, Memory organization, Programmable logic, Tri state logic etc.

SECTION – I

1. **Basic Real-Time Concepts :** Terminology, Systems Concepts, Real-Time Definitions, Events and Determinism, CPU Utilization, Real-Time System Design, Issues Example Real-Time Systems ,Common Misconceptions, Brief History Theoretical Advances,

Early Systems, Hardware Developments, Early Software, Commercial Operating System Support Hard versus soft Real time system. (4)

2. **Hardware Considerations :** Basic Architecture, Hardware Interfacing, Latching, Edge versus Level Triggered, Systems Interfaces and Buses, Central Processing Unit, Fetch and Execute Cycle, Instruction Forms, Core Instructions, Addressing Modes, RISC versus CISC, Memory - Access, Technologies, Hierarchy, Organization, Input/Output - Programmed I/O, Direct Memory Access, Memory-Mapped I/O, Interrupts, Enhancing Performance, Locality of Reference Cache Pipelining Coprocessors, Other Special Devices, Applications-Specific Integrated Circuits, Programmable Array Logic / Programmable Logic Array, Non-von-Neumann Architectures, Parallel Systems Flynn's Taxonomy for Parallelism in Real-Time. (4)

3. **Operating Systems:** Real-Time Kernels, Pseudo kernels, Interrupt-Driven Systems Preemptive, Priority Systems, Hybrid Systems, The Task-Control Block Model, Theoretical Foundations of Real-Time Operating Systems Process Scheduling, Round-Robin Scheduling Cyclic Executives, Fixed-Priority Scheduling–Rate-Monotonic Approach, Dynamic-Priority Scheduling: Earliest-Deadline–First Approach Inter task Communication and Synchronization, Buffering Data, Time-Relative Buffering, Ring Buffers, Mailboxes, Queues, Critical Regions, Semaphores, Other Synchronization Mechanisms, Deadlock Priority Inversion Memory Management, Process Stack Management, Run-Time Ring Buffer, Maximum Stack Size, Multiple-Stack Arrangements, Memory Management in the Task-Control-Block Model, Swapping Overlays, Block or Page Management, Replacement Algorithms Memory Locking Working Sets Real-Time Garbage Collection, Contiguous File Systems Building versus Buying Real-Time Operating Systems Selecting Real-Time Kernels, Case Study: POSIX Threads POSIX Mutexes and Condition Variables POSIX Semaphores Using Semaphores and Shared Memory POSIX Messages, Real-Time POSIX Signals, Clocks and Timers Asynchronous Input and Output , POSIX Memory Locking. (5)

4. **Software Requirements Engineering :** Requirements-Engineering process, Types of Requirements, Requirements Specification for Real-Time Systems ,Formal Methods in Software Specification ,Limitations of Formal Methods ,Finite State Machines, State charts, Petri Nets ,Requirements Analysis with Petri Nets, Structured Analysis and Design, Object-Oriented Analysis and the Unified Modeling, Language Use Cases, Class Diagram Recommendations on Specification Approach for Real-Time Systems, Organizing the Requirements Document, Organizing and Writing Requirements, Requirements Validation and Review, Requirements Validation Using Model Checking ,Automated Checking of Requirements, Case Study in Software Requirements Specification for Four-Way Traffic Intersection Traffic Light Controller System. (5)

SECTION – II

5. **Software System Design :** Properties of Software, Reliability, Correctness ,Performance, Usability, Interoperability, Maintainability, Portability, Verifiability Summary of Software Properties and Associated Metrics, Basic Software Engineering Principles, Rigor and Formality, Separation of Concerns, Modularity, Anticipation of Change, Generality Incrementality Traceability , The Design Activity,. Procedural-Oriented Design , Parnas Partitioning Structured Design , Design in Procedural Form

Using Finite State Machines, Object-Oriented Design, Benefits of Object Orientation, Design Patterns ,Object-Oriented Design Using the Unified Modeling Language, Case Study in Software Requirements Specification. (4)

6. **Programming Languages and the Software Production Process :** Introduction, Assembly Language, Procedural Languages, Parameter Passing Techniques, Call-by-Value and Call-by-Reference, Global Variables, Recursion, Dynamic Memory Allocation ,Typing, Exception Handling ,Modularity ,Cardelli's Metrics and Procedural Language Object-Oriented Languages ,Synchronizing Objects ,Garbage Collection, Cardelli's Metrics and Object-Oriented Languages, Object-Oriented versus Procedural Languages, Brief Survey of Languages, Ada, C#, Java, Occam ,Special Real-Time Languages, Know the Compiler and Rules of Thumb Coding Standards. (4)

7. **Performance Analysis And Optimization :** Theoretical Preliminaries, NP-Completeness ,Challenges in Analyzing Real-Time Systems ,The Halting Problem , Amdahl's Law , Gustafson's Law ,Performance Analysis ,Code Execution Time Estimation, Analysis of Polled Loops , Analysis of Co-routines, Analysis of Round-Robin Systems, Response-Time Analysis for Fixed-Period Systems ,Response-Time Analysis, Analysis of Sporadic and A periodic Interrupt Systems, Deterministic Performance, Application of Queuing Theory, The M/M/1 Queue Service and Production Rates, Some Buffer-Size Calculations, Response-Time Modeling, Other Results from Queuing Theory, Little's Law , Erlang's Formula, I/O Performance ,Basic Buffer-Size Calculation ,Performance Optimization, Post integration Software Optimization ,Flow-of-Control Optimization ,Loop Unrolling ,Loop Jamming ,More Optimization Techniques, Analysis of Memory Requirements, Reducing Memory Utilization , Fragmentation. (6)

8. **Engineering Considerations :** Metrics , Lines of Code, McCabe's Metric ,Halstead's Metrics, Function Points, Feature Points, Metrics for Object-Oriented Software, Objections to Metrics, Best Practices, Faults, Failures, and Bugs , The Role of Testing ,Testing Techniques ,System-Level Testing , Design of Testing Plans ,Fault-Tolerance, Spatial Fault-Tolerance, Software Black Boxes, *N*-Version Programming Built-In-Test Software ,CPU Testing , Memory Testing ROM RAM Other Devices,Spurious and Missed Interrupts Handling Spurious and Missed Interrupts The Kalman Filter Systems Integration Goals of System Integration System Unification System Verification ,System Integration Tools ,Simple Integration Strategy Patching, The Probe Effect Fault-Tolerant Design: A Case Study ,Re-factoring Real-Time Code , Delays as Loops, Dubious Constraints ,Duplicated Code Generalizations Based on a Single Architecture ,Large Procedures , Lazy Procedure Long Parameter List , Message-Passing Overload Self-Modifying Code, Speculative Generality, Telltale Comments, Unnecessary Use of Interrupts , Cost Estimation Using COCOMO , Basic COCOMO Intermediate and Detailed COCOMO ,COCOMO II. (5)

Books :

1. Real time system design and analysis by Phillip A. Laplante (3^{rd} edition)
2. Real time system by Jane W. S. Liu

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

4. ELECTIVE – I : C) DATA MINING & WAREHOUSING

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term Work**	**: 25 Marks**

SECTION – I

1. **Data Mining in Context:** What is Data Mining, What can Data Mining do? The Business Context for Data Mining, The Technical Context for Data Mining, the societal context for Data Mining, four approaches for Data Mining. (5)

2. **Data Mining Methodology:** Two styles of Data Mining, The Virtuous Cycle Of Data Mining, Identifying The Right Business Problem, Transforming Data Into Actionable Results, Acting On The Results, Measuring The Models Effectiveness, What Makes Predictive Modeling Successful? (6)

3. **Data Mining Techniques & Algorithms:** Different Goals For Different Techniques, Three Data Mining Techniques, Automatic Cluster Detection, Decision Trees, Neural Networks. (4)

4. **Data, Data Everywhere:** What Should Data Look Like, What Does Data Really Look Like? How Much Data Is Enough? Derived Variables, Case Study: Defining Customers Behavior, Dirty Data (4)

SECTION – II

5. **Building Effective Predictive Models:** Building Good Predictive Models, Working With The Model Set, Using Multiple Models, Experiment. (4)

6. **Taking Control:** Getting Started, Case 1: Building Up A Core Competency Internally, Case 2: Building A New Line Business, Case 3: Building Data Mining Skills On Data Warehouse Efforts, Case 4: Data Mining Using Tessera RME. (5)

7. **System Process & Process Architecture:** Introduction, Typical Process Flow Within A Data Warehouse, Extract & Load Process, Clean & Transform Process, Backup & Archive Process, Query Management Process, Load Manager, Warehouse Manager,

Query Managerm Detailed Information, Summary Information, Metadata, Data Marting. (6)

8. **Database Schema:** Introduction, Starflake Schemas, Identifying Facts & Dimensions, Designing Fact Tables, Designing Dimension Tables, Designing The Starflake Schema, Query Redirection, Multidimensional Schemas. (4)

Text Books:

1. Mastering Data Mining – Michael J. A. Berry & Gordon S. Linoff (WILEY publ.)
2. Data Warehousing – Sam Anahory & Dennis Murray (Pearson Ed.)

Reference Books:

1. Data Mining Introductory and Advanced Topics - Margaret H. Dunham
2. Data Mining Practical Machine Learning Tools and Techniques - Ian H. Witten, Eibe Frank
3. Data Warehousing – Soumendra Mohanty (TMGH)
4. Data Warehouse Development Tools – Dr. K.V.K.K. Prasad (Dreamtech Press)

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

5. LAB - I

Practicals : 2 hrs/week **Term Work : 25 Marks**

The term work should consist of 3-4 practical assignments each on the following subjects.

1. Mathematical Foundations of Computer Science
2. Advanced Distributed Systems
3. Design & Analysis of Algorithms.

The practical assignments are to be given and evaluated by the respective subject teacher. A common journal is to be prepared by individual student and duely signed by the respective teachers be submitted to the department at the end of the semester.

6. RESEARCH METHODOLOGY - I

Tutorial : 2 hours / Week **Term Work : 25 Marks**

Note :

This subject is a self study subject and the students are expected to study and perform the termwork under the guidance of the teacher.

1. **Research :** Definition, Applications & types of research, research process and steps in it, Deductive & inductive reasoning, validity-conclusion, internal construct and external.

2. **Formulating a Research Problem :** Need, Procedure – Search for existing literature, Review the literature selected, Develop a theoretical and conceptual framework, writing up the review, Formulating a research problem : Sources, Considerations, Steps in formulation of a problem, formulation of objectives, Definition of variables – Concepts, indicators and variables, Types of variables, Types of measurement scales, Constructing the Hypothesis – Null (Research) and alternative, one-tailed and two-tailed, Hypothesis testing, errors in testing.

3. **Research Modeling :** Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling, Data collection methods, Surveys-types and method selection.

4. **Methods of Data Collection and Analysis :** Collection of Primary and Secondary Data, Selection of appropriate method, Data Processing Operations, Elements of Analysis, Statistics in Research, Measures of Dispersion, Measures of Skewness, Regression Analysis, Correlation.

5. **Ethical Issues in Data Collection :** Ethics, Stakeholders in research, Ethical issues concerning research participants, Ethical issues relating to the researcher, Ethical issues regarding the sponsoring organization.

6. **Research Proposal & Writing a Research Report :** Contents-Preamble, the problem, objectives, hypothesis to be tested, study design, setup, measurement procedures, analysis of data, organization of report; displaying data-tables, graphs and charts, Writing a research report – developing an outline, key elements – Introduction, Methods, Measurement section, Design and Procedure section, Results, Conclusion section, Referencing of books and research papers, Report writing – Prewriting considerations, Formats of report writing, Formats of publication in Research Journals.

Text Books :

1. Ranjit Kumar, (2006), Research Methodology – A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN : 81-317-0496-3

2. Research Methodology – C.R. Kothari, Wiley Eastern.

References :

1. Trochim, William M.K. (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN : 81-7722-372-0
2. Montgomery, Douglas C., & Tunger, George C. (2007). 3/e, Applied Statistics & Probability for Engineers, (Wiley India).

Term Work:

1. It should consist of performing exercises based upon the operational steps in the research process & can be applied to the development of any research project. The aim of these exercises is to provide a broad framework for developing the operational steps. Within each exercise, questions are provided to stimulate awareness of issues relevant to the steps, to help you to think through procedures and to provide a framework for the development of an outline for your study.
   The exercises are to be done as mentioned in the Appendix of first the Text Book, which includes - Formulating a research problem, Identifying variables, Constructing hypothesis, Conceptualizing a study design, Developing a research instrument, Selecting a sample, Data analysis & developing a framework of analysis, Developing an outline of your chapters.

2. The practical batch of 9 students may be grouped into 3-4 students per group and each group should be assigned different problems or research project.

3. A joint report per group should be evaluated by the concerned teachers.

The termwork is to be evaluated for 25 marks (Internal).

7. SEMINAR - I

Practicals : 1 hr/week **Term Work : 50 Marks**

It should consist of a talk of @ 40-45 minutes on a topic preferably from the area in which a student intends to work for his dissertation during Semester – III and Semester – IV. The report there-on is to be submitted which is to be internally assessed for 50 marks.

M.E. (COMPUTER SCIENCE & ENGINEERING) Sem – II (Revised)

1. DESIGN OF DATABASE SYSTEMS

Lectures : 3 Hrs/week — Theory : 100 Marks
Tutorial : 1 Hr/week — Term work : 25 Marks

SECTION – I

1. **Introduction to Database Design :** Overview of the design process, the Unified Modeling Language (UML), features of good relational designs, database-design process, database design methodology : conceptual, logical & physical database design. Case study : relational database design of enterprise system. (5)

2. **Object Database System :** Motivation, structured data types, operations on structured data, encapsulation and ADTs, inheritance, objects OIDs and reference types, database design for ORDBMS, ORDBMS implementation challenges, OODBMS, comparisons of RDBMS, OODBMS and ORDBMS. Case study : Object database design using Oracle / IBM DB2. (5)

3. **Semistructured Data and XML :** Semistructured data, introduction to XML, XML-related technologies, XML Query Languages. Case study : Semistructured and XML data handling in Oracle / IBM DB2. (4)

4. **Security and Authorization :** Introduction to database security, access control, discretionary access control, mandatory access control, security for internet applications, additional issues related to security. Case study : Security and authorization in Oracle / IBM DB2. (4)

SECTION – II

5. **Advanced Transaction Processing :** Transaction-processing monitors, transactional workflows, main memory databases, real-time transaction system, long-duration transactions, transaction management in multi-databases. (5)

6. **Performance Tuning :** Various issues in performance tuning, performance benchmarks, standardization, application migration. Performance tuning in Oracle / IBM DB2. (4)

7. **Data Warehousing Design :** Designing a data warehouse database, dimensionality modeling, database design methodology for data warehouses, criteria for accessing the dimensionality of a data warehouse, data warehousing design using Oracle. (5)

8. **Data Mining :** Introduction, counting co-occurrences, mining for rules, tree-structured rules, clustering, similarity search over sequences, incremental mining and data streams, Web Mining : web content mining & web usage mining. Case study : data mining tools in Oracle / IBM DB2. (5)

Reference Books :

1. Database System Concepts – Silberschatz, korth & Sudarshan (McGrawHill) 5th Edition.
2. Database Management Systems – Ramakrishnan & Gehrke (McGrawHill) 3rd Edition.
3. Database Systems : A practical approach to design, implementation and management – Thomas Connolly & Carolyn Begg (Pearson Education) 3rd Edition
4. Data Mining : Introductory and Advanced Topics – Margaret H. Dunham (Pearson Education)
5. Oracle / IBM DB2 documentation/manuals : www.oracle.com / www.ibm.com.

Term Work :

1. It should consist of 10-12 design experiments based on above topics.
2. The thrust should be given to design, modeling and implementation using standard CASE tools.
3. Use C# as Programming Language. For database programming / Scripting use PL/SQL in Oracle / IBM DB2.

2. NETWORK CORE PROTOCOLS & MANAGEMENT

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term work**	**: 25 Marks**

SECTION – I

1. **Introduction to Network Protocols :** Introduction to OSI, TCP/IP Architecture details, Physical & link layer protocols – overview & characteristics of WLAN, FWA, Components of Network. (4)

2. **Internet Protocol :** IP standard, datagrams, packets delivery datagram independence, housekeeping, fragmentation & reassembly, prioritization & service-based routing, IP header fields-overview. (6)

3. **Transmission Control Protocol :** TCP standard, services, Virtual circuits, Application I/o Management, Network I/O Management, Flow Control, Reliability, TCP header fields – overview, A complete session between HTTP client & server, opening & closing VCs, Bulk data transfer & errors recovery, troubleshooting TCP. (6)

4. **Specifying Network Protocols :** Semantics syntax of protocol specifications – traditional & new, protocol examples – RR protocol, Manchester Encoding Protocol. (3)

SECTION – II

5. **Data Communication & Network Management :** Analogy of Telephone Network Management, Data & Telecom network, Effect of DCE, TCP/IP, Communication Protocols & standards on NM, NM challenges & goals, network & system management, current status of NM, Managed & unmanaged network devices, various configurations & connectors. (6)

6. **NM Standards :** Various NM standards, characteristics, models, ASN.1, Encoding structure & Macros. (4)

7. **SNMPV1 NM :** SNMP model- organization model, SNMP NM Architecture, Information Model, MIB module structure & MIB-II groups, communication model, SNMP operations, Functional model, Major changes in SNMPV2 & V3. (6)

8. **Remote monitoring, NM Tools & Applications :** RMON, RMON groups & functions, Common & Ethernet groups, NM Tools – functional role, resources & components managed, mechanisms, Basic software tools, protocol analyzer, NM systems, Commercial network & Enterprise Management System (4)

Books :

1. Internet Core Protocols – The definitive guide by Eric A. Hall (O'Reilly, SPD)
2. Elements of network protocol design – M.G. Gouda (Wiley)
3. Network Management – Principles & Practice – Mani Subramanian (Pearson Education)

References :

1. Understanding TCP/IP by Libor D Ostalek, Alena Kabelova (SPD)
2. Network Management – Concepts & Practice : A Hands-on Approach by J. Richard Burke (Pearson Education)
3. Network Management, MIBs & MPLS, Principles, Design & Implementation -/Stephen B. Morris (Pearson Eduction).
4. TCP/IP Protocol Suite – B.A. Forouzan (TMH Edition)

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

3. PARALLEL ALGORITHMS AND DESIGN

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term work**	**: 25 Marks**

SECTION – I

1. **Introduction :** Introduction, Why Parallel Architecture, Application Trends .., Technology Trends, Architectural Trends, Supercomputers, Convergence of Parallel Architectures, Communication Architecture, SharedMemory, Message-Passing, Convergence, Data Parallel Processing, Other Parallel Architectures, A Generic Parallel Architecture, Fundamental Design Issues, Communication Abstraction, Programming Model Requirements, Naming, Ordering, Communication and Replication, Performance. (4)

2. **Parallel Programs :** Introduction, Parallel Application Case Studies, Simulating Ocean Currents, Simulating the Evolution of Galaxies, Visualizing Complex Scenes using Ray Tracing, Mining Data for Associations, The Parallelization Process, Steps in the Process, Parallelizing Computation versus Data, Goals of the Parallelization Process, Parallelization of an Example Program, A Simple Example: The Equation Solver Kernel, Decomposition, Assignment, Orchestration under the Data Parallel Model, Orchestration under the Shared Address Space Model, Orchestration under the Message Passing Model. (4)

3. **Programming for Performance :** Introduction, Partitioning for Performance, Load Balance and Synchronization Wait Time, Reducing Inherent Communication, Reducing the Extra Work, Summary, Data Access and Communication in a Multi-Memory System, A Multiprocessor as an Extended Memory Hierarchy, Artifiactual Communication in the Extended Memory Hierarchy, Orchestration for Performance, Reducing Artifiactual Communication, Structuring Communication to Reduce Cost, Performance Factors from the Processors' Perspective, The Parallel Application Case Studies: An In-Depth Look, Ocean, Barnes-Hut, Raytrace, Data Mining, Implications for Programming Models. (4)

4. **Shared Memory Multiprocessors :** Introduction, Cache Coherence, The Cache Coherence Problem, Cache Coherence Through Bus Snooping, Memory Consistency, Sequential Consistency, Sufficient Conditions for Preserving Sequential Consistency, Design Space for Snooping Protocols, A 3-state (MSI) Write-back Invalidation Protocol, A 4-state (MESI) Write-Back Invalidation Protocol, A 4-state (Dragon) Write-back Update Protocol, Assessing Protocol Design Tradeoffs, Workloads, Impact of Protocol Optimizations. (4)

5. **Scalable Multiprocessors :** Introduction, Scalability, Bandwidth Scaling, Latency Scaling, Cost Scaling, Physical scaling, Scaling in a Generic Parallel Architecture, Realizing Programming Models, Primitive Network Transactions, Shared Address Space, Message Passing, Common challenges, Communication architecture design space, Physical DMA, A Case Study: nCUBE/2, User-level Access, Case Study: Thinking Machines CM-5, User Level Handlers, Dedicated Message Processing, Case Study: Intel Paragon, Case Study: Meiko CS-2, Shared Physical Address Space, Case study: Cray T3D, Cray T3E, Summary, Clusters and Networks of Workstations, Case Study: Myrinet SBus Lanai, Case Study: PCI Memory Channel, Comparison of Communication Performance, Network Transaction

Performance, Shared Address Space Operations, Message Passing Operations, Application Level Performance, Synchronization, Algorithms for Locks, Algorithms for Barriers. (4)

SECTION – II

6. **Performance Characteristics :** Cache-based Directory Protocols: The Sequent NUMA-Q Cache Coherence Protocol Dealing with Correctness Issues Protocol Extensions Overview of NUMA-Q Hardware Protocol Interactions with SMP Node IQ-Link Implementation. Performance Characteristics Comparison Case Study: The HAL S1 Multiprocessor erformance Parameters and Protocol Performance Synchronization Performance of Synchronization Algorithms Supporting Atomic Primitives ,Implications for Parallel Software Tertiary Caches ,Cache-only Memory Architectures (COMA) Reducing Hardware Cost Hardware Access Control with a Decoupled Assist. (4)

7. **Interconnection Network Design :** Introduction, Basic definitions, Basic communication performance, Organizational Structure, Links, Switches, Network Interfaces, Interconnection Topologies, Fully connected network, Linear arrays and rings, Multidimensional meshes and tori, Trees, Butterflies, Hypercubes, Evaluating Design Trade-offs in Network Topology, Unloaded Latency, Latency under load, Routing, Routing Mechanisms.. , Deterministic Routing, Deadlock Freedom, Virtual Channels, Up*-Down* Routing, Turn-model Routing, Adaptive Routing, Switch Design, Ports, Parallel Computer Networks vs. LANs and WANs., Link-level flow control, End-to-end flow control, Case Studies, Cray T3D Network, IBM SP-1, SP-2 Network, Scalable Coherent Interconnect, SGI Origin Network, Myricom Network. (4)

8. **Combinational search :** Divide & conquer, Branch &bound ,Parallel branch & bound algorithm, alpha- beta search, parallel alpha –beta search, Enumeration sort, lower bound of parallel sort odd –even transposition sort, merge ,quick sort base algorithm random read and random write complexity of parallel search , searching on multiprocessor graph algorithm depth first breath first , shortest path minimum cost spanning tree. (4)

9. **Solving Linear System :** Back substituting odd even reduction ,Gaussian elimination the jacoib algorithm ,Gauss Scidal algorithm ,Jacoib over relaxation & successive over relaxation multi grid method , conjugate gradient method. (3)

10. **Matrix Multiplication & Fast fourier transform :** Sequential matrix multiplication algorithm for multiprocessor ,processor array algorithm multi-row-column oriented multiplication , block-oriented algorithm ,Discrete fourier transform ,inverse discrete fourier transform ,implementation of the hypercube multi-computer and other computer systems. (4)

Books :

1. Parallel Computer Architecture A Hardware / Software Approach - David Culler University of California, Berkeley ,Jaswinder Pal Singh Princeton University with Anoop Gupta Stanford University
2. Parallel Algorithm by Michel Queen Parallel Algorithm by Michel Queen

Reference Books :

1. Parallel computing by Michael Quinn, McGraw Hill Inc.
2. Analysis and Design of Parallel Algorithms by S. Laxmivarham, S.K. Dhall McGraw

Hill Inc.
3. Parallel Computer Architecture by David Culler and J. Palsingh. Morhan Kaufmann Publishers / Inc. Francisco California.
4. An introduction to Parallel Algorithms – Joseph J.A. Addison – Wesley 1992 – University of Warwick – 30 Kcs.
5. Scalable Cluster Computing by Kaihwang.

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

4. ELECTIVE – II : A) OPERATING SYSTEM DESIGN & EVALUATION

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term work**	**: 25 Marks**

SECTION – I

1. **Design Techniques :**
   Operating Systems & design, Design Problems, Design Techniques, Two Level Implementation, Interface design, Connection in Protocols, Interactive & Programming Interfaces, Decomposition Patterns, Problems. (5)

2. **Process Implementation :**
   Implementation of a simple OS, Implementation of Processor, System Initialization, Process Switching, Implementation of Waiting, Flow of Control through the OS, Signaling, Interrupts, Operating Systems as Event and Table Managers, Monoprogramming Vs. Multiprogramming, Problems. (5)

3. **Parallel Systems :**
   Multiprocessor Operating System, examples, Threads, Kernel-mode process, Implementation of Mutual Exclusion, Problems. (4)

4. **IPC Patterns :**
   Using IPC, Patterns, Problems when processes complete, Race conditions, Atomic actions, IPC Pattern : Mutual Exclusion, Signaling, Rendezvous, Producer – Consumer, Client-Server, Database Access & Update, Problems. (4)

SECTION – II

5. **File System Implementation & Organization :**
   Introduction, Need, Abstraction, Naming, Objects & Operations, Implementation, Example File System Implementation, Problems, File Descriptors, File blocks, File System Optimization, File System Reliability, Security & Protection, Examples. (4)

6. **Device & Resource Management :**
   Introduction, Devices & Controllers, Terminal devices, Communication devices, Disk Devices, Disk Device Driver Access Strategies, Issues, Types of Resources, Protection of resources, (S/w & H/w), User authentication, Representation of Protection Information, Example of Protection attacks, Mechanism for software protection, Examples in Windows NT & Unix. (5)

7. **Memory Management - I :**
   Linking and loading a Process, Static vs. Dynamic Memory allocation, The management design problems and solution, allocation of free blocks, examples of dynamic memory allocation, logical and physical memory, allocation of memory to processes, memory protection (5)

8. **Memory Management - II :**
   Fragmentation and compaction, Swapping, Overlays, Implementation of Virtual Memory, Virtual Memory Management, Daemons and Events, Page replacement techniques and Evaluation, Thrashing and Load Control (4)

Reference Books :

1. Operating System – A Designed Oriented Approach – Crowley (TMGH)
2. Unix Operating System – Maurice Bach (PHI)

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks.

.

4. ELECTIVE – II : B) ARTIFICIAL NEURAL NETWORKS & GENETIC ALGORITHMS

Lectures : 3 hrs/week **Theory : 100 Marks**
Tutorials : 1 hr/week **Term work : 25 Marks**

Section – I

1. **Introduction:** Inspiration from Neuroscience, History, Issues. (**2**)

2. **Hopfield Model: A**ssociative memory problem, Model, Stochastic Networks, Capacity of Stochastic n/w. **(4)**

3. **Optimization Problems:** Weighted matching problem, Traveling salesman problem, Graph bipartioning, optimization problems in image processing. **(4)**

4. **Simple Perceptrons:** Feed forward n/w, Threshold units, Linear units, Nonlinear units, Stochastic units, Capacity of simple perceptrons. **(3)**

5. **Multi-Layer n/w:** Back propagation, Examples & applications, Performance of multilayer feed forward network, Kohoanan self organizing n/w. **(4)**

Section – II

6. **Learning:** Supervised, Unsupervised (Hebbian /Competitive), Adaptive resonance theory. **(3)**

7. **Introduction to Genetic Algorithm:** Robustness of traditional optimization and search methods, Goals of Optimization, GA v/s Traditional methods, Simple GA, GA at work, Similarity templates, Learning the lingo, Mathematical foundations- The fundamental theorem, Schema processing at work, The 2- armed & k-armed Bandit Problem, The building block hypothesis, Minimal Deceptive Problem. **(5)**

8. **GA Operators:** Data structures, Reproduction, Roulette-wheel selection, Boltzmann selection, Tournament selection rank, Selection- Steady- state selection, Crossover, mutation, A Time to Reproduce, a Time to Cross, Mapping Objective Functions to Fitness Form, Fitness Scaling, Codings- A Multi-parameter, Mapped, Fixed-point Coding, Discretization, Constraints. **(4)**

9. **Applications of GA:** The rise of GA, GA Applications of Historical Interest, DE JONG and Function Optimization, Current applications of GA. (**3**)

10. **Advanced Operators & Techniques in Genetic Search** : Dominance, Diploidy & Abeyance, Inversion & other reordering operators, Other Micro Operators, Niche and

Speciation, Multiobjective Optimization, Knowledge Based techniques, GA & Parallel Processes, Real life problem. (4)

Reference Books:

1. Introduction to Theory of Neural Computation – Hertz, Keogh, Palmer.
2. Genetic Algorithms – David E. Goldberg, Publication- Pearson Education
3. Introduction to Artificial Neural Networks- B. Yegnanarayana (PHI)

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks

4. ELECTIVE – II : C) MULTICORE ARCHITECTURE & PROGRAMMING

Lectures	**: 3 hrs/week**	**Theory**	**: 100 Marks**
Tutorials	**: 1 hr/week**	**Term work**	**: 25 Marks**

SECTION - I

1. **Introduction:** Evolution of Computer Architecture - Trends; Fundamentals of Parallel Computers; Need for multi-core architectures (6)

2. **Parallel Programming:** Overview, Parallel programming design patterns, Multithreading goals and issues, OpenMP Directives – Parallel, work sharing, task, synchronization constructs & other directives, Exercises on Multithreading with OpenMP. (12)

SECTION – II

3. **Software Optimization & Performance Analysis:** Processor Architecture basics, Need for software optimization, Algorithms analysis, Performance analysis - Hot spots, Branching, Memory, Loops (10)

4. **Benchmarking multi-core architecture:** Bench marking of processors. Comparison of processor performance for specific application domains. (8)

Text Books:

1. The Software Optimization Cookbook; Richard Gerber, Aart J.C. Bik, Kevin B. Smith and Xinmin Tian; Intel Press.
2. Multi-Core Programming; Shameem Akhter and Jason Roberts; Intel Press.

References:

1. OpenMP Spec 3.0 handbook available on the Web
2. Lecture Notes & Web Reference

Term Work :

It should consist of 10-12 assignments based on the syllabus. The students should be assigned at least 1 or 2 assignments of analyzing relevant articles from International journals and are further supposed to submit a report containing the analysis, alternatives in the design or solution, suggestions regarding improvements on the topics chosen. The term work is to be internally assessed for 25 marks

5. LAB - II

Practicals : 2 hrs/week **Term Work : 25 Marks**

The term work should consist of 3-4 practical assignments each on the following subjects.

1. Design of Database Systems
2. Network Core Protocols and Management
3. Parallel Algorithms & Design.

The practical assignments are to be given and evaluated by the respective subject teacher. A common journal is to be prepared by individual student and duely signed by the respective teachers be submitted to the department at the end of the semester.

6. RESEARCH METHODOLOGY - II

Tutorial : 2 hours / Week **Term Work : 25 Marks**

Each student is expected to make a literature survey on the topic of his/her interest and prepare a review paper or research proposal as a case study. The student can refer to doctoral thesis /Standard journal papers / books / literature etc. The work carried here should help the student in finalizing his/her dissertation synopsis.

The report / research proposal should be evaluated by the concerned teacher for 25 marks (Internal).

7. SEMINAR - II

Practicals : 1 hr/week **Term Work : 50 Marks**

It should consist of a talk of @ 40-45 minutes on a topic preferably from the area in which a student intends to work for his dissertation during Semester – III and Semester – IV. The report there-on is to be submitted which is to be internally assessed for 50 marks. The student should finalize his dissertation topic as an outcome of Seminar-II.

M.E. (COMPUTER SCIENCE & ENGINEERING) Sem – III (Revised)

DISSERTATION PHASE - I

Practicals : 4 hr/week **Term work : 25 Marks**
Orals : 75 Marks

The dissertation title should be finalized on the basis of literature survey presented in Seminar II subject to the approval of the department. The synopsis of the dissertation topic should be prepared and submitted to the university for its approval within the first month of the starting of the semester-III.

The student shall carry work related to the dissertation with the consent of the guide. This work shall include related software / hardware assignments, field work (if required) as decided by the guide. The student shall submit a monthly progress report after presentation of the work done to the department and submit the progress report of the work done. The student should submit minimum 2 progress reports to the department before the end of the semester. The progress work is to be evaluated by the respective guide for 25 marks as the term work. The dissertation phase-I work is to be jointly assessed for 75 marks by an Internal and an external examiners appointed by the University during Oral examination.

Note:

1. The students failing to submit the synopsis and / or minimum 2 monthly progress reports are allowed to submit the same in the beginning of the next semester.
2. The evaluation of such work should be done at the end of the respective semesters by the guide.

M.E. (COMPUTER SCIENCE & ENGINEERING) Sem – IV (Revised)

DISSERTATION PHASE - II

Practicals : 4 hr/week **Term Work : 100 Marks**
Oral Exam : 100 Marks

The student shall submit a monthly progress report after presentation of the work done to the department and submit the progress report of the same. The student should submit minimum 3 progress reports to the department before the end of the semester-IV. The progress work is to be evaluated by the respective guide for 100 marks as the term work. The dissertation phase-II work is to be jointly assessed for 100 marks by an Internal examiner (Guide) and an external examiner appointed by the University during Oral examination.