First Year M.Tech Programme in Computer Science and Engineering
Semester-I

Sr. No.	Course Code	Name of the Course	Group	Teaching Scheme				Credits	Audit
				Theory Hrs/ Week	Tutorial Hrs/ Week	Practical Hrs/ Week	Total		
1	CSL532	Mathematical Foundation of Computer Science	D	3	1	-	4	4	-
2	CSL533	Design and Analysis of Algorithms	D	3	1	-	4	4	-
3	CSL534	Service Oriented Architecture	D	3	1	-	4	4	-
4	CSLEL1	Elective -I	D	3	1	-	4	4	-
5	CSLEL2	Elective -II	D	3	1	-	4	4	-
6	CSL541	Research Methodology	C,F	2	1	-	3	3	-
7	CSP542	Design and Analysis of AlgorithmsLab	D	-	-	2	2	1	-
8	CSP543	Service Oriented ArchitectureLab	D	-	-	2	2	1	-
9	CSPEL1	Elective -I Lab	D	-	-	2	2	1	-
10	CSD547	Seminar-I	F	-	-	2	2	2	-
Total				17	6	8	31	28	-

Group Details
A: Basic Science
B: Engineering Science
C: Humanities Social Science & Management
D: Professional Courses & Professional Elective
E: Open Elective F: Seminar/Training/ Project

CSLEL1 - Elective I	
CSL535	Business Intelligence and Data Mining
CSL536	Advanced Software Engineering
CSL537	Visualization Techniques

CSLEL2 - Elective II	
CSL538	Pattern Recognition
CSL539	High Performance Computer Architecture
CSL540	Computer Vision

CSPEL1 - Elective I Lab	
CSP544	Business Intelligence and Data Mining Lab
CSP545	Advanced Software Engineering Lab
CSP546	Visualization Techniques Lab

First Year M.Tech.Sem-I

CSL532: Mathematical Foundation of Computer Science

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To enhance the problem solving skills in the areas of theoretical computer science.
2. To use the mathematical concepts in the development of computer applications.
3. To make the student aware of mathematical tools, formal methods & automata techniques to computing.
4. To strengthen the students' ability to carry out formal and higher studies in computer science.

Course Outcomes

At the end of the course students will be able to

1. Use mathematical concepts in the development of language design.
2. Design regular expressions and automata for different language classes.
3. Design context free grammar and push down automata for different applications.
4. Describe different types of Turing Machine their use, capability, and limitations.
5. Determine decidability and reducibility of computational problems.
6. Determine Computability and Computational Complexity.

Course Contents

Unit 1. Introduction **7 Hrs.**

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.

Unit 2. **Regular Languages** **7 Hrs.**

Finite automata, DFA, NFA, Equivalence of DFA & NFA. An application, Regular expressions and languages, applications

Unit 3. **Context free languages** **6 Hrs.**

CFGs, Applications, Ambiguity removal, pushdown automata and Equivalence with CFGs.

Unit 4. **Turing Machine** **6 Hrs.**

Turing machines, variants of TMs, non-deterministic Turing machine, universal Turing machine, programming techniques for TMs, Restricted TMs, TMs and Computers

Unit 5. **Decidability and Reducibility** **7 Hrs.**

Decidable languages, decidable problems concerning Context free languages, The halting problem – Diagonalization method, halting problem is undecidable. Undecidable problems from language theory – Regular expressions, Turing machines, Reduction. A simple undecidable problem (PCP),mapping reducibility, and other undecidable problems

Unit 6. **Computability and Computational Complexity** **6 Hrs**

Primitive recursive functions, computable functions, examples, the recursion theorem. Tractable and Intractable problems – Growth rates of function, time complexity of TM, tractable decision problems, theory of Optimization.

Reference 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)
4. Discrete Mathematical structures with application to Computer Science – J.P. Tremblay and R. Manohar
5. Theory of Computer Science – E. V. Krishnamoorthy

First Year M.Tech.Sem-I

CSL533: Design and Analysis of Algorithms

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To provide solution to problems using different algorithm design paradigms.
2. To analyse performance of algorithms and find lower bound.
3. To synthesize algorithms for different parallel architectures.

Course Outcomes

At the end of the course students will be able to

1. Discover solution to problems using different algorithm design paradigms like Divide and Conquer and Greedy Approach.
2. Apply dynamic programming approach to tackle problems.
3. Analyse performance of algorithms using asymptotic analysis.
4. Find lower bound of complexity to solve different problems.
5. Synthesize efficient algorithms for different parallel architectures.

Course Contents

Unit 1. Divide and Conquer and Greedy Method **8 Hrs.**

Algorithm basics, Performance Analysis, Recurrence relations.

Divide and Conquer- The general method, Binary search, finding the maximum and minimum, Merge sort, Quick sort, Analysis of algorithms designed. Greedy Method- The general method, Knapsack problem, Job sequencing with deadlines, minimum-cost spanning trees – Prim's and Kruskal's Algorithms, Optimal merge patterns, Single source shortest paths, Analysis of algorithms designed.

Unit 2. **Dynamic Programming** **7 Hrs.**

The general method, Multistage graphs, All pair shortest paths, Optimal binary search trees, 0/1 knapsack, Reliability design, Traveling Salesperson problem, Flow shop scheduling, Analysis of algorithms designed.

Unit 3. **Lower Bound Theory and NP Hard, NP Complete Problems** **7 Hrs.**

Lower Bound Theory- Comparison trees, Oracles and adversary arguments, Lower bounds through reductions.NP Hard and NP Complete Problems - Basic Concepts, Cook's Theorem, NP Hard Graph Problems, NP Hard Scheduling Problems, NP-Hard Code Generation Problems

Unit 4. **Approximation Algorithms** **5 Hrs.**

Introduction, Absolute approximations, ε- approximations, Polynomial time approximation Schemes, Fully Polynomial Time Approximation Schemes, Probabilistically Good Algorithms.

Unit 5. **PRAM and MESH Algorithms** **7 Hrs.**

PRAM Algorithms- Introduction, Computational Model, Fundamental Techniques and Algorithms, Selection, Merging, Sorting, Graph Problems. MESH Algorithms- Computational Model, Packet routing, Fundamental algorithms, Selection, Merging, Sorting, Graph Problems.

Unit 6. **HYPERCUBE and BUTTERFLY Algorithms** **5 Hrs.**

Computational Model, PPR Routing, Fundamental Algorithms, Selection, Merging, Sorting, Graph Problems.

Reference Books

1. Fundamentals of Computer Algorithms - Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, Universities Press, Second Edition.
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. Algorithm Design – Foundations, Analysis and Internet Examples by Michael T. Goodrich, Roberto Tamassia (Wiley Student Edition)

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CSL534: Service Oriented Architecture

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To provide an overview of XML Technology and modeling databases in XML.
2. To provide an overview of Service Oriented Architecture and Web services and their importance.
3. To introduce Security solutions in XML and Web Services and to introduce Security standards for Web Services.

Course Outcomes

At the end of the course students will be able to

1. Model XML databases.
2. Create web services.
3. Make web services secure.

Course Contents

Unit 1. XML Technology **6 Hrs.**

XML – XML and Web - Name Spaces – XML Document Structure - Structuring with Schemas and DTD - Modeling Databases in XML – XQuery.

Unit 2. SOA Basics **7Hrs.**

Service Oriented Architecture (SOA) – Comparing SOA with Client-Server and Distributed architectures- Characteristics of SOA – Benefits of SOA -- Principles of Service orientation – Service layers -Business Process management.

Unit 3. **Web Services (WS)** **7 Hrs.**

SOA and Web Services – Web Services Protocol Stack – Service descriptions – WSDL – Messaging with SOAP – Service discovery – UDDI. Service-Level Interaction patterns – XML and Web Services - Enterprise Service Bus - .NET and J2EE Interoperability.

Unit 4. **SOA Implementation** **6 Hrs.**

SOA using REST – RESTful Services – RESTful Services with and without JWS – Role of WSDL, SOAP and Java/XML mapping in SOA – JAXB Data Binding.

Unit 5. **WS Technologies and Standards** **7 Hrs.**

Web Services Technologies - JAX-RPC, JAX-WS. Web Service Standards – WS-RM, WS-Addressing, WS-Policy. Service Orchestration and Choreography – Composition Standards - BPEL. Service Oriented Analysis and Design.

Unit 6. **XML and WS Security** **6 Hrs.**

XML Security Overview – Canonicalization – XML Security Framework – XML Encryption – XML, Signature – XKMS Structure. Web Services Security - XACML - WS-Security.

ReferenceBooks

1. Ron Schmelzer et al. "XML and Web Services", Pearson Education, 2008. (Unit 1 and 3)
2. Thomas Erl, "Service Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005 (Unit 2, 3, 5, and 6).
3. Frank P.Coyle, "XML, Web Services and the Data Revolution", Pearson Education, 2002 (Unit 6).
4. Shankar Kambhampaly, "Service – Oriented Architecture for Enterprise Applications",Wiley India Pvt Ltd, 2008.
5. Mark D. Hansen, "SOA using Java Web Services", Practice Hall, 2007.
6. Eric Newcomer, Greg Lomow, "Understanding SOA with Web Services", Addison Wesley,2005.
7. James McGovern, Sameer Tyagi, Michael E Stevens, Sunil Mathew, "Java Web Services Architecture", Elsevier, 2011.
8. Mark O' Neill, et al., "Web Services Security", Tata McGraw-Hill Edition, 2003.
9. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services: An Architect's Guide", Prentice Hall, 2004

First Year M.Tech.Sem-I

CSL535: Business Intelligence and Data Mining

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. Introduce the students with business intelligence tasks.
2. To study pattern mining techniques.
3. To study the basics of web mining.
4. To study & implement pattern mining techniques.
5. To study & implement the web mining's pre-processing.

Course Outcomes

At the end of the course students will be able to

1. Recognize the need for business intelligence to support business management.
2. Understand and apply data mining techniques to data set.
3. Familiar with leading data mining software
4. Know the importance of B.I. applications.
5. Describe dimensional Modeling and designing.

Course Contents

Unit 1. Introducing the Technical Architecture **6 Hrs.**

The value of architecture, Technical Architecture overview, Back room Architecture, Presentation Server Architecture, Front room Architecture, Infrastructure, Metadata, Security.

Unit 2. Introducing Dimensional Modeling and designing **6 Hrs.**

Making the Case for Dimensional Modeling, Dimensional Modeling primer, Enterprise Data Warehouse Bus Architecture, More on Dimensions & Facts. Modeling Process overview, Getting Organized, Four Step Modeling Process, Design the Dimensional Model.

Unit 3. **Introducing Extract, Transformation & Load** **6 Hrs.**

Round up the requirements, the 34 subsystems of ETL, Extracting Data, Cleaning & Conforming data.

Unit 4. **Introducing Business Intelligence Applications and Designing & Developing** **7 Hrs.**

Importance of B.I. Applications, Analytical cycle for B.I., Types of B.I. Applications, Navigating Applications via the B.I portal. B.I. Application resource planning, B.I. Application Specification, B.I. Application Development, B.I. Application maintenance.

Unit 5. **Web Mining and social network analysis** **8 Hrs.**

Introduction, Web Content Mining, Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining, Page Rank, Clever, Web Usage Mining, Pre-processing, Data Structures, Pattern Discovery, Pattern Analysis,Social Network Analysis: What Is a Social Network? , Characteristics of Social Networks Link Mining: Tasks and Challenges, Mining on Social Networks.

Unit 6. **Mining Stream, Time-Series, and Sequence Data** **6 Hrs**

Mining Data Streams, Mining Time-Series Data,Mining Sequence Patterns in Transactional Databases, Mining Sequence Patterns in Biological Data.

Reference Books

1. The Data Warehouse Lifecycle Toolkit By RaiphKimball,Ross, 2nd edition, Wiley Publication
2. Data mining concepts and techniques, Jawai Han, MichellineKamber, Jiran Pie, Morgan Kaufmann Publishers, 3rd Edition.
3. Data Mining:Introductory and Advanced Topics ,M.H.Dunham, Pearson Education
4. Data Warehousing in the Real World – Anahory& Murray, Pearson Edt.
5. Data Warehousing Fundamentals – Ponniah [Wiley Publication]
6. Introduction to Business Intelligence & Data Warehousing, IBM, PHI.
7. Business modeling and Data Mining Dorian Pyle, Elsevier Publication MK.
8. Data Mining Practical Machine Learning Tools and Techniques - Ian H. Witten, Eibe Frank.

First Year M.Tech.Sem-I

CSL536: Advanced Software Engineering

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1 To understand the essentials of component-based software engineering.
2 To understand the essentials of client/server software engineering
3 To understand the basics of web engineering
4 To know principle of reengineering.

Course Outcomes

At the end of the course students will be able to

1. Understand the essentials of component-based software engineering.
2. Understand the essentials of client/server software engineering
3. Understand the basics of web engineering
4. Know principle of reengineering.
5. Study and Use the software engineering tools

Course Contents

Unit 1. Formal Methods **7 Hrs.**

Basic Concepts, Mathematical Preliminaries, Applying Mathematical Notation for Formal Specification, Formal Specification Languages, Using Z to Represent an Example Software Component, The Ten Commandments of Formal Methods.

Unit 2. Component-Based Software Engineering **7 Hrs.**

Engineering of Component-Based Systems, The CBSE Process, Domain Engineering, Component-Based Development, Classifying and Retrieving Components, Economics of CBSE.

Unit 3. **Client/Server Software Engineering** **6 Hrs.**

The Structure of Client/Server Systems, Software Engineering for c/s Systems, Analysis Modeling Issues, Design for c/s Systems, Testing Issues, Overall c/s Testing Strategy, c/s Testing Tactics.

Unit 4. **Web Engineering** **7 Hrs.**

The Attributes of Web-Based Applications ,The WebE Process ,A Framework for WebE ,Formulating/Analyzing Web-Based Systems ,Design for Web-Based Applications ,Architectural Design ,Navigation Design ,Interface Design, Testing Web-Based Applications.

Unit 5. **Reengineering** **5 Hrs.**

Business Process Reengineering, Software Reengineering, Reverse Engineering Restructuring, Forward Engineering, The Economics of Reengineering.

Unit 6. **Software Quality:** CASE tools, metrics, Standards, TQM, computer-aided software engineering, What is CASE? , Building Blocks for CASE, A Taxonomy of CASE Tools, Integrated CASE Environments, The Integration Architecture ,The CASE Repository **7 Hrs**

Reference Books

1. Software Engineering a Practitioners Approach, Roger S. Pressman, McGraw-Hill 8thEdition, 2014
2. Formal Specification and Documentation testing - A Case Study Approach, J.Bowan, International Thomson Computer Press, 2003
3. Software Engineering for Embedded Systems: Methods, Practical and Applications, Robert Oshana, Mark Kraeling, Newnes Publisher, 2013
4. Software engineering an engineering approach, James S. Peters, WitoldPedrycz, Wiley India, 2011.
5. Software Engineering Principles and Practice, Hans Van Vliet, Yded, 2015

First Year M.Tech.Sem-I

CSL537: Visualization Techniques

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1 An understanding of the key techniques and theory used in visualization.

2 Exposure to a number of common data domains and including multivariate data, graph, text.

3 To knowaboutEffective Visualizations.

Course Outcomes

At the end of the course students will be able to

1. Understand key techniques and theory used in visualization
2. Exposure to a number of common data domains and including multivariate data, graph, text.
3. Know about Effective Visualizations.
4. Introduction to available visualization software.
5. Implementation any Data pre-processing technique.

Course Contents

Unit 1. What is Visualization, the visualization process, Data Foundations, types of data – continuous data, sampled data, discrete datasets, Human Perception and Information Processing, Visualization Foundations. **6 Hrs.**

Unit 2. Visualization Techniques for Spatial Data: 1D, 2D and 3D, Dynamic Data, Geospatial Data, Visualizing Point, Line and Area Data, Visualization Techniques for Multivariate Data, Visualization Pipeline. **7 Hrs.**

Unit 3.	Visualization Techniques Graphs, Text and Document: Visualizing Trees, Graphs, and Networks, Displaying Hierarchical Structures, Arbitrary Graphs/Network, Levels of Text Representation, the Vector Space Model, Single Document Visualization, and Document Collection Visualization.	**7 Hrs.**
Unit 4.	Scientific Visualization: Scalar, Vector, Tensor Visualization, Domain Modeling Technique, Image and Volume Visualization.	**6 Hrs.**
Unit 5.	Interaction Concepts: Interaction Operators, Operands and Spaces, Interaction Techniques – Screen Space/Object Space, Data Space, Attribute Space, Animating Transformations, Designing Effective Visualizations Comparing and Evaluating Visualization Techniques, Visualization Systems	**7 Hrs.**
Unit 6.	Designing Effective Visualizations, Steps in Designing Visualizations, Problems in Designing Effective Visualizations	**6 Hrs.**

Reference Books

1. Interactive Data Visualization: Foundations, Techniques, and Applications (AK Peters) by Matthew O. Ward, Georges Grinstein and Daniel Keim
2. Interactive Data Visualization for the Web by Scott Murray, Free online version,http://chimera.labs.oreilly.com/books/1230000000345/index.html
3. AlexandruTelea, Data Visualization Principles and Practices, A K Peters 2010
4. Visualization Design and Analysis: Abstractions, Principles, and Methods by Tamara Munzner

First Year M.Tech.Sem-I
CSL538: Pattern Recognition

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1 To introduce student to various Pattern recognition techniques
2 To study the Representation and description and feature extraction
3 To study the principles of decision trees and clustering in pattern recognition.

Course Outcomes

At the end of the course students will be able to
1. Develop algorithms for Pattern Recognition.
2. Design the nearest neighbour classifier.
3. Develop and analyse decision tress.

Course Contents

Unit 1. Introduction: **7 Hrs.**

Definition of PR, Applications, Datasets for PR, Different paradigms for PR, Introduction to probability, events, random variables, Joint distributions and densities, moments. Estimation minimum risk estimators, problems.

Unit 2. Representation: **7 Hrs.**

Data structures for PR, Representation of clusters, proximity measures, size of patterns, Abstraction of Data set, Feature extraction, Feature selection, Evaluation.

Unit 3.	**Nearest Neighbour based classifiers**: Nearest neighbour algorithm, variants of NN algorithms, use ofNN for transaction databases, efficient algorithms, Data reduction, prototype selection.	**6 Hrs.**
Unit 4.	**Bayes classifier:** Bayes theorem, minimum error rate classifier, estimation of probabilities, estimation of probabilities, comparison with NNC, Naive Bayes classifier, Bayesian belief network.	**6 Hrs.**
Unit 5.	**Decision Trees:** Introduction, DT for PR, Construction of DT, Splitting at the nodes, Over-fitting & Pruning, Examples.	**6 Hrs.**
Unit 6.	**Clustering:** Hierarchical (Agglomerative, single/complete/average linkage, wards, Partitional (Forgy's, k-means, Isodata), clustering large data sets, examples.	**7 Hrs.**

Reference Books

1. Pattern Recognition (An Introduction) , V Susheela Devi, M Narsimha Murthy, Universities Press.
2. Pattern Recognition & Image Analysis, Earl Gose, Richard Johnsonbaugh, Steve Jost. PHI

First Year M.Tech.Sem-I

CSL539: High Performance Computer Architectures

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1 Introduce types of computer architectures.
2 Introduce concepts of Memory Hierarchy and latency.
3 Instruction Level Parallelism.
4 Study of Data-Level Parallelism in Vector, SIMD, and GPU Architectures.
5 Study of Warehouse-Scale Computers.

Course Outcomes

At the end of the course students will be able to

1. Explain different computer architectures.
2. Describe memory hierarchy and calculate memory latency.
3. Explain instruction level parallelism and its exploitation
4. Explain vector, SIMD and GPU architectures.
5. Describe thread level parallelism.
6. Explain warehouse-scale computer architecture.

Course Contents

Unit 1. Fundamentals of Quantitative Design and Analysis **5 Hrs.**

Introduction, Classes of Computers, Defining Computer Architecture, Trends in Technology, Trends in Power and Energy in Integrated Circuits, Trends in Cost, Dependability Measuring, Reporting, and Summarizing Performance Quantitative Principles of Computer Design Putting It AllTogether: Performance, Price, and Power, Fallacies and Pitfalls.

Unit 2. Memory Hierarchy Design **6 Hrs.**

Introduction, Ten Advanced Optimizations of Cache Performance, Memory Technology and Optimizations, Protection: Virtual Memory and Virtual Machines, Crosscutting Issues: The Design of Memory Hierarchies, Putting It All Together: Memory Hierarchies in the ARM Cortex-A8 and Intel Core I7, Fallacies and Pitfalls.

Unit 3. **Instruction-Level Parallelism and Its Exploitation** **8 Hrs.**

Instruction-Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP , Reducing Branch Costs with Advanced Branch Prediction, Overcoming Data Hazards with Dynamic Scheduling ,Dynamic Scheduling: Examples and the Algorithm , Hardware-Based Speculation, Exploiting ILP Using Multiple Issue and Static Scheduling , Exploiting ILP Using Dynamic Scheduling, Multiple Issue, and Speculation , Advanced Techniques for Instruction Delivery and Speculation ,Studies of the Limitations of ILP Cross-Cutting Issues: ILP Approaches and the Memory System, Multithreading: Exploiting Thread-Level Parallelism to Improve Uniprocessor Throughput , Putting It All Together: The Intel Core i7 and ARM Cortex-A8 233 Fallacies and Pitfalls.

Unit 4. **Data-Level Parallelism in Vector, SIMD, and GPU Architectures** **6 Hrs.**

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

Unit 5. **Thread-Level Parallelism** **7Hrs.**

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

Unit 6. **Warehouse-Scale Computers to Exploit Request-Level and Data-Level Parallelism** **7 Hrs.**

Introduction, Programming Models and Workloads for Warehouse-Scale Computers, Computer Architecture of Warehouse-Scale Computers, Physical Infrastructure and Costs of Warehouse-Scale Computers, Cloud Computing: The Return of Utility Computing, Crosscutting Issues, Putting It All Together: A Google Warehouse-Scale Computer Fallacies and Pitfalls.

Reference Books

1. Computer Architecture -A Quantitative Approach,FifthEdition by John L. Hennessy and David A. Patterson published by Elsevier.

First Year M.Tech.Sem-I

CSL540: Computer Vision

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. Introduce basic image operations.
2. Study of Image Thresholding and edge detection techniques.
3. Corner and interest point detection methods.
4. Binary Shape analysis
5. Fundamental vision operation like line, circle and ellipse detection.

Course Outcomes

At the end of the course students will be able to

1. Write algorithms for basic image processing operations.
2. Write algorithms for Thresholding and edge detection.
3. Explain corner and interest point detection methods
4. Explain methods for binary shape analysis.
5. Write algorithm for line detection and boundary analysis
6. Write algorithm for line and circle detection.

Course Contents

Unit 1. Low-Level Vision- Basic Image Operations **7 Hrs.**

Introduction, Gray Scale Versus Colour ,Image Processing Operations ,Some Basic Operations on Greyscale Images ,Basic Operations on Binary Images, Convolutions and Point Spread Functions, Sequential Versus Parallel Operations. Noise Suppression by Gaussian Smoothing, Median Filters, Mode Filters, Rank Order Filters, Reducing Computational Load, Sharp Unsharp Masking, Shifts Introduced by Median Filters, Discrete Model of Median Shifts, Shifts Introduced by Mode, Shifts Introduced by Mean and Gaussian Filters, Shifts Introduced by Rank Order Filters, Shifts in Rectangular Neighbourhoods, The Role of Filters in Industrial Applications of Vision Colour in Image Filtering.

Unit 2. **Low-Level Vision- Thresholding and Edge detection** **7 Hrs.**

Region-Growing Methods, Thresholding, Finding a Suitable Threshold, Tackling the Problem of Bias in Threshold Selection, Adaptive Thresholding , The Chow and Kaneko Approach, Local Thresholding Methods, More Thoroughgoing Approaches to Threshold Selection Variance-Based Thresholding, Entropy-Based Thresholding , Maximum Likelihood Thresholding, The Global Valley Approach to Thresholding, Practical Results Obtained Using the Global Valley Method, Histogram Concavity Analysis.Edge Detection- Basic Theory of Edge Detection ,The Template Matching Approach, Theory of 3x3x3 Template Operators, The Design of Differential Gradient Operators ,The Concept of a Circular Operator, Detailed Implementation of Circular Operators, The Systematic Design of Differential Edge Operators, Problems with the Above Approach—Some Alternative Schemes, Hysteresis Thresholding, The Canny Operator, The Laplacian Operator, Active Contours, Practical Results Obtained Using Active Contours, The Level Set Approach to Object Segmentation,The Graph Cut Approach to Object Segmentation

Unit 3. **Corner and Interest Point Detection** **7 Hrs.**

Template Matching , Second-Order Derivative Schemes, Median Filter-Based Corner Detector, Analyzing the Operation of the Median Detector, Practical Results ,The Harris Interest Point Operator ,Corner Signals and Shifts for Various Geometric Configurations, Performance with Crossing Points and Junctions, Different Forms of the Harris Operator, Corner Orientation Local Invariant Feature Detectors and Descriptors, Harris Scale and Affine-Invariant Detectors and Descriptors, Hessian Scale and Affine-Invariant Detectors and Descriptors, The SIFT Operator ,The SURF Operator ,Maximally Stable Extremal Regions, Comparison of the Various Invariant Feature Detectors

Unit 4. **Binary Shape Analysis** **6 Hrs.**

Connectedness in Binary Images ,Object Labeling and Counting , Solving the Labelling Problem in a More Complex Case, Size Filtering, Distance Functions and Their Uses, Local Maxima and Data Compression, Skeletons and Thinning, Crossing Number, Parallel and Sequential Implementations of Thinning ,Guided Thinning, A Comment on the Nature of the Skeleton ,Skeleton Node Analysis, Application of Skeletons for Shape Recognition ,Other Measures for Shape Recognition ,Boundary Tracking Procedures

Unit 5. **Boundary Pattern Analysis and Line Detection** **6 Hrs.**

Boundary Tracking Procedures, Centroidal Profiles, Problems with the Centroidal Profile Approach, Some Solutions, The (s, ψ) Plot, Tackling

the Problems of Occlusion, Accuracy of Boundary Length Measures.Application of the Hough Transform to Line ,The Foot-of-Normal Method, Longitudinal Line ,Final Line Fitting , RANSAC for Straight Line Detection, Location of Laparoscopic Tools

Unit 6. Circle and Ellipse Detection **6 Hrs**

Hough-Based Schemes for Circular Object Detection, The Problem of Unknown Circle Radius, The Problem of Accurate Center Location, Overcoming the Speed Problem, Ellipse Detection, Human Iris Location ,Hole Detection.

Reference Books

1. Computer and Machine Vision: Theory, Algorithms, Practicalities-Fourth Edition by E. R. Davies, Elsevier Publication.

First Year M.Tech.Sem-I

CSL541: Research Methodology

Teaching Scheme	
Lectures	2 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	3

Evaluation Scheme	
CIE	50
Total	**50**

Course Objectives

1. To familiarise students with the dimensions and methods of research.
2. To familiarise students with different methods of data collection.
3. Give students an insight into the steps to be followed in doing a research

Course Outcomes

At the end of the course students will be able to

1. Understand the dimensions and methods of research.
2. Use appropriate method for data collection.
3. Perform research by following research process steps systematically.

Course Contents

Unit 1. Fundamentals of Research **4 Hrs.**

Introduction, Concepts of Research, Research Process, Creativity in Research, Ethics in Research, Managers and Research

Unit 2. Research Problem **4 Hrs.**

Introduction, Concept of Research Problem, Conditions and Components of Research Problem

Unit 3. Research Design **4 Hrs.**

Introduction, Concept of Research Design, Need and Features of Research Design, Components of Research Design, Types of Research Design

Unit 4. Methods of Data Collection **5 Hrs.**

Concepts of Data Collection, Types of Data, Methods of Primary Data Collection, Some other Methods of Primary Data Collection, Methods of Secondary Data Collection, Selecting an Appropriate Method of Data Collection

Unit 5. **Data Processing and Analysis** **5 Hrs.**

Introduction, Concepts of Data Processing, Concept of Data Analysis, Measures of Central Tendency, Measures of Dispersion, Measures of Skewness, Measures of Relationship, Other Statistical Measures used in Research

Unit 6. **Computer Application in Research Methodology** **4 Hrs.**

Introduction, Computer Application in Research Methodology, SPSS Software, Descriptive Statistics, Bivariate Statistics, Regression Analysis

Reference Books

1. Research Methodology by G.C.Ramamurthy&Kogent Learning Solutions Inc. (dreamtech press)

First Year M.Tech.Sem-I

CSP542– Design and Analysis of Algorithms Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments

1. Demonstration of use of profiler.
2. Implementation of binary search and its analysis.
3. Write efficient algorithm to find minimum and maximum of given numbers.
4. Implementation of Merge Sort and its analysis.
5. Implementation of Quick Sort and its analysis.
6. Write program to find single source shortest path.
7. Implementation of Prim's and Kruskal's algorithm to find minimum cost spanning tree.
8. Implementation of Huffman coding.
9. Write program to give solution to Knapsack Problem.
10. Write program to give solution to Job sequencing with deadlines problem.
11. Write program to give solution to multistage graph problem.
12. Write program to give solution to all pair shortest path problem.
13. Write program to find Optimal Binary Search Tree.
14. Write program to give solution to Reliability design problem.

First Year M.Tech.Sem-I

CSP543– Service Oriented Architecture Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments

1. Demonstration of Web Services.
2. Invoke EJB components as web services.
3. Invoking J2EE web service in ASP.Net using C#.
4. Invoking ASP.Net web service using J2EE.
5. Implementation of CORBA.
6. Develop a j2ee client to access a .net web service.
7. Develop a .net client to access a j2ee web service.
8. To implement calculator and to calculate simple and complex interest using .net.
9. To develop an invoice order processing using .net components.
10. Creation of a bpel module and a composite application.

First Year M.Tech.Sem-I

CSP544– Business Intelligence and Data Mining Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

It should consist of minimum 8-10 experiments based on the following and syllabus topics.

1 Implement of preprocessing on sample dataset .

2 Implementation of cube operator in OLAP queries in data warehousing and decision support system.

3 Implement apriori algorithm in data mining for sample dataset.

4 Implement association rule mining for sample dataset.

5 Implement sequence mining for sample dataset

6 Implement web usage mining algorithm.

7 Implement data pre-processing for server log files.

8 Study of data mining tools like weka.

9 Implementation of OLAP queries.

First Year M.Tech.Sem-I

CSP545– Advanced Software EngineeringLab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

Practical: It should consist of minimum 8-10 experiments based on the following and syllabus topics.

1 Use case tools for analyzing and designing software

2 Using rational rose draw all diagrams to be drawn for small sample software.

3 A Case study for UML diagrams.

4 Study of Any Testing Tool (Win Runner).

5 Study of any web testing tool (e.g. Selenium).

6 Study of Any Bug Tracking Tool (Bugzilla, Bugbit).

7 Study of Any Test Management Tool (Test Director).

8 Study of any open source testing tool (Test Link).

8 Identifying the Requirements from Problem Statements

10 Estimation of Project Metrics

11 Modeling UML Use Case Diagrams and Capturing Use Case Scenarios

12 E-R Modeling from the Problem Statements

13 Identifying Domain Classes from the Problem Statements

14 Drawing State chart and Activity Modelling, Data Flow Diagramsfrom the Problem Statements.

First Year M.Tech.Sem-I
CSP546– Visualization Techniques Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

Practical:

It should consist of minimum 8-10 experiments based on the following and syllabus topics.

1 Prepare data files for data mining .
2 Study of weka tool.
3 Implement any Data preprocessing technique
4 Study of following visualization tools.

- Xmdvtool (a multivariate visualization tool, Windows)
  Xmdvtool Home Page for help
- OpenDX (open interactive visualization software also from IBM, Windows)
  OpenDX Complete documentation
- GGobi (interactive tool for multivariate data viz), Windows)
- Protovis visualizations implemented in Javascript (Stanford University)
  Protovis is superceded by D3 and tutorials
  at https://github.com/mbostock/d3/wiki/Tutorials
- Graphviz (graph layout algorithms, Windows)
- Prefuse (toolkit for building Java viz applications)
- OpenRefine, formerly Google Refine, is a desktop application with algorithms to seek similarities in data records. Other features make it easier to do various types of data editing and clustering. You can also compare entries in your data with items in another database to standardize records, as long as the reference database has a Reconciliation Service API. Possible reconciliation databases include OpenCorporatesand Freebase.
- Google Chart Tools. Find it at: https://developers.google.com/chart/
- Quantum GIS (QGIS) An open source alternative to ArcGIS. Get it: http://www.qgis.org
- R Project for Statistical Computing R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS.
- Processing
  A free, open source programming language and environment. Allows for rapid prototyping of visual, interactive programs.
- Data-Driven Documents (d3)

A free, small Javascript library well suited for interactive data visualization on the web.

- Many Eyes
  A free online visualization tool that allows users to upload data, select a visualization technique, and share the resulting visualization. Provided by IBM Research and the IBM Cognos software group.
- Tableau Public
  A free service allowing uses to publish interactive data visualizations to the web.

Visualizing.org

A website that allows users to create and share visualizations, and hosts datasets and visualization challenges.

5 Create web-based interactive visualizations using Java and D3.

6 Use Java and other tools to scrape, clean, and process data.

First Year M.Tech.Sem-I
CSD547: Seminar-I

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	2

Evaluation Scheme	
CIE	100
Total	**100**

Each student is required to do a seminar presentation on a topic preferably from the area in which a student intends to work for his dissertation during Semester – III and Semester – IV. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review and develop confidence to present the material by the student. The seminar shall be evaluated by a Department Committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester.

First Year M. Tech Programme in Computer Science and Engineering
Semester-II

Sr. No.	Course Code	Name of the Course	Group	Teaching Scheme				Credits	Audit
				Theory Hrs/ Week	Tutorial Hrs/ Week	Practical Hrs/ Week	Total		
1	CSL548	Advanced Network Engineering	D	4	1	-	5	5	-
2	CSL549	Design of Database Systems	D	4	-	-	4	4	-
3	CSL550	Parallel Algorithms Design	D	4	-	-	4	4	-
4	CSLEL3	Elective –III	D	3	1	-	4	4	-
5	CSLEL4	Elective -IV	D	3	1	-	4	4	-
6	CSP557	Design of Database Systems Lab	D	-	-	2	2	1	-
7	CSP558	Parallel Algorithms Design Lab	D	-	-	2	2	1	-
8	CSPEL3	Elective -III Lab	D	-	-	2	2	1	-
9	CSD562	Seminar-II	F	-	-	2	2	2	-
Total				18	3	8	29	26	-

Group Details

A: Basic Science

B: Engineering Science

C: Humanities Social Science & Management

D: Professional Courses & Professional Elective

E: Open Elective F: Seminar/Training/ Project

CSLEL3 - Elective III	
CSL551	Advanced Operating Systems
CSL552	Advanced Distributed Systems
CSL553	Embedded Systems and Robotics

CSLEL4 - Elective IV	
CSL554	Visual Cryptography
CSL555	Soft Computing
CSL556	Biometrics

CSPEL3 - Elective III Lab	
CSP559	Advanced Operating Systems Lab
CSP560	Advanced Distributed Systems Lab
CSP561	Embedded Systems and Robotics Lab

First Year M.Tech.Sem-II

CSL548– Advanced Network Engineering

Teaching Scheme	
Lectures	4 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	5

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To understand network protocols, architectures and applications
2. To study the functionality of various layers of the OSI model / TCP/IP model and understand the interactions between them
3. To Study description of the various Routing in the Internet and the working of ATM.
4. To understand the networking management principals

Course Outcomes

At the end of the course students will be able to

1. Understand network protocols, architectures and applications.
2. Understand the functionality of various layers of the OSI model / TCP/IP model and understand the interactions between them
3. Describe various Routing in the Internet and the working of ATM.
4. Understand the networking management principals.
5. Use various tools and utilities of networking

Course Contents

Unit 1. Introduction **12 Hrs.**

Protocols and standards, Standards Organizations, Internet Standards, Internet Administration, Overview of reference models : The OSI model, TCP/IP protocol suite, Addressing, Connectors, Network interface cards and PC cards, Repeaters, Hubs, Bridges, Switches, Routers and Gateway, Network architecture , Networking principles, Network services and Layered architecture , e.g. networks (Internet , ATM , Cable TV, Wireless – Bluetooth, Wi-Fi, WiMax,Cell phone).

Unit 2. **ATM :The WAN Protocol** **9 Hrs.**

Introducing ATM Technology, Introducing Faces of ATM, Explaining the basic concepts of ATM Networking, Exploring the B-ISDN reference model, explaining the Physical Layer, Explaining the ATM Layer, Explaining the ATM Adaptation Layer, Exploring ATM Physical interface, choosing an Appropriate ATM Public Service.

Unit 3. **Common Protocols and Interfaces in Upper Layer** **6 Hrs.**

TCP/IP suite, Network Layer, Transport Layer, Applications Layer.

Unit 4. **Routing in the Internet** **9 Hrs.**

Intra and interdomain routing; Unicast Routing Protocols : RIP, OSPF, BGP; Multicast Routing Protocols : MOSPF, DVMRP. Drawbacks of traditional routing methods, Idea of TE, TE and Different Traffic classes. IP over ATM, Multi protocol Label switching (MPLS).

Unit 5. **Network Management and Services** **8 Hrs.**

SNMP: Concept, Management components, SMI, MIB, SNMP format, Messages.

Unit 6. **Traffic Engineering and Capacity Planning** **8 Hrs.**

Traffic Engineering Basics: Requirement, Traffic sizing, characteristics, Protocols, Time Delay considerations, Connectivity, Reliability, Availability and Maintainability, Throughput calculations.

Reference Books

1. TCP/IP Protocol Suite, (B. A. Forouzan), Tata McGraw Hill
2. Advance Computer Network- DayanandAmbawade, Dr.Deven shah, Prof.MahendraMehra- Wiley India
3. CCNA Intro – Study Guide – Todd Lammle, Sybex
4. Computer Networks: Principles, Technologies and Protocols for Network design, (N. Olifer, V. Olifer), Wiley India.
5. TCP/IP Volume 1, 2, 3, (W. Richard Stevens), Addison Wesley
6. TCP/IP Volume I and II, (D. E. Comer), Pearson Education.
7. High Performance Communication Networks, (J. Walrand, P. Varaiya), Morgan Kaufmann.
8. Computer Networks, (A. S. Tanenbaum), Pearson Education, Fourth Edition.
9. High-Speed Networks and Internets, Performance and Quality of Service, - William Stallings, PearsonEducation
10. Larry L. Peterson, Bruce S ,"Computer Networks: A Systems Approach", 4th edition, Davie Publisher

First Year M.Tech.Sem-II
CSL549– Design of Database Systems

Teaching Scheme	
Lectures	4 Hrs. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To learn the modeling and design of databases.
2. To acquire knowledge on parallel and distributed databases and its applications
3. To study the usage and applications of Object Oriented database
4. To understand the principles of intelligent databases.
5. To understand the usage of advanced data models

Course Outcomes

At the end of the course students will be able to

1. Model and design databases.
2. Understand parallel and distributed databases.
3. Use Object Oriented databases.
4. Use advanced data models.
5. Understand intelligent databases.

Course Contents

Unit 1. Introduction to Database Design **10 Hrs.**

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.

Unit 2. Object Database System **9 Hrs.**

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

Unit 3. Parallel And Distributed Databases **10 Hrs.**

Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Design of Parallel Systems- Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Case Studies.

Unit 4. Emerging Technologies **9Hrs.**

XML Databases: XML-Related Technologies-XML Schema- XML Query Languages- Storing XML in Databases-XML and SQL- Native XML Databases- Web Databases- Geographic Information Systems- Biological Data Management- Cloud Based Databases: Data Storage Systems on the Cloud- Cloud Storage Architectures-Cloud Data Models- Query Languages- Introduction to Big Data-Storage-Analysis.

Unit 5. Security and Authorization **6 Hrs.**

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

Unit 6. Business Intelligence and Data Warehouses **8 Hrs.**

The Need for Data Analysis, Business Intelligence, Business Intelligence Architecture, Decision Support Data, Online Analytical Processing, Star Schemas, Implementing a Warehouse, Data Mining, SQL Extension for OLAP.

Text Books

1. Database System Concepts – Silberschatz, Korth, Sudarshan – 5th Edi(MGH International Edition).
2. Fundamentals of Database Systems - Elmasri and Navathe [4e], Pearson Education3. Database Systems, Design, Implementation and Management - Coronel-Morris-Rob)
3. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design,Implementation and Management", Third Edition, Pearson Education, 2007.
4. Database Management System – Raghu Ramkrishnan, Johannes Gehrke, Database Management Systems[3e], (MGH)
5. Advanced Database Management System – RiniChakrabarti -ShilbhadraDasgupta
6. Data Mining : Introductory and Advanced Topics – Margaret H. Dunham (Pearson Education)
7. Oracle / IBM DB2 documentation/manuals : www.oracle.com / www.ibm.com

First Year M.Tech.Sem-II
CSL550: Parallel Algorithms Design

Teaching Scheme	
Lectures	4 Hrs. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. Understanding of parallel program structure
2. Parallel algorithm design process
3. Parallel Algorithm Performance Issues
4. Shared memory architecture and its issues
5. Study of parallel algorithms.

Course Outcomes

At the end of the course students will be able to

1. Design parallel algorithms for different problems
2. Analyse performance of parallel programs
3. Describe shared memory architecture and cache coherence issues
4. Explain parallel algorithms for matrix multiplication, reduction and linear equations
5. Explain parallel algorithms for Sorting and searching.

Course Contents

Unit 1. Parallel Programs **10 Hrs.**

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.

Unit 2. **Programming for Performance** **9 Hrs.**

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.

Unit 3. **Shared Memory Multiprocessors** **9 Hrs.**

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

Unit 4. **Processor Array, Multiprocessor and Multicomputer:** **8 Hrs.**

Processor organization, processor array, Multiprocessor, Multicomputer, Flyann's taxonomy, speedup, scaled speedup and parallelizability, mapping data to processors on processor array and multicomputer.

Unit 5. **Parallel Algorithms-Reduction, Matrix Multiplication and Linear Systems** **8 Hrs.**

Reduction, Matrix Multiplication -Sequential matrix multiplication, algorithm for multiprocessor, processor array algorithm, multi-row-column oriented multiplication, block-oriented algorithm. Linear System Algorithms -Back substituting odd even reduction, Gaussian elimination, the Jacobi algorithm, Gauss-Seidel algorithm, Jacobi over relaxation & successive over relaxation, multi grid method, conjugate gradient method.

Unit 6. **Parallel Algorithms - Sorting and searching** **8 Hrs.**

Enumeration Sort, Lower bound on parallel sorting, odd-even transportation sort, Bitonic Merge, QuickSort based algorithms. Combinatorial Search – Divide and conquer, branch and bound, parallel branch and bound algorithm, alpha-beta search, parallel alpha-beta search.

Reference Books

1. Parallel Computer Architecture: A Hardware/Software Approach, by David Culler, Jaswinder Pal Singh , Anoop Gupta,1st edition, Elsevier Publication.

2. Parallel Computing: Theory and Practice, by Michael Quinn, McGraw Hill Education India Private Limited Publication.

First Year M.Tech.Sem-II

CSL551–Advanced Operating Systems

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To obtain the knowledge of advanced operating systems concepts including its architecture and other important aspects.
2. To introduce with the concepts of process management tasks and its relevance in the advanced operating systems.
3. To introduce the distributed operating systems through its architecture, network structures and its applications.
4. To obtain the insight of real time operating systems, their implementation and applications through case studies.

Course Outcomes

At the end of the course students will be able to

1. Identify the scope of advanced operating systems in comparison with traditional operating systems under various criteria such as process management and scheduling.
2. Demonstrate deadlock concepts such as deadlock detection and deadlock prevention.
3. Discuss various resource management techniques in distributed operating systems.
4. Demonstrate the key features of Linux kernel and its relevance with advanced and distributed operating systems.

Course Contents

Unit 1. Fundamentals Of Operating Systems **8 Hrs.**

Overview, Process Scheduling, Interprocess Communication, Multithreading Models, Threading Issues, Scheduling criteria, Scheduling algorithms, Deadlocks- Method for handling deadlocks, prevention, avoidance and detection, Memory Management- Swapping, Contiguous Memory Allocation, Paging, Segmentation

Unit 2. Distributed Operating Systems **8 Hrs.**

Types of Distributed OS, Network Structure, Network Topology, Communication structure, Communication Protocols, Robustness, Design Issues

Unit 3. Distributed Resource Management **7 Hrs.**

Distributed File Systems- Naming and Transparency, Remote File Access, Stateful Versus Stateless Service, Distributed Synchronization – Event ordering, Mutual Exclusion, Atomicity, Concurrency Control, Election Algorithms, Reaching Agreement

Unit 4. Real Time Operating Systems **8 Hrs.**

System Characteristics, Features of Real-Time Kernels, Implementing Real Time Operating Systems, Real Time CPU Scheduling,
Multimedia Systems – multimedia, compression, requirements of multimedia kernels, CPU scheduling, Disk Scheduling, Network Management, CineBlitz
Influential Operating Systems – Early Systems, Atlas, XDS-940, THE, RC 4000, CTSS, MULTICS, IBM OS / 360, Mach, Other Systems

Unit 5. Case Studies: Linux, Android and iOS **5 Hrs.**

Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, Input and Output File System Interprocess Communication.
iOS and Android: Architecture and SDK Framework Media Layer Services Layer Core OS Layer File System.

Unit 6. Study of Commercial Operating Systems **3 Hrs.**

QNX : Real Time Operating System, VX Works , Features and applications

Reference Books

1. Abraham Silberschatz; Peter Baer Galvin; Greg Gagne, ― "Operating System Concepts", Seventh Edition, John Wiley & Sons, 2004.
2. Daniel P Bovet and Marco Cesati, ― "Understanding the Linux kernel", 3rd edition, O'Reilly, 2005.
3. Rajib Mall, ― "RealTime Systems: Theory and Practice", Pearson Education India, 2006.
4. Neil Smyth, ―" iPhone iOS 4 Development Essentials – Xcode", Fourth Edition
5. MukeshSinghal and Niranjan G. Shivaratri, ― "Advanced Concepts in Operating Systems – Distributed, Database, and Multiprocessor Operating Systems", Tata McGrawHill, 2001.

First Year M.Tech.Sem-II
CSL552–Advanced Distributed Systems

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To understand concept of distributed systems and different architectures.
2. To understand concept and need of fault tolerant systems in distributed environment.
3. To establish local cloud environment in the campus.
4. To understand concept of virtualization in cloud computing.

Course Outcomes

At the end of the course students will be able to

1. Demonstrate need of distributed systems.
2. Build local cloud environment for uploading different parameters.
3. Apply concept of virtualization for real world problems.
4. Work on data security issues in cloud environment.

Course Contents

Unit 1. **Introduction** **7 Hrs.**

Definition, Need of distributed system ,Goals, Types of distributed systems: Distributed Computing System, Distributed Information System, Architecture: Architectural, Styles, System Architecture

Unit 2. Processes and Communication Remote Procedure Call, Message Oriented Transient Communication, Physical Clock Synchronization, Logical Clock, Mutual exclusion, Election Algorithms **6 Hrs.**

Unit 3.	Distributed File Systems and Fault Tolerance Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Introduction to fault tolerance, Process Resilience, Distributed Commit, Recovery	**7 Hrs.**
Unit 4.	Introduction to Cloud 04 Getting to know the Cloud, Cloud and other similar configurations, Components of Cloud Computing, Cloud Types and Models: Private Cloud, Community Cloud, Public Cloud, Hybrid Clouds.	**6 Hrs.**
Unit 5.	Virtualization: Introduction and benefits, Implementation Levels of Virtualization, Virtualization at the OS Level, Virtualization Structure, Virtualization Mechanism, Open Source Virtualization Technology, Xen Virtualization Architecture, Binary Translation with Full Virtualization, Para virtualization, Virtualization of CPU, Memory and I/O Devices.	**6 Hrs.**
Unit 6.	Cloud Computing Services and Data Security in Cloud 08 Infrastructure as a Service, Platform as a Service, Software as a Service, Database as a Service , Specialized Cloud Services, Challenges with Cloud Data, Challenges with Data Security, Data Confidentiality and Encryption, Data availability, Data Integrity, Cloud Storage Gateways	**7 Hrs.**

Reference Books

1. Distributed Systems: Principles and Paradigms- Tanenbaum, Steen
2. Cloud Computing Black Book- Jayaswal, Kallakurchi, Houde, Shah, Dreamtech Press
3. Cloud Computing: Principles and Paradigms – Buyya, Broburg, Goscinski
4. Cloud Computing for Dummies – Judith Hurwitz.

First Year M.Tech.Sem-II
CSL553–Embedded System and Robotics

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To understand basic concepts in embedded systems.
2. To understand software engineering process for design of embedded systems.
3. To learn basic robot operations.
4. To program robots for simple operations.
5. To understand applications of robotics in industries.

Course Outcomes

At the end of the course students will be able to

1. Design simple embedded systems.
2. Differentiate embedded system and microcontroller based systems.
3. Program robots.
4. Demonstrate simple applications using robotics platforms.

Course Contents

Unit 1. **Introduction to Embedded systems** **3 Hrs.**
Embedded Systems, Embedded hardware units and devices in systems, embedded software, design process, types of embedded system.

Unit 2. 8051 Architecture, real world interfacing, advanced architectures ,processor and memory organizations, instruction level parallelism, performance metrics, memory types , memory map and addresses, processor selection, memory selection **7 Hrs.**

Unit 3. **Device drivers and interrupt services mechanism** **6 Hrs.**

Programmed I/O ,Busy –wait approach,ISR concept, Interrupt services, Multiple interrupts, context and periods for context switching, Interrupt latency and deadline, MA, Device driver programming

Unit 4. **Microcontroller families for Embedded systems** **8 Hrs.**

PIC microcontroller, intel microcontroller, Texas Instruments Microcontrollers, Atmel AVR, ARM. Architecture of Atmel AVR microcontroller, Instructions, addressing and programming in assembly language. Serial , parallel input output programming Mixed C and Assembly language programming, interfacing low voltage and high voltage circuits, Timers, counters programming, using interrupts for i/o operations

Unit 5. **Designing Embedded Systems** **7 Hrs.**

Architecture of Embedded system, hardware/software tradeoff and design, programming embedded systems, process of embedded system development, hardware platforms, communication interfaces.

Unit 6. **Robotics** **8 Hrs.**

Introduction to Fire Bird robot platform, Programming fire bird platform in handle C., Implementing mail merge algorithm on firebird platform, Interfacing HD camera to firebird. six axis and eight axis robot platforms, pick and place robots. Wireless interface for robots, controlling robots using tablets.

Reference Books

1. Embedded Systems: Architecture, Programming and Design 2nd Edition, Raj Kamal, McGraw-Hill Publication. (For Unit 1-5)
2. www.eyantr.org , www. iitbombayx.in (moocs server) for unit 6
3. Embedded Real Time Systems: Concepts, Design and Programming -Dr. K.V.K. Prasad - Black Book, Edition: 2014 (Unit 6)

First Year M.Tech.Sem-II
CSL554 –Visual Cryptography

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1 To explain fundamentals of Visual Cryptography.
2 To distinguish between traditional and extended Visual Cryptography.
3 To summarize different Visual Cryptography schemes.
4 To Apply various Visual Cryptography schemes.

Course Outcomes

At the end of the course students will be able to

1 Explain fundamentals of Visual Cryptography.
2 Describe mathematical model for Visual Cryptography.
3 Distinguish between traditional and extended Visual Cryptography.
4 Summarize different Visual Cryptography schemes.
5 Apply various Visual Cryptography schemes.

Course Contents

Unit 1. Fundamentals of Visual Cryptography **6 Hrs.**

Secret sharing, Visual Cryptography, Implementation of Visual Cryptography Scheme, 2-out-of-2 Visual Cryptography Scheme, n-out-of-n Visual Cryptography Scheme, 2-out-of-n Visual Cryptography Scheme, Pixel Expansion, OR-based Visual Cryptography, XOR-based Visual Cryptography, Characteristics of Basic Visual Cryptography Scheme, Shortcomings of Basic Visual Cryptography Scheme, Cheating Prevention in Visual Cryptography Schemes.

Unit 2. **Various Visual Cryptography Schemes** **7 Hrs.**

(k, n) Visual Cryptography Scheme, Visual Cryptography for General Access Structure, Recursive Threshold Visual Cryptography Scheme, Halftone Visual Cryptography. Visual Cryptography for Gray level images, Multiple Secret Sharing Scheme, Segment Based Visual Cryptography.

Unit 3. **Extended Visual Cryptography** **6 Hrs.**

Fundamentals of Extended Visual Cryptography, Half toning, Dithering, Embedding Shares,Extended Visual Cryptography Scheme Using One Shared Image

Unit 4. **Visual Cryptography for ColorImages** **6 Hrs.**

Introduction, Color Models, Color Visual Cryptography Schemes, Color Extended Visual Cryptography Schemes, Visual Information Pixel (VIP) Synchronization- fundamentals, Matrix Derivation for VIP Synchronization

Unit 5. **Progressive and Region Incrementing Visual Cryptography Schemes** **7 Hrs.**

Progressive Visual Cryptography Scheme- Basic Model, Visual Cryptography with perfect restoration, Progressive multi-resolution Visual Cryptography, Progressive Visual Cryptography with expanded shares, Progressive Visual Cryptography with unexpanded shares.
Region Incrementing Visual Cryptography Scheme- Basic Model, Construction of N-Level Region Incrementing Visual Cryptography Scheme, k out of n Region Incrementing Visual Cryptography Scheme.

Unit 6. **Applications of Visual Cryptography** **7 Hrs.**

Information Hiding, Watermarking, Resolution variant Visual Cryptography- Licence Plate Embedding, Multi-resolution Visual Cryptography Schemes, Secure transaction, Authentication, Voting System.

Reference Books

1 Jonathan Weir and WeiQi Yan, "Visual Cryptography and Its Applications", Ventus Publishing ApS, ISBN 978-87-403-0126-7
2 Feng Liu, Wei Qi Yan, "Visual Cryptography for Image Processing and Security-Theory, Methods, and Applications", Springer
3 StelvioCimato, Ching-Nung Yang, "Visual Cryptography and Secret Image Sharing", CRC Press

First Year M.Tech.Sem-II

CSL555 –Soft Computing

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To familiarize with soft computing concepts.
2. To introduce the ideas of Neural networks and fuzzy logic.
3. To understand the concepts of Genetic algorithm and its applications.

Course Outcomes

At the end of the course students will be able to

1. Understand fundamentals of Artificial Neural Networks.
2. Compare different Associative Memory Networks.
3. Perform fuzzy arithmetic.
4. Classify Genetic Algorithms.
5. Evaluate hybrid soft computing techniques.

Course Contents

Unit 1. Artificial Neural Networks – Introduction **6 Hrs.**

Introduction – Fundamental concept – Evolution of Neural Networks – Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron – Linear Separability – Hebb Network. Supervised Learning Network: Perceptron Networks – Adaline – Multiple Adaptive Linear Neurons – Back-Propagation Network – Radial Basis Function Network.

Unit 2. Associative Memory Networks **7 Hrs.**

Training Algorithms for Pattern Association – Auto associative Memory Network – Heteroassociative Memory Network – Bidirectional Associative Memory – Hopfield Networks – Iterative Auto associative Memory Networks – Temporal Associative Memory Network. Unsupervised Learning Networks: Fixed weight Competitive Nets – Kohonen Self-Organizing Feature Maps – Learning Vector Quantization – Counter propagation Networks – Adaptive Resonance Theory Networks – Special Networks.

Unit 3. Fuzzy Set Theory **6 Hrs.**

Introduction to Classical Sets and Fuzzy sets – Classical Relations and Fuzzy Relations – Tolerance and Equivalence Relations – Noninteractive Fuzzy sets – Membership Functions: Fuzzification – Methods of Membership Value Assignments – Defuzzification – Lambda-Cuts for Fuzzy sets and Fuzzy Relations – Defuzzification Methods.

Unit 4. Fuzzy Arithmetic and Fuzzy Measures **6 Hrs.**

Fuzzy Rule Base and Approximate Reasoning: Truth values and Tables in Fuzzy logic – Fuzzy Propositions – Formation of Rules – Decomposition and Aggregation of rules – Fuzzy Reasoning – Fuzzy Inference Systems (FIS) – Fuzzy Decision Making – Fuzzy Logic Control Systems.

Unit 5. Genetic Algorithm **7 Hrs.**

Introduction – Basic Operators and Terminologies in GAs – Traditional Algorithm vs. Genetic Algorithm – Simple GA – General Genetic Algorithm – The Scheme Theorem – Classification of Genetic Algorithm – Holland Classifier Systems – Genetic Programming. Applications of Soft Computing: A Fusion Approach of Multispectral Images with SAR Image for Flood Area Analysis – Optimization of Travelling Salesman Problem using Genetic Algorithm Approach – Genetic Algorithm based Internet Search Technique – Soft Computing based Hybrid Fuzzy Controllers – Soft Computing based Rocket Engine – Control.

Unit 6. Hybrid Soft Computing **7 Hrs.**

Neuro-fuzzy hybrid systems – genetic neuro hybrid systems – genetic fuzzy hybrid and fuzzy genetic hybrid systems – simplified fuzzy ARTMAP – Applications: A fusion approach of multispectral images with SAR, optimization of traveling salesman problem using genetic algorithm approach, soft computing based hybrid fuzzy controllers.

Reference Books

1. S.N. Sivanandan and S.N. Deepa, Principles of Soft Computing, Wiley India, 2007. ISBN: 10: 81-265-1075-7.
2. S. Rajasekaran and G.A.V.Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI, 2003.
3. J.S.R.Jang, C.T.Sun and E.Mizutani, Neuro-Fuzzy and Soft Computing, PHI, 2004, Pearson Education.

First Year M.Tech.Sem-II
CSL556 – Biometrics

Teaching Scheme	
Lectures	3 Hrs. /Week
Tutorials	1 Hr. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objectives

1. To understand fundamentals of biometrics.
2. To gain a broader knowledge and understand the different Biometric techniques.
3. To learn about biometrics for network security.

Course Outcomes

At the end of the course students will be able to

1. Understand fundamentals of biometrics.
2. Grasp the benefits of Biometric security.
3. Do Verification and identification.
4. Compare different technologies of biometric systems.
5. Apply biometrics for network security.

Course Contents

Unit 1. Biometric Fundamentals **7 Hrs.**

Introduction, Benefits of biometric security, Verification and identification, Basic working of biometric matching, Accuracy, False match rate, False nonmatch rate, Failure to enroll rate, Derived metrics, Layered biometric solutions.

Unit 2. Finger scan **7 Hrs.**

Features, Components, Operation (Steps), Competing finger Scan technologies, Strength and weakness, Types of algorithms used for interpretation.

Unit 3. Facial Scan **6 Hrs.**

Features, Components, Operation (Steps), Competing facial Scan technologies, Strength and weakness.

Unit 4. **Iris Scan** **6 Hrs.**
Features, Components, Operation (Steps), Competing iris Scan technologies, Strength and weakness.

Unit 5. **Voice Scan** **6 Hrs.**
Features, Components, Operation (Steps), Competing voice Scan (facial) technologies, Strength and weakness.

Unit 6. **Biometrics for Network Security** **7 Hrs.**
Biometrics Application, Privacy risks of Biometrics, Biometric standards – (BioAPI , BAPI), Biometrics for Network Security, Statistical measures of Biometrics, Biometric Transactions.

Reference Books

1. Samir Nanavati, Michael Thieme, Raj Nanavati "Biometrics – Identity Verification in a Networked World", WILEY- Dream Tech Edition 2009.
2. Paul Reid "Biometrics for Network Security", Pearson Education.2009.
3. John D. Woodward, Jr. Wiley Dreamtech Biometrics- The Ultimate Reference-, Reprint 2009.
4. Anil K Jain, Patrick Flynn and Arun A Ross, "Handbook of Biometrics", Springer, USA, 2010.

First Year M.Tech.Sem-II

CSP557– Design of Database Systems Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments

It should consist of minimum 10-12 assignments, based on the syllabus and below mentioned experiment list.

1. To develop and write SQL queries for a distributed database of Bookstore at four sites S1, S2, S3 and S4. The Bookstores are divided into four sites by their ZIP codes.
2. Deadlock Detection Algorithm For Distributed Database Using Wait For Graph.
3. Implement Partitioning on the tables.
4. Implement semi join in distributed DBMS.
5. Implement bloom join in Distributed DBMS
6. Implement two phase commit in distributed DBMS.
7. Develop an application using multivalued Attributes, complex types, procedure, function and Inheritance in ORDBMS
8. Demonstration of Active Database.
9. Implementation of Oracle Packages, Synonyms and Sequence.
10. Implementation of XML commands.
11. Designing XML Schema For Company Database using Xpath and Xquery.
12. Implement K-Means Data Mining Clustering Algorithm.
13. Implement a priori algorithm.
14. Implementation of OLAP queries.
15. Implementation of cube operator in OLAP queries in data warehousing and decision support system.
16. Implement view modification and materialization in data warehousing and decision support systems.

First Year M.Tech.Sem-II
CSP558–Parallel Algorithms Design Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments

1 Study of different parallel architectures.

2 Write a parallel program to calculate value of PI for different architectures

3 Write a parallel program to calculate prefix sum for different architectures

4 Write a parallel program to perform matrix multiplication for SIMD architecture

5 Write a parallel program to solve linear equations for MIMD architecture.

6 Write a parallel program to find root of non-linear equation.

7 Write a parallel program to solve partial differential equation.

First Year M.Tech.Sem-II
CSP559–Advanced Operating Systems Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

Students should perform 10-12 experiments based on the following topics

1 Study of the concept "Process and its relevance" in different operating systems.

2 Implementation of IPC mechanism I – Shared Memory System

3 Implementation of IPC mechanism II – Message Passing System

4 Implementation of Deadlock Simulation – Detection and Prevention

5 Simulation of Communication protocols in distributed systems using TCP.

6 Simulation of Communication protocols in distributed systems using UDP.

7 Study of DNS.

8 Simulation of mutual exclusion in distributed systems.

9 Implementation of The Bully Algorithm.

10 Implementation of Ring Algorithm

11 Case Study – RTLinux

12 Implement simple android application.

13 Case Study – Micro Kernel

14 Case Study - TinyOS

First Year M.Tech.Sem-II
CSP560–Advanced Distributed Systems Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

1 Installation and configuration of Hadoop/Euceliptus

2 Perform Service deployment and Usage over cloud.

3 Management of cloud resources.

4 Using existing cloud characteristics & Service models.

5 Cloud Security Management.

6 Performance evaluation of services over cloud.

7 Design a distributed application using RMI. Where client submits two strings to the server and server returns the concatenation of the given strings.

8 Design a distributed application which consist of a statefull server using socket primitives.

9 Design a distributed application which consist of a stateless server using socket primitives

10 Design a distributed application which consist of a server and client using threads

First Year M.Tech.Sem-II
CSP561–Embedded Systems and Robotics Lab

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

1 Study of ARM evaluation system

2 LED interfacing and programming

3 Seven segment interfacing and programming

4 Touch screen sensing

5 LCD interfacing and programming

6 Delay generation using timers

7 Stepper motor interfacing and programming

8 DC motor interfacing and programming

9 Key pad sensing

10 Appliance interfacing through relay

First Year M.Tech.Sem-II
CSD562: Seminar-II

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	2

Evaluation Scheme	
CIE	100
Total	**100**

Each student is required to do a seminar presentation on a topic preferably from the area chosen for Seminar-I and in which a student intends to work for his dissertation during Semester – III and Semester – IV. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review and develop confidence to present the material by the student. The seminar shall be evaluated by a Department Committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester.