SCHEME OF INSTRUCTION
BE (AI & ML) - SEMESTER- V

S. No.	CourseCode	Course Title	Scheme of Instruction			Contact Hours/ Week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
THEORY									
1.	PC 501 AI	Design and Analysis of Algorithms	3	0	0	3	30	70	3
2.	PC 502 AI	Operating Systems	3	0	0	3	30	70	3
3.	PC 503 AI	Database Management Systems	3	0	0	3	30	70	3
4.	PC 504 AI	Automata Languages and Computation	3	0	0	3	30	70	3
5.	PC 505 AI	Artificial Intelligence	3	0	0	3	30	70	3
6.	PC 506 AI	Data Mining	3	0	0	3	30	70	3
7.	**Professional Elective-I**		3	0	0	3	30	70	3
	PE 511 AI	Web Programming							
	PE 512 AI	Software Engineering							
	PE 513 AI	Computer Graphics							
	PE 514 AI	Graph Theory							
Practicals									
8.	PC 551 AI	Database Management Systems Lab	0	0	4	4	25	50	2
9.	PC 552 AI	Operating Systems Lab	0	0	2	2	25	50	1
10.	PC 553 AI	Artificial Intelligence & Data Mining Lab	0	0	2	2	25	50	1
Total			**21**	**0**	**8**	**29**	**285**	**640**	**25**

PC 501 AI	**DESIGN AND ANALYSIS OF ALGORITHMS**					
Prerequisites	**Data Structures**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	Analyze the asymptotic performance of algorithms.
2	Write rigorous correctness proofs for algorithms
3	Demonstrate a familiarity with major algorithms and data structures.
4	Apply important algorithmic design paradigms and methods of analysis.
5	Synthesize efficient algorithms in common engineering design situations.

Course Outcomes On completion of this course, the student will be able to	
CO1	Analyze the complexity of the algorithm in asymptotic notations.
CO2	Apply the various algorithm approaches based on the complexities and analyze the graph traversal techniques
CO3	Develop the dynamic programming algorithms, and analyze it to determine its computational complexity

UNIT – I
Introduction: Characteristics of algorithm, Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem

UNIT – II
Fundamental Algorithmic Strategies: Brute-Force, Greedy, Dynamic Programming, Branch and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving, Bin Packing, Knap Sack and Travelling Salesman problem.

UNIT – III
Graph and Tree Algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive Closure, Minimum Spanning Tree, Topological Sorting, Network Flow Algorithm.

UNIT – IV
Tractable and Intractable Problems: Computability of Algorithms, Computability classes – P, NP, NP-complete and NP-hard. Cook's theorem, Standard NP-Complete problems and Reduction techniques.

UNIT – V
Advanced Topics: Approximation algorithms, Randomized algorithms, Class of problems beyond NP – P SPACE.

Suggested Reading:

1	*Introduction to Algorithms*, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill, 4th Edition, 2002
2	*Fundamentals of Algorithms* – E. Horowitz, Satraj Sahani, Computer Science Press, 1997
3	*Algorithm Design*, First Edition, Jon Kleinberg and ÉvaTardos, Pearson, 2006
4	*Algorithm Design: Foundations, Analysis, and Internet Examples*, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley Publishers, 2006
5	*Algorithms - A Creative Approach*, 3rd Edition, UdiManber, Addison-Wesley, 1995.

PC 502 AI	**OPERATING SYSTEMS**					
Prerequisites	**Programming in C and Data Structures**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce the concepts of OS structure and process synchronization
2	To study different memory management strategies
3	To familiarize the implementation of file system
4	To understand the principles of system security and protection
5	To discuss the design principles and structure of Windows 7 and Linux

Course Outcomes On completion of this course, the student will be able to	
CO1	Evaluate various process scheduling algorithms
CO2	Analyze the steps in address translation and different page replacement strategies
CO3	Compare file allocation methods and choose appropriate allocation strategies for a file.
CO4	Apply the appropriate mechanisms to control access to resources

UNIT – I
Introduction to Operating Systems: OS structure and strategies, Process concepts, Multithreaded Programming, Process scheduling, Process synchronization, Deadlocks.

UNIT – II
Memory management strategies with example architectures: Swapping, Contiguous allocation, Paging, Segmentation, Segmentation with paging, Virtual memory management: Demand paging, Page replacement, Thrashing.

UNIT – III
File system interface: File concepts, Access methods and protection. File system implementation: File system structure, Allocation methods, Directory implementation of file systems, Mass storage structures, I/O systems.

UNIT – IV
System Protection: Principles and Domain, Access Matrix and implementation, Access control and access rights, Capability based systems, Language based Protection. System Security: Problem, Program threats, cryptography, user authentication, implementing security defenses, Firewalling, Computer security Classification.

UNIT – V
Case Studies: The Linux System–Design principles, Kernel modules, Process management, Scheduling, Memory management, File systems, Input and Output, Inter process communication. Windows 7 –Design principles, System components, Terminal services and fast user switching File systems, Networking, Programmer Interface.

Suggested Reading:

1	Abraham Silberschatz, Peter B Galvin, *Operating System Concepts*, 9th Edition, Wiley, 2016
2	William Stallings, *Operating Systems-Internals and Design Principles*, 8th Edition, Pearson, 2014
3	Andrew S Tanenbaum, *Modern Operating Systems*, 4th Edition, Pearson, 2016.

PC 503 AI	**DATABASE MANAGEMENT SYSTEMS**					
Prerequisites	**Data Structures**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce three schema architecture and DBMS functional components
2	To learn formal and commercial query languages of RDBMS
3	To understand the principles of ER modeling and theory of normalization
4	To study different file organization and indexing techniques
5	To familiarize theory of serializablity and implementation of concurrency control, and recovery

Course Outcomes On completion of this course, the student will be able to	
CO1	Understand the mathematical foundations on which RDBMS are built
CO2	Model a set of requirements using the Extended Entity Relationship Model (EER), transform an EER model into a relational model, and refine the relational model using theory of Normalization.
CO3	Develop Database application using SQL and Embedded SQL
CO4	Use the knowledge of file organization and indexing to improve database application Performance.
CO5	Understand the working of concurrency control and recovery mechanisms in RDBMS.

UNIT – I

Introduction: Database System Applications, Purpose of Database Systems, View of Values, Nested Sub-queries, Complex Queries, Views, Modification of the Database, Joined Relations Data, Database Languages, Relational Databases, Database Design, Object–based and Semi-structured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators.

Database Design and the E-R Model: Overview of the Design Process, The Entity- Relationship Model, Constraints, Entity-Relationship Diagrams, Entity – Relationship Design Issues, Weak Entity Sets, Extended E-R Features, Database Design for Banking Enterprise, Reduction to Relational Schemas, Other Aspects of Database Design

UNIT – II

Relational Model: Structure of Relational Databases, Fundamental Relational-Algebra Operations, Additional Relational – Algebra Operations, Extended Relational - Algebra Operations, Null Values, Modification of the Databases.

Structured Query Language: Data Definition, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Null.

UNIT – III

Advanced SQL: SQL Data Types and Schemas, Integrity Constraints, Authorization,

Embedded SQL, Dynamic SQL, Functions and Procedural Constructs, Recursive Queries, Advanced
SQL Features. Relational Database Design: Features of Good Relational Design, Atomic Domains and First Normal Form, Functional-Dependency Theory, Decomposition using Functional Dependencies.

UNIT – IV

Indexing and Hashing: Basic Concepts, Ordered Indices, B+-tree Index Files, B-tree Index Files, Multiple Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices.
Index Definition in SQL Transactions: Transaction Concepts, Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability.

UNIT – V

Concurrency Control: Lock-based Protocols, Timestamp-based Protocols, Validation-based Protocols, Multiple Granularity, Multi-version Schemes, Deadlock Handling, Insert and Delete Operations, Weak Levels of Consistency, Concurrency of Index Structures.
Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-Based Recovery, Recovery with Concurrent Transactions, Buffer Management, Failure with Loss of Nonvolatile Storage, Advanced Recovery Techniques, Remote Backup Systems.

Suggested Reading:

1	Abraham Silberschatz, Henry F Korth, S Sudarshan, *Database System Concepts,* McGraw-Hill International Edition, 6th Edition, 2010
2	Ramakrishnan, Gehrke, *Database Management Systems*, McGraw-Hill International Edition, 3rd Edition, 2003.
3	Elmasri, Navathe, Somayajulu, *Fundamentals of Database Systems*, Pearson Education, 4th Edition, 2004.

PC 504 AI	**AUTOMATA LANGUAGES AND COMPUTATION**					
Prerequisites	**Data Structures**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	Introduce the concept of formal specification of languages and different classes of formal languages
2	Discuss automata models corresponding to different levels of Chomsky hierarchy.
3	Understand the concept of computability and decidability

Course Outcomes On completion of this course, the student will be able to	
CO1	Design Finite State Machine, Pushdown Automata, and Turing Machine
CO2	Determine the Chomsky hierarchy and regular, context-free, and recursively enumerable grammars
CO3	Convert the languages from DFAs, NFAs, and regular expressions, and between PDAs and CFGs.
CO4	Analyze the halting problem, relationships between classes.

UNIT – I

Introduction: Finite state automata, Non-deterministic finite state automata, FA with ε-transitions, Regular expressions, FA with outputs, Applications of FA. Properties of regular sets-Pumping Lemma, Closure properties, Myhill-Nerode Theorem, Minimization of FA, Decision Algorithms.

UNIT – II

Context Free Grammars and Languages: Derivations, Parse-trees, Ambiguity in Grammars and Languages.

Pushdown Automata–Definitions, The languages of PDA, Equivalence of PDAs and CFGs, Deterministic Pushdown Automata (DPDA).

UNIT – III

Properties of CFLs: Normal forms for CFGs, Pumping Lemma, Closure properties, Decision algorithms, Deterministic Context Free Languages, Predicting machines, Decision properties, LR(0) grammars, LR(0) and DPDA, LR(k) grammars.

UNIT – IV

Turing Machines: Introduction, Computational Languages and Functions, Techniques for construction of Turing machines. Modifications of TM, TM as enumerator, Restricted TM.

UNIT – V

Undecidability: Recursive and Recursively enumerable languages, UTM and undecidable problem, Rice Theorem, Post‟s correspondence problem. Chomsky‟s Hierarchy – Regular grammars, Unrestricted grammar, CSL, Relationship between classes of languages.

Suggested Reading:

1	John E. Hopcroft, Jeffrey D. Ullman, *Introduction to Automata Theory, Languages and Computation*, Narosa, 1979.
2	Zvi Kohavi, *Switching and Finite Automata Theory*, TMH, 1976.

PC 505 AI	**ARTIFICIAL INTELLIGENCE**					
Prerequisites	**Data Structures**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To learn basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning
2	To Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
3	Explore the current scope, potential, limitations, and implications of intelligent systems.

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
CO3	Demonstrate an ability and limitations and implications on Society.

UNIT – I

Introduction to Artificial Intelligence: Introduction, Brief History, Intelligent Systems, foundations of AI, Sub-Areas of AI, Applications, Tic-Tac Game Playing, Development of AI Languages, Current Trends in AI.

Agents: Agents and Environments, Good Behavior: The concept of Rationality, Performance measures, The nature of Environments, The Structure of Agents, Simple agents, Rational agents, problem solving agents, intelligent agents.

UNIT – II

Solving Problem by Searching: Problem-Solving Agents, Searching for Solutions, Uninformed search strategies.

Informed Search and Exploration: Informed Search Strategies, Heuristic Functions, Local-Search Algorithms and Optimization Problems.

Adversarial Search: Games, Optimal Decisions in Games, Alpha-Beta Pruning, Iterative Deepening.

UNIT – III

Logic Concepts and Logic Programming: Introduction, Propositional Calculus, Propositional Logic, Natural Deduction System, Axiomatic System, Predicate Logic, Logic Programming.

Knowledge Representation: Introduction, Approaches to Knowledge Representation, Knowledge Representation using Semantic Network, Knowledge Representation using Frames.

UNIT – IV
Probabilistic Reasoning **Expert System**: Introduction, Phases in Building Expert Systems, Expert System Architecture, Expert System versus Traditional Systems, Rule-Based Expert Systems. **Uncertainty Measures:** Introduction, Probability Theory, Bayesian Belief Networks. **Fuggy Logic Systems:** Introduction, Crisp Sets, Fuzzy Sets, Fuzzy Terminology, Fuggy Logic Control, Neuro Fuzzy Systems.

UNIT – V
Connectionist Models: Introduction: Hopfield Networks, learning in Neural Networks, Applications of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI and Symbolic AI. **Chatbots**

Suggested Reading:

1	*Artificial Intelligence*, Saroj Kaushik, Cengage Learning, 2011
2	*Artificial Intelligence*, 3rd Edition, Elaine Rich, Kevin Knight, Shivashankar B Nair, Tata McGraw Hill., 2019
3	*Artificial Intelligence-A Modern Approach*, 2nd Edition , Stuart Russell, Peter Norvig, 2016.

PC 506 AI	**DATA MINING**					
Prerequisites	**Data Structures**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce the basic concepts of data Mining and its applications
2	To understand different data mining like classification, clustering and Frequent Pattern mining
3	To introduce current trends in data mining

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply the data mining concepts for preprocessing
CO2	Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on a given data set
CO3	Define and apply metrics to measure the performance of various data mining algorithms

UNIT – I

Introduction: Importance of Data Mining, Major issues in Data Mining, Getting to know your data: Data objects and attributed types. Basic statistical descriptions of data. Data visualization, Measuring data similarity and dissimilarity.

UNIT – II

Mining Frequent patterns, Associations and Correlations: Basic concepts and methods, Frequent Item set Mining Methods, Pattern evaluation methods.

UNIT – III

Classification: Basic Concepts, Decision tree induction, Bayes classification methods, Advance methods, Bayesian Belief Network, Classification by back propagation, Support vector machines.

UNIT – IV

Cluster Analysis: Concepts and Methods, Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, and Evaluation of Clustering.

UNIT – V

Data Mining Trends and Research Frontiers: Mining Complex Data Types, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining trends.

Suggested Reading:

1	Jiawei Han, Micheline Kamber, Jin Pei, "*Data Mining: Concepts & Techniques*", 3rd Edition., Morgon Kauffman, 2011.
2	Vikram Pudi, P.Radha Krishna, "*Data Mining*", Oxford University Press, 1st Edition, 2009.
3	Pang-Ning Tan, Michael Steinbach, Vipin Kumar," *Introduction to Data Mining*", Pearson Education, 2008.

PROFESSIONAL ELECTIVE-I

PE 511 AI	**WEB PROGRAMMING**					
Prerequisites	**Programming Concepts**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To learn HTML5 and JavaScript
2	To familiarize the tools and technologies to process XML documents
3	To learn various server-side and database connectivity technologies

Course Outcomes On completion of this course, the student will be able to	
CO1	Design a website with static and dynamic web pages.
CO2	Develop a web application with session tracking and client side data validations.
CO3	Develop web content publishing application that accesses back-end data base and publishes data in XML format.

UNIT – I

Introduction to World Wide Web: Web Browsers, Web Servers, Uniform Resource Locators, HTTP. HTML5: Introduction, Links, Images, Multimedia, Lists, Tables, Creating Forms, Styling Forms.

UNIT – II

Introduction to XM: XML document structure, Document Type Definition, Namespaces, XML Schemas, Displaying raw XML documents, Displaying XML documents with CSS, XPath Basics, XSLT, XML Processors.

UNIT – III

Introduction to Java Script: Java Script and Forms Variables, Functions, Operators, Conditional Statements and Loops, Arrays DOM, Strings, Event and Event Handling, Java Script Closures.

Introduction to Ajax, Pre-Ajax Java Script Communication Techniques, XML HTTP Request Object, Data Formats, Security Concerns, User Interface Design for Ajax. Introduction to Python, Objects and Methods, Flow of Control, Dynamic Web Pages.

UNIT – IV

Java Servlets: Java Servlets and CGI Programming, Benefits of Java Servlet, Life Cycle of Java Servlet, Reading data from client, HTTP Request Header, HTTP Response Header, working with Cookies, Tracking Sessions. Java Server Pages: Introduction to JSP, JSP Tags, Variables and Objects, Methods, Control Statements, Loops, Request String, User Sessions, Session Object, Cookies.

UNIT – V
Introduction to PHP: Overview of PHP, General Syntactic Characteristics, Primitives, Operations, Expressions, Control Statements, Arrays, Functions, Pattern matching, Form handling, Files, Cookies, Session Tracking. Database access through Web: Architectures for Database Access Database access with Perl - Database access with PHP-Database access with JDBC.

Suggested Reading:

1	Robert W.Sebesta, *Programming the World Wide Web*, 3rd Edition, Pearson Education, 2006.
2	Wendy Willard, *HTML5*, McGraw Hill Education, 2013
3	Thomas Powell, *The Complete Reference: Ajax*, Tata-McGraw-Hill, 2011
4	John Pollock, *Java Script*, 4th Edition, McGraw Hill Education, 2013.
5	Jim Keogh, *J2EE : The Complete Reference*, Tata-McGraw-Hill, 2002

PE 512 AI	**SOFTWARE ENGINEERING**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
2	To impart knowledge on various phases , methodologies and practices of software development
3	To understand the importance of testing in software development and study various testing strategies and software quality metrics

Course Outcomes On completion of this course, the student will be able to	
CO1	Acquire working knowledge of alternative approaches and techniques for each phase of software development
CO2	Acquire skills necessary for independently developing a complete software project
CO3	Understand the practical challenges associated with the development of a significant software system

UNIT – I

Introduction to Software Engineering:

A generic view of Process: Software Engineering, Process Framework, CMM Process Patterns, Process Assessment.

Process Models: Prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.

An Agile view of Process: Introduction to Agility and Agile Process, Agile Process Models.

UNIT – II

Software Engineering Principles: SE Principles, Communication Principles, Planning Principles, Modeling Principles, Construction Principles, Deployment.

System Engineering: Computer-based Systems, The System Engineering Hierarchy, Business Process Engineering, Product Engineering, System Modeling.

Requirements Engineering: A Bridge to Design and Construction, Requirements Engineering Tasks, Initiating Requirements Engineering Process, Eliciting Requirements, Developing Use-Cases, Building the Analysis Model, Negotiating Requirements, Validating Requirements.

UNIT – III

Building the Analysis Model: Requirements Analysis Modeling Approaches, Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling, Creating a Behavioral Model.

Design Engineering: Design within the context of SE, Design Process and Design Quality, Design Concepts, The Design Model, Pattern-based Software Design.

UNIT – IV
Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design, Assessing Alternative Architectural Designs, Mapping Data Flow into a Software Architecture. Modeling Component-Level Design: Definition of Component, Designing Class-based Components, Conducting Component-level Design, Object Constraint Language, Designing Conventional Components. Performing User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT – V
Software Quality Assurance: Basic Elements, Tasks, Goals and Metrics, Formal Approaches, Statistical Software Quality Assurance, Software Reliability, ISO 9000 Quality Standards, SQA Plan. Testing Strategies: A Strategic Approach to Software Testing, Strategic Issues, Test Strategies for O-O Software, Validation Testing, System Testing, The Art of Debugging. Testing Tactics: Software Testing Fundamentals, Black-box and White-box Testing, Basis Path Testing, Control Structure Testing, O-O Testing Methods, Testing Methods applicable on the Class Level, Inter Class Test Case Design, Testing for Specialized Environments, Architectures and Applications, Testing Patterns. Product Metrics: Software Quality, A Framework for Product Metrics, Metrics for the Analysis Model, Metrics for the Design Model, Metrics for Source Code, Metrics for Testing, Metrics for Maintenance.

Suggested Reading:

1	Roger S.Pressman, *Software Enigneering: A Practitioner"s Approach*, 7th Edition, McGraw Hill, 2009.
2	Ali Behforooz and Frederick J.Hudson, *Software Engineering Fundamentals*, Oxford University Press, 1996.
3	Pankaj Jalote, *An Integrated Approach to Software Engineering*, 3rd Edition, Narosa Publishing House, 2008.

PE 513 AI	**COMPUTER GRAPHICS**					
Prerequisites	**Data Structures and Discrete Mathematics**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduction of fundamental concepts and theory of computer graphics.
2	To learn the 2D and 3D object transformations and algorithms
3.	To understand the computer animation sequence and its methods

Course Outcomes On completion of this course, the student will be able to	
CO1	Acquire familiarity with the relevant mathematics of computer graphics.
CO2	Design basic graphics application programs, including animation.
CO3	Design applications that display graphic images to given specifications

UNIT – I

Introduction: Application areas of Computer Graphics, overview of graphics systems, video-display devices, raster-scan systems, random scan systems, graphics monitors and work stations and input devices

Output primitives: Points and lines, line drawing algorithms (Bresenham's and DDA Algorithm), mid-point, Circle and ellipse algorithms, Polygon Filling: Scan-line algorithm, boundary-fill and flood-fill algorithms.

UNIT – II

2-D geometrical transforms: Translation, scaling, rotation, reflection and shear transformations, matrix representations and homogeneous coordinates, composite transforms, transformations between coordinate systems. 2-D viewing: The viewing pipeline, viewing coordinate reference frame, window to view-port coordinate transformation, viewing functions, Cohen-Sutherland algorithms, Sutherland – Hodgeman polygon clipping algorithm.

UNIT – III

3-D object representation: Polygon surfaces, quadric surfaces, spline representation, Hermite curve, Bezier curve and B-Spline curves, Bezier and B-Spline surfaces. Basic illumination models, polygon rendering methods.

UNIT – IV

3-D Geometric transformations: Translation, rotation, scaling, reflection and shear transformations, composite transformations. viewing: Viewing pipeline, viewing coordinates, view volume and general projection transforms and clipping.

UNIT – V

Computer Animation: Design of animation sequence, general computer animation functions, raster animation, computer animation languages, key frame systems, motion specifications

Visible surface detection methods: Classification, back-face detection, depth-buffer, BSP-tree methods and area sub-division methods.

Suggested Reading:

1	"*Computer Graphics C version*", Donald Hearn and M. Pauline Baker, Pearson Education, 2nd Edition, 1997.
2	"*Computer Graphics Principles & Practice*", 2nd Edition in C, Foley, Van Dam, Feiner and Hughes, Pearson Education, 1996.
3	*Computer Graphics- A programming Approach,* Steven Harrington, TMH, 1987.

PE 514 AI	**GRAPH THEORY**					
Prerequisites	**Data Structures and Discrete Mathematics**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To familiarize a variety of different problems in Graph Theory
2	To learn various techniques to prove theorems
3	To understand and analyze various graph algorithms

Course Outcomes On completion of this course, the student will be able to	
CO1	Write precise and accurate mathematical definitions of objects in graph theory
CO2	Validate and critically assess a mathematical proof
CO3	Develop algorithms based on diverse applications of Graphs in different domains

UNIT – I
Preliminaries: Graphs, isomorphism, subgraphs, matrix representations, degree, operations on graphs, degree sequences Connected graphs and shortest paths: Walks, trails, paths, connected graphs, distance, cut vertices, cut-edges, blocks, connectivity, weighted graphs, shortest path algorithms Trees: Characterizations, number of trees, minimum spanning trees.

UNIT – II
Special classes of Graphs: Bipartite graphs, line graphs, chordal graphs Eulerian graphs: Characterization, Fleury‟s algorithm, chinese-postman-problem.

UNIT – III
Hamilton Graphs: Necessary conditions and sufficient conditions Independent sets, coverings, matchings: Basic equations, matchings in bipartite graphs, perfect matchings, greedy and approximation algorithms.

UNIT – IV
Vertex Colorings: Chromatic number and cliques, greedy coloring algorithm, coloring of chordal graphs, Brook‟s theorem Edge colorings: Gupta-Vizing theorem, Class-1 graphs and class-2 graphs, equitable edge-coloring.

UNIT – V
Planar Graphs: Basic concepts, Eulers formula, polyhedrons and planar graphs, characterizations, planarity testing, 5-color-theorem. Directed graphs: Out-degree, in-degree, connectivity, orientation, Eulerian directed graphs, Hamilton directed graphs, tournaments.

Suggested Reading:

1	F.Harry, *Graph Theory*, Narosa Publications, 1988.
2	C.Berge: *Graphs and Hypergraphs*, North Holland/Elsevier, 1973
3	J A Bondy and U.S. R Murthy, *Graph Theory with Applications*, Elsevier Science Ltd, 1976
4	Douglas B West, *Introduction to Graph Theory*, Prentice Hall, 2004.

PC 551 AI	**DATABASE MANAGEMENT SYSTEMS LAB**					
Prerequisites			**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Evaluation	**CIE**	**25 Marks**	**SEE**		**50 Marks**	

Course Objectives	
1	To practice various DDL commands in SQL
2	To write simple and Complex queries in SQL
3	To familiarize PL/SQL

Course Outcomes On completion of this course, the student will be able to	
CO1	Design and implement a database schema for a given problem
CO2	Populate and query a database using SQL and PL/SQL
CO3	Develop multi-user database application using locks.

The list of programs suggested:

Creation of database (exercising the commands for creation).

1. Simple to Complex condition query creation using SQL Plus.
   Usage of Triggers and Stored Procedures.
2. Creation of Forms for Student information, Library information, Pay roll etc.
3. Writing PL/SQL procedures for data validation.
4. Report generation using SQL reports.
5. Creating password and security features for applications.
6. Usage of File locking, Table locking facilities in applications.
7. Creation of small full- fledged database application spreading over3 sessions.

Note:-The creation of sample database for the purpose of the experiments is expected to be pre-decided by the instructor.

PC 552 AI	**OPERATING SYSTEMS LAB**					
Prerequisites			**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**
Evaluation	**CIE**	**25 Marks**	**SEE**		**50 Marks**	

Course Objectives	
1	To learn shell programming and the use of filters in the LINUX environment
2	To practice multithreaded programming
3	To implement CPU Scheduling Algorithms and memory management algorithms

Course Outcomes On completion of this course, the student will be able to	
CO1	Write shell scripts for simple system administration tasks
CO2	Write concurrent programs with synchronization constricts
CO3	Compare the performance of various CPU Scheduling Algorithm
CO4	Critically analyze the performance of the various Memory management algorithms

The list of programs suggested:

Creation of database (exercising the commands for creation).

1-3. Memory Management Algorithms
4-5. Examples of Multithreading
6. Producer & Consumer problem using Semaphores and shared memory
7-8. Processor Scheduling algorithms
9. Dining Philosophers problem using Semaphores
10. Readers and Writers problem using Semaphores
11. Shell-programming exercises

PC 553 AI	**ARTIFICIAL INTELLIGENCE AND DATA MINING LAB**					
Prerequisites			**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**
Evaluation	**CIE**	**25 Marks**	**SEE**		**50 Marks**	

Course Objectives	
1	To impart knowledge on different search techniques.
2	To understand facts and rules through Prolog
3	To evaluate data with different data mining approaches

Course Outcomes On completion of this course, the student will be able to	
CO1	Analyze uninformed and informed search strategies and develop game planning.
CO2	Develop classification and clustering models to enhance their performance.
CO3	Understand the association between data and frequent item sets.

The list of programs suggested:

Creation of database (exercising the commands for creation).

1. Write a program to implement Uninformed search techniques:
   a. BFS
   b. DFS
2. Write a program to implement Informed search techniques
   a. Greedy Best first search
   b. A algorithm
3. Write a program to implement Tic-Tac-Toe Problem.
4. Study of Prolog its facts, and rules.
   a. Write simple facts for the statements and querying it.
   b. Write a program for Family-tree.
5. Write a program to train and validate the following classifiers for given data (scikit-learn):
   a. Decision Tree
   b. Multi-layer Feed Forward neural network
6. Develop a program to demonstrate Similarity and dissimilarity measures.
7. a. Create an Employee Table with the help of Data Mining Tool WEKA.
   b. Apply Pre-Processing techniques to the training data set of Employee Table.
8. Demonstrate performing classification on data sets.
9. Demonstrate performing clustering on data sets.
10. Find association between data and find the frequent item set for text mining.

SCHEME OF INSTRUCTION
BE (AIML) - SEMESTER- VI

S. No.	Course Code	Course Title	Scheme of Instruction			Contact Hours / Week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
Theory									
1	PC 601 AI	Machine Learning	3	0	0	4	30	70	3
2	PC 602 AI	Computer Networks	3	1	0	4	30	70	3
3.	**Professional Elective-II**								
	PE 611 AI	Computer Vision	3	0	0	3	30	70	3
	PE 612 AI	Distributed Systems							
	PE 613 AI	Number Theory & Cryptography							
	PE 614 AI	Information Retrieval Systems							
4.	**Professional Elective-III**								
	PE 621 AI	Internet of Things	3	0	0	3	30	70	3
	PE 622 AI	Cloud Computing							
	PE 623 AI	Natural language processing							
	PE 624 AI	Distributed Databases							
5	**Open Elective-I**								
	OE 601 BE	Micro Electro-Mechanical Systems	3	0	0	3	30	70	3
	OE 601 CE	Disaster Management							
	OE 602 CE	Geo Spatial Techniques							
	OE 601 AI	Operating Systems							
	OE 602 AI	OOP Using Java							
	OE 601 EC	Embedded Systems							
	OE 602 EC	Digital System Design using Verilog HDL							
	OE 601 EE	Reliability Engineering							
	OE 601 ME	Industrial Robotics							
	OE 602 ME	Material Handling							
	OE 601 LA	Intellectual Property Rights							
Practicals									
6	PC651AI	Machine learning Lab	0	0	2	2	25	50	1
7	PC652AI	Computer Networks Lab	0	0	2	4	25	50	2
8	PC653AI	Mini Project	0	0	3	6	50	-	3
9	PW961AI	Summer Internship	Six Weeks during summer vacation Evaluation will be done in VII-Semester						
Total			**15**	**1**	**7**	**28**	**250**	**450**	**21**

PC 601 AI	**MACHINE LEARNING**					
Prerequisites	Artificial Intelligence		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce the basic concepts of machine learning and range of problems that can be handled by machine learning.
2	To introduce the concepts of instance based learning and decision tree induction
3	To introduce the concepts of linear separability ,Perceptron and SVM
4	To learn the concepts of probabilistic inference, graphical models and evolutionary learning
5	To learn the concepts of ensemble learning, dimensionality reduction and clustering

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply different machine learning techniques.
CO2	Select suitable model parameter for different machine learning technique
CO3	Design & implement machine learning algorithms to real world applications
CO4	Evaluate learning methods to develop the research based solutions in different domains.

UNIT – I

Introduction: Learning, Types of Machine Learning, Machine Learning Examples, Decision Tree Learning, **Concept learning:** Introduction, Version Spaces and the Candidate Elimination Algorithm. **Learning with Trees:** Decision Tree Learning, **Linear Discriminants:** Learning Linear Separators, The Perceptron Algorithm, Margins.

UNIT – II

Estimating Probabilities from Data, Bayes Rule, MLE, MAP, **Naive Bayes:** Conditional Independence, Naive Bayes: Why and How, Bag of Words, **Logistic Regression:** Maximizing Conditional likelihood, Gradient Descent , **Kernels:** Kernalization Algorithm, Kernalizing Perceptron, **Discriminants:** The Perceptron, Linear Separability, Linear Regression. **Multilayer Perceptron (MLP):** Going Forwards, Backwards, MLP in practices, Deriving back Propagation.

UNIT – III

Support Vector Machines: Geometric margins, Primal and Dual Forms, Kernalizing SVM **Generalization & Overfitting:** Sample Complexity, Finite Hypothesis classes, VC Dimension Based Bounds, **Some Basic Statistics:** Averages, Variance and Covariance, The Gaussian, The Bias-Variance Tradeoff Bayesian learning: Introduction, Bayes theorem. Bayes Optimal Classifier, Naive Bayes Classifier. **Graphical Models:** Bayesian networks, Approximate Inference, Making Bayesian Networks, Hidden Markov Models, The Forward Algorithm, Monte-Carlo Markov Chains.

UNIT – IV

Model Selection & Regularization: Structural Risk Minimization, Regularization, k-Fold Cross Validation. **Linear Regression:** Linear regression, minimizing squared error and maximizing data Likelihood. **Neural Networks:** Back Propagation. **Evolutionary Learning**: (Genetic Algorithm)

UNIT – V
Clustering: Introduction, Similarity and Distance Measures, Outliers, Hierarchical Methods, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes, Comparison. **Dimensionality Reduction:** Linear Discriminant Analysis, Principal Component Analysis **Interactive Learning:** Active Learning, Active Learning, Common heuristics, Sampling bias, Safe Disagreement Based Active Learning Schemes. **Semi-Supervised Learning:** Semi-supervised Learning, Transductive SVM, Co-training **Reinforcement Learning:** Markov Decision Processes, Value Iteration, and Q-Learning.

Suggested Reading:

1	Tom M. Mitchell, *Machine Learning*, Mc Graw Hill, 1997
2	Chistopher Bishop, *Pattern recognition and Machine Learning*, Springer 2006.
3	Stephen Marsland, *Machine Learning - An Algorithmic Perspective*, CRC Press, 2009

PC 602 AI	**COMPUTER NETWORKS**					
Prerequisites	**Data Structures and Programming Concepts**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To study the design issues in network layer and various routing algorithms
2	To introduce internet routing architecture and protocols
3	To learn the flow control and congestion control algorithms in Transport Layer
4	To introduce the TCP/IP suite of protocols and the networked applications supported by it
5	To learn basic and advanced socket system calls

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply the function of each layer of OSI and trace the flow of information from one node to another node in the network
CO2	Understand the principles of IP addressing and internet routing
CO3	Analyze the working of networked applications such as DNS, mail file transfer and www
CO4	Implement client-server socket-based networked applications.

UNIT – I
Data Communications: Components, analog and digital signals and Encoders, Modems, RS232 Interfacing. Switching: Circuit Switching, Message Switching and Packet Switching. Topologies – Concept of layering.-Protocols and Standards – ISO / OSI model, TCP/IP.

UNIT – II
Data Link Layer: Error Control: Error detection and correction (CRC and Hamming code for single bit correction) Flow Control: stop and wait – - sliding window protocols-go Back-N ARQ – selective repeat ARQ MAC LAYER: Ethernet IEEE 802.3LAN, Manchester encoding, Binary exponential algorithm, Efficiency calculation, ARP and RARP.

UNIT – III
Network Layer : Internetworks – virtual circuit and Datagram approach Routing – Distance Vector Routing ,Link State Routing , OSPF and BGP IPv4 , addressing, Subnetting, IPv6, CIDR, ICMP and IGMP protocols.

UNIT – IV
Transport Layer: Services of transport layer, Multiplexing and crash recovery Transmission Control Protocol (TCP) – TCP window management Congestion Control, timer management and User Datagram Protocol (UDP).

UNIT – V
Socket Programming: Primitive and advanced system calls, client/server iterative and concurrent programs IO multiplexing, Asynchronous IO and select system call. APPLICATION LAYER : Domain Name Space (DNS) – SMTP – FTP – HTTP.

Suggested Reading:

1	*Computer Networks*, 5th Edition, Andrew S. Tanenbaum , David J. Wetherall , Pearson Education, 2021
2	*Computer Networks: A Systems Approach*, Larry Peterson and Bruce Davie, Elsevier , 5th Edition, 2021
3	*Computer Networking: A Top-Down Approach*, 6th Edition, James F. Kurose , Keith W. Ross , Pearson , 2022

PROFESSIONAL ELECTIVE-II

PE 611 AI	**COMPUTER VISION**					
Prerequisites	**Computer Graphics**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce students the fundamentals of image formation, Image Processing.
2	To gain knowledge on major ideas, methods, and techniques of computer vision and object recognition
3	To understand Morphological operations, Computational photography

Course Outcomes On completion of this course, the student will be able to	
CO1	Implement fundamental image processing techniques required for computer vision
CO2	Understand Image formation process
CO3	Develop computer vision applications

UNIT – I

Image Formation: Geometric primitives and transformations, Photometric image formation, The digital camera.

Image Processing: Image Preprocessing-Noise reduction-spatial filtering, frequency filtering, Point Operators, Linear filtering, More neighbourhood operators, Fourier Transforms, Pyramids and wavelets

UNIT – II

Feature detection and matching: Points and matches, Edges, Lines.

Segmentation: Active contours, Split and merge, mean shift and mode finding, Normalized cuts.

Feature-based alignment: 2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration.

UNIT – III

Morphological Operations: Structure from motion: Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment. **Dense motion estimation:** Translational alignment, Parametric motion, Spline-based motion, Layered motion.

UNIT – IV

Image stitching: Motion Models, Global alignment, Compositing.

Computational photography: Photometric calibration, High dynamic range imaging, super-resolution and blur removal, image matting and compositing.

UNIT – V

Image-based rendering: View interpolation, Layered depth images, Light fields and Lumigraphs, Environment mattes, Video-based rendering.

Recognition: Object detection, Face recognition, Instance recognition, context and scene understanding

Suggested Reading

1	"*Computer Vision: Algorithms and Applications*" Richard Szeliski, Springer, 2010
2	"*Numerical Methods for Computer Vision, Machine learning, and Graphics*", Justin Solomon, CRC Press, 2020.
3	*Digital Image Processing*, Rafael C. Gonzalez and Richard E. Woods, 3rd Edition, Prentice Hall 2008.

PE 612 AI	**DISTRIBUTED SYSTEMS**					
Prerequisites	**Operating Systems**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To acquire an understanding of the issues in distributed systems
2	To study architectures and working of distributed file systems
3	To expose the students to distributed transaction management, security issues and replication

Course Outcomes On completion of this course, the student will be able to	
CO1	Describe the problems and challenges associated with distributed systems
CO2	Implement small scale distributed systems
CO3	Understand design tradeoffs in large-scale distributed systems

UNIT – I

Introduction: Goals and Types of Distributed Systems

Architectures: Architectural Styles, System Architectures, Architectures versus Middleware, and Self-Management in Distributed Systems.

Processes: Threads, Virtualization, Clients, Servers, and Code Migration.

Communication: Fundamentals, Remote Procedure Call, Message-Oriented Communication, Stream-Oriented Communication, and Multicast Communication

UNIT – II

Naming: Names, Identifiers and Addresses, Flat Naming, Structured Naming, and Attribute-Based Naming. Synchronization: Clock Synchronization, Logical Clocks, Mutual Exclusion, Global Positioning of Nodes, and Election Algorithms.

Consistency and Replication: Introduction, Data-Centric Consistency Models, Client-Centric Consistency Models, Replica Management, and Consistency Protocols.

UNIT – III

Fault Tolerance: Introduction to Fault Tolerance, Process Resilience, Reliable Client-Server Communication, Reliable Group Communication, Distributed Commit, and Recovery.

Distributed Object-Based Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security.

UNIT – IV

Distributed File Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security.

Distributed Web-Based Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security

UNIT – V
Distributed Coordination-Based Systems: Introduction to Coordination Models, Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security. Map-Reduce: Example, Scaling, programming model, Apache Hadoop, Amazon Elastic Map Reduce, Mapreduce.net, Pig and Hive.

Suggested Reading

1	Andrew S. Tanenbaum and Maarten Van Steen, *Distributed Systems*, PHI 2nd Edition, 2009
2	R.Hill, L.Hirsch, P.Lake, S.Moshiri, *Guide to Cloud Computing, Principles and Practice*, Springer, 2013.
3	R.Buyya, J. Borberg, A. Goscinski, *Cloud Computing-Principles and Paradigms*, Wiley 2013.

PE 613 AI	**NUMBER THEORY AND CRYPTOGRAPHY**					
Prerequisites	**Discrete Mathematics**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To Learn basics in number theory and cryptology
2	To identify and apply various properties of and relating to the integers and understand the concept of a congruence
3	To impart the knowledge of encryption and decryption techniques and their applications

Course Outcomes On completion of this course, the student will be able to	
CO1	Solve problems in elementary number theory
CO2	Apply elementary number theory to cryptography
CO3	Develop a conceptual understanding of the theoretical basis of number theory and identify how number theory is related to and used in cryptography

UNIT – I
Elementary Number Theory: Time estimates for doing arithmetic, Divisibility and Euclidean algorithm, congruence's, applications to factoring.

UNIT – II
Finite Fields and Quadratic Residues: Finite fields, Legendre symbol, quadratic residues and reciprocity, Jacobi symbol. **Galois field in Cryptography, Chinese Remainder Theorem.**

UNIT – III
Cryptography: Cryptosystems, diagraph transformations, enciphering matrices, Symmetric key cryptosystem, traditional techniques, Key range and size, Deffie-Hellman key exchange, various types of attacks, algorithm types and modes, various symmetric key algorithms (DES, IDEA, RC5, Blowfish).

UNIT – IV
Asymmetric key Cryptography: concept, RSA algorithm, digital envelope, concept of message digest, MD5 algorithm, Authentication requirements, Digital signatures, message authentic codes, Knapsack algorithm.

UNIT – V
Primality and Factoring, Pseudo-primes, Carmichael number, Primality tests, Strong Pseudo-primes, Monte Carlo method, Fermat factorization, Factor base, Implication for RSA, Continued fraction method. Elliptic curves - basic facts, Elliptic curve cryptosystems.

Suggested Reading:

1	Neal Koblitz, *A Course in Number Theory and Cryptology*, Graduate Texts in Mathematics, Springer, 1994
2	Williams Stallings, *Cryptography & Network Security*, Pearson Education 3rd Edition, 2004
3	Atul Kahate, *Cryptography & Network Security*, Tata McGraw Hill, New Delhi, 2005.

PE 614 AI	**INFORMATION RETRIEVAL SYSTEMS**					
Prerequisites	**Data Mining**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To understand indexing and querying in information retrieval systems
2	To learn the different models for information retrieval
3	To expose the students to text classification and clustering
4	To learn about web searching

Course Outcomes On completion of this course, the student will be able to	
CO1	Understand the algorithms and techniques for information retrieval (document indexing and retrieval, query processing)
CO2	Quantitatively evaluate information retrieval systems
CO3	Classify and cluster documents
CO4	Understand the practical aspects of information retrieval such as those in web search engines.

UNIT – I

Boolean Retrieval: Introduction, Building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval. The term vocabulary and postings lists: Document delineation and character sequence decoding, determining the vocabulary of terms, faster postings list intersection via skip pointers, Positional postings, and Phrase queries. Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction. Index construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, dynamic indexing, Other types of indexes.

UNIT – II

Index Compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression. Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, and Variant tf-idf functions. Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction. Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

UNIT – III

Relevance feedback and Query Expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation. XML retrieval: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval. Probabilistic information retrieval: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model. Language models for information retrieval: Language models, The query likelihood model.

UNIT – IV
Text classification and Naive Bayes: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, and Feature selection. Vector space classification: Document representations and measures of relatedness in vector spaces, Rocchio classification, k- nearest neighbor, Linear versus nonlinear classifiers. Flat clustering: Clustering in information retrieval, Problem statement, Evaluation of clustering, k means. Hierarchical clustering: Hierarchical agglomerative clustering, Single-link and complete-link clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering

UNIT – V
Matrix decompositions and Latent semantic indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing. Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling. Web crawling and Indexes: Overview, Crawling, Distributing indexes, Connectivity servers. Link analysis: The Web as a graph, Page Rank, Hubs and Authorities.

Suggested Reading:

1	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, "*An Introduction to Information Retrieval*", Cambridge University Press, Cambridge, England, 2008.
2	David A. Grossman, Ophir Frieder, "I*nformation Retrieval – Algorithms and Heuristics*", Springer, 2nd Edition (Distributed by Universities Press), 2004.
3	Gerald J Kowalski, Mark T Maybury. "*Information Storage and Retrieval Systems*", Springer, 2000.
4	Soumen Chakrabarti, "*Mining the Web: Discovering Knowledge from Hypertext Data*", Morgan-Kaufmann Publishers, 2002.

PROFESSIONAL ELECTIVE-III

PE 621 AI	**INTERNET OF THINGS**					
Prerequisites	**Computer Organization and Microprocessors**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To learn fundamentals of IoT and its applications and requisite infrastructure
2	To understand Internet principles and communication technologies relevant to IoT
3	To learn hardware and software aspects of designing an IoT system.
4	To apply the concepts of cloud computing and Data Analytics
5	To discuss business models and manufacturing strategies of IoT products

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply the various applications of IoT and other enabling technologies
CO2	Comprehend various protocols and communication technologies used in IoT
CO3	Design simple IoT systems with requisite hardware and C programming software
CO4	Comprehend the business model of IoT from developing a prototype to launching a product

UNIT – I

Introduction to Internet of Things: IOT vision, Strategic research and innovation directions, Iot Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues

UNIT – II

Internet Principles and Communication Technology: Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addressess, TCP and UDP Ports, Application Layer Protocols – HTTP,HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source

UNIT – III

Prototyping and programming for IoT : Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping, Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling.

Techniques for writing embedded C code: Integer data types in C, Manipulating bits - AND,OR,XOR,NOT, Reading and writing from I/ O ports. Simple Embedded C programs for LED Blinking, Control of motor using switch and temperature sensor for arduino board.

UNIT – IV

Cloud computing and Data Analytics: Introduction to Cloud storage models -SAAS, PAAS, IAAS. Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform.

Introduction to Data Analytics for IoT - Apache Hadoop- Map Reduce job execution workflow

UNIT – V

IoT Product Manufacturing - From prototype to reality, Business model for IoT product

manufacturing, Business models canvas, Funding an IoT Startup, Mass manufacturing - designing kits, designing PCB,3D printing, certification, Scaling up software, Ethical issues in IoT- Privacy, Control, Environment, solutions to ethical issues.

Suggested Reading:

1	*Internet of Things - Converging Technologies for smart environments and Integrated ecosystems*, Ovidiu Vermesan, Peter Friess, River Publishers, 2022
2	*Designing the Internet of Things* , Adrian McEwen, Hakim Cassimally. Wiley India Publishers, 2013.
3	*Fundamentals of Embedded Software: where C meets assembly*, Daniel W Lewis, Prentice Hall , 2002.

PE 622 AI	**CLOUD COMPUTING**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce basic concepts cloud computing and enabling technologies
2	To learn about Auto-Scaling, capacity planning and load balancing in cloud
3	To introduce security, privacy and compliance issues in clouds
4	To introduce cloud management standards and programming models

Course Outcomes On completion of this course, the student will be able to	
CO1	Understand the architecture and concept of different cloud models: IaaS, PaaS,SaaS
CO2	Create virtual machine images and deploy them on cloud
CO3	Identify security and compliance issues in clouds

UNIT – I
Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning

UNIT – II
Scaling in the Cloud, Capacity Planning , Load Balancing, File System and Storage

UNIT – III
Multi-tenant Software, Data in Cloud , Database Technology, Content Delivery Network, Security Reference Model , Security Issues, Privacy and Compliance Issues

UNIT – IV
Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

UNIT – V
Enterprise architecture and SOA, Enterprise Software , Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem

Suggested Reading:

1	*Cloud Computing* , Sandeep Bhowmik, Cambridge University Press, 2017
2	*Enterprise Cloud Computing - Technology, Architecture, Applicatios,* Gautam Shroff, Cambridge University Press, 2016
3	Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, *Distributed and Cloud Computing From Parallel Processing to the Internet of Things,* Elsevier, 2012.

PE 623 AI	**NATURAL LANGUAGE PROCESSING**					
Prerequisites	**Data Mining and Machine Learning**		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce to basic concepts of Natural Language processing
2	To understand morphological processing, and syntactic parsing methods
3	To learn probabilistic NLP and classification of text using Python‟s NLTK Library.

Course Outcomes On completion of this course, the student will be able to	
CO1	write Python programs to manipulate and analyze language data
CO2	understand key concepts from NLP and linguistics to describe and analyze language
CO3	apply the appropriate data structures and algorithms in NLP
CO4	classify texts using machine learning

UNIT – I

Language Processing and Python: Computing with Language: Texts and Words, A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control, Automatic Natural Language Understanding Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency Distributions, Lexical Resources, WordNet

UNIT – II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings. Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation Based Tagging, How to Determine the Category of a Word**.**

UNIT – III

Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers Extracting Information from Text: Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction.

UNIT – IV

Analyzing Sentence Structure: Some Grammatical Dilemmas, Usage of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar, Dependencies and Dependency Grammar, Grammar Development, Building Feature-Based Grammars.

UNIT – V

NLP Applications: Topic modeling, Text classification, Sentiment analysis, Word sense disambiguation, Speech recognition and speech to text, Text to speech, Language detection and translation.

Suggested Reading:

1	Steven Bird, Ewan Klein, and Edward Lope, " *Natural Language Processing with Python*", O‟Reily, 2009.
2	Akshay Kulkarni, Adarsha Shivananda, " *Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python*", Apress, 2019.

PE 624 AI	**DISTRIBUTED DATABASES**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To learn the theoretical and practical aspects of the database technologies, and distributed database technology.
2	To understand the principles and implementation techniques of distributed database systems
3	To discuss the research issues in distributed database systems and application development
4	To learn the distributed database query engine, subject to remote Web service calls

Course Outcomes On completion of this course, the student will be able to	
CO1	To apply models and approaches to be able to select and apply the appropriate methods.
CO2	To identify primary references and come up with meaningful conclusions
CO3	To apply learned skills to solving practical database related tasks

UNIT – I

Introduction: Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases, Database Design, Object-Based and Semistructured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators, History of Database Systems.

Relational Model: Structure of Relational Databases, Fundamental Relational-Algebra Operations, Additional Relational-Algebra Operations, Extended Relational-Algebra Operations, Null Values, Modification of the Database

UNIT – II

Query Processing: Overview, Measures of query cost, Selection operation, sorting, Join operation, other operations, Evaluation of Expressions.

Query Optimization: Overview, Transformation of Relational expressions, Estimating statistics of expression results, Choice of evaluation plans, Materialized views.

UNIT – III

Parallel Systems: Speedup and Scaleup, Interconnection Networks, Parallel Database Architectures.

Parallel Databases: Introduction, I/O Parallelism, Interquery Parallelism, Intraquery Parallelism, Interoperation Parallelism, Intraoperation Parallelism, Design of Parallel Systems.

UNIT – IV

Distributed Databases: Reference architecture for DDB, Types of Data Fragmentation, Distribution Transparency for Read-only applications, Distribution Transparency for Update applications, Distributed

Database Access Primitives, Integrity Constraints in DDB.

Distributed Database Design: A frame work for Distributed Database Design, The design of Database fragmentation, The allocation of fragmentation.

UNIT – V
Translation of Global Queries to Fragment Queries: Equivalence transformations for queries, Transforming global queries into fragment queries, Distributed grouping and aggregate function evaluation, Parametric queries.Optimization of Access Strategies: Access Control Models, Database Security, A framework for query optimization, Join queries, General queries.

Suggested Reading:

1	Silberschatz A, Korth HF, Sudarshan S, *Database System Concepts*, McGraw-Hill International Edition, 5th Edition, 2006
2	Ceri S, Pelagatti G, *Distributed Databases: Principles and Systems*, McGraw-Hill International Edition, 1984

OE 601 BE	**MICRO ELECTRO-MECHANICAL SYSTEMS**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce to basics of Micro-electro-mechanical systems
2	To understand properties of materials involved in MEMS
3	To pertain fabrication methods involved in MEMS manufacturing
	To apply the concepts for various applications

Course Outcomes On completion of this course, the student will be able to	
CO1	Elucidate basic concepts involved in MEMS technologies
CO2	Realize the properties of various materials involved in MEMS technologies
CO3	Apply the concepts and technologies involved in designing of MEMS
CO4	Relate different manufacturing processes involved in fabrication of MEMS
CO5	Recognize micro sensors, micro actuators and their applications in various fields.

UNIT – I
Introduction to MEMS: What is MEMS, Historical Background, classification, Micro-engineering, importance of micro-engineering. Technological advancements in MEMS, advantages and disadvantages of MEMS.

UNIT – II
MEMS Materials: Materials used in MEMS. Material properties: electrical, mechanical, thermal, chemical, biological, optical and processing. Reliability issues of materials.

UNIT – III
Designing of MEMS: Design and analysis process for MEMS. Initial design process, structured design process. Commonly used design flow, structured design flow. Design flow for MEMS cad design. Design and verification flow for integrated MEMS

UNIT – IV
MEMS Fabrication Techniques: Photolithography, materials for micromachining, bulk micromachining Surface micromachining, High aspect-ration-micromachining, assembly and system integration.

UNIT – V
MEMS structures and devices: Mechanical sensors, mechanical actuators, micro-fluidic devices, optical/photonic micro-systems, biological transducers.

Suggested Reading:

1	Adams TM, Layton RA. "*Introductory MEMS: Fabrication and applications*", 2010
2	Tobergte DR, Curtis S. "*An Introduction to Micro-electro-mechanical Systems Engineering*" Second Edition. vol. 53. 2013.
3	Kreith F, Kreider JF. "*The MEMS Handbook*" CRC Press 2002
4	Reza Ghodssi · Pinyen Lin. "*MEMS Materials and Processes Handbook*" Springer 2013
5	Gad-el-Hak M. "*MEMS applications*" 2nd Edition, CRC press 2006.

OE 601 CE	**DISASTER MANAGEMENT**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce basic conceptual understanding of natural & man-made hazards and different contextual aspects.
2	To develop the knowledge and understanding of the International and national strategy for disaster reduction (UN-ISDR).
3	To ensure skills and abilities to analyze potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.
4	To promote the use of science and technology for implementing the disaster risk reduction (DRR) plans and policies.

Course Outcomes On completion of this course, the student will be able to	
CO1	To promote the use of science and technology for implementing the disaster risk reduction plans and policies.
CO2	Ability to understand various aspects of natural and man-made hazards and emerging trends
CO3	Ability to understand various aspects of natural and man-made hazards and emerging trends
CO4	Knack to appreciate the national policy and role of individuals, communities, and government organizations in disaster management
CO5	Capacity to identifying current technological constraints and hazard specific solutions, particularly construction codes etc

UNIT – I

INTRODUCTION TO DISASTER

Understanding the Concepts, Definitions and Terminologies used in the field of Disaster Management (i.e. Hazard, Risk, Vulnerability, Resilience, and Capacity Building).

Differential impacts of Disasters in terms of Gender, Age, Social Status, Location, Prosperity, Disabilities. Disaster- Development Nexus.

UNIT – II

TYPES of HAZARDS AND EMRGING TRENDS

Classification, Causes, Consequences and Controls of Geophysical hazards-Earthquakes, Landslides, Tsunami Weather related hazards- Meteorological (Cyclones, Storm-surge and Lighting) Hydrological (Floods, Droughts, Avalanches), Climatological (Wildfire, Cold & Heat Waves) Biological hazards-Epidemic & Pandemics, Technological hazards-Chemical, Industrial, Nuclear Man-made hazards-Structural Failure, Fire, Transportation accidents, Terrorism and Wars Emerging Disasters- Urban Areas, Climate Change. Regional and Global Trends-loss of life & Property in various hazards.

UNIT – III

DISASTER MANAGEMENT CYCLE AND INTERNATIONAL FRAMEWORK

Disaster Management Cycle , Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness, During Disaster – Evacuation – Disaster Communication – Search and Rescue– Emergency Operation Centre – Incident Command System – Relief and Rehabilitation, Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment, Paradigm Shift in Disaster Management: International Decade for Natural Disaster Reduction; Yokohama Strategy; Hyogo Framework of Action.

UNIT – IV

DISASTER RISK MANAGEMENT IN INDIA

Disaster Profile of India – Mega Disasters of India and Lessons Learnt, Disaster Management Act 2005 – Institutional and Financial Mechanism, National Policy on Disaster Management,
National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter-governmental Agencies.

UNIT – V

TECHNOLOGICAL APPROACHES TO DISASTER RISK REDUCTION

Geo-informatics in Disaster Management (RS, GIS, GPS and RS) , Disaster Communication System (Early Warning and Its Dissemination) , Land Use Planning and Development Regulations, Disaster Safe Designs and Constructions, Structural and Non Structural Mitigation of Disasters
Science &Technology Institutions for Disaster Management in India.

Suggested Reading

1	Coppola D P, 2007. *Introduction to International Disaster Management*, Elsevier Science (B/H), London.
2	*Manual on natural disaster management in India*, M C Gupta, NIDM, New Delhi
3	*An overview on natural & man-made disasters and their reduction*, R K Bhandani, CSIR, New Delhi
4	World Disasters Report, 2009. *International Federation of Red Cross and Red Crescent*, Switzerland
5	10 Disaster Management Act 2005, Publisher by Govt. of India
6	*Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management*
7	National Disaster Management Policy, 2009, GoI.

OE 602 CE	**GEO SPATIAL TECHNIQUES**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	Description about various spatial and non-spatial data types, and data base management Techniques.
2	Development of the concepts and professional skills in utility of geospatial techniques.
3	Enhancement of knowledge of geospatial techniques to field problems.

Course Outcomes On completion of this course, the student will be able to	
CO1	Ability to apply the Geospatial Techniques to select appropriate coordinates and steps of GIS.
CO2	Perform spatial data analysis and data management to apply to GIS
CO3	Analyze a digital elevation model of land surface terrain to derive watersheds and stream networks.
CO4	Perform digital image analysis to extract data from the remote sensing images for Civil Engineering applications.
CO5	Understand the concept of the remote sensing techniques for the field and its application to Civil Engineering.

UNIT – I

Introduction: Basic concepts, socio economic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems: Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, and map analysis

UNIT – II

Data Acquisition and Data Management: Data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing: Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors.

UNIT – III

Data Modeling: Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions: Organizing data for analysis, analysis function, maintenance and

analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non spatial data.

UNIT – IV
Applications of GIS: Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT – V
Applications of GIS: Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

Suggested Reading:

1	Burrough, P. A., and McDonnell R. A. (1998), "*Principles of Geographical Information Systems"*, Oxford University Press, New York.
2	Choudhury S., Chakrabarti, D., and Choudhury S. (2009), "*An Introduction to Geographic Information Technology*", I.K. International Publishing House (P) Ltd, New Delhi
3	Kang-tsung Chang. (2006), "*Introduction to Geographical information Systems*", Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi.
4	Lilys and T.M., and Kiefer R.W. (2002), "*Remote Sensing and Image Interpretation*", John Wiley and Sons, Fourth Edition, New York.
5	Sabins F.F. Jr. (1978), "*Remote Sensing Principles and Interpretations*", W.H. Freeman and Company, San Francisco.
6	Tor Bernhardsen. (2002), "*Geographical Information System*", Wiley India (P) Ltd., Third Edition, New Delhi.
7	Hoffman-Wellenh of, B, et al. (1997), "*GPS Theory and Practice*", 4th Edition, Springer Wein, New York.

OE 601 AI	**OPERATING SYSTEMS**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To understand CPU, Memory, File and Device managements
2	To learn about concurrency control, protection and security
3	To gain knowledge of Unix and Windows NT internals

Course Outcomes On completion of this course, the student will be able to	
CO1	Acquire a solid grasp of operating system concepts encompassing structure, process management, inter process communication, synchronization, and CPU scheduling strategies
CO2	Demonstrate proficiency in managing memory through techniques like paging, segmentation, and demand paging
CO3	Develop skills to identify, prevent, avoid, detect, and recover from deadlocks, and gain insight into protection mechanisms.

UNIT – I
Introduction to Operating Systems: OS structure and strategies, Process concepts, Threads, Interprocess communication, CPU scheduling algorithms, Process synchronization, Critical section problem, Semaphores, Monitors.

UNIT – II
Memory management: Swapping, Contiguous allocation, Paging, Static and dynamic partitions, Demand paging, Page replacement algorithms, Thrashing, Segmentation, Segmentation with paging. File system interface: File concepts, Access methods and protection. File system implementation: File system structure, Allocation methods, Directory implementation.

UNIT – III
Deadlocks: Necessary conditions, Resource allocation graph, Methods for handling deadlocks, Prevention, Avoidance, Detection and recovery. Protection: Goals, Domain of protection, Access matrix. Security: Authentication, Threat monitoring, Encryption

UNIT – IV
Device Management: Disk scheduling methods, Disk management, Device drivers and interfaces, CPU-device interactions, I/O optimization.

UNIT – V
Case Studies: Unix Operating system – General architecture, Unix system calls, Unix Shell, Files and directories in Unix. Windows NT – General architecture, The NT kernel, The NT executive.

Suggested Reading:

1	Abraham Silberschatz, Peter B Galvin, *Operating System Concepts*, Addison Wesley, 2006
2	William Stallings, *Operating Systems-Internals and Design Principles*, 5th Edition, PHI, 2005
3	Andrew S Tanenbaum, Modern Operating Systems, PHI, 1996

OE 602 AI	**OOP USING JAVA**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To introduce object oriented concepts of Java programming Language
2	To introduce concepts of exception handling and multithreading
3	To use various classes and interfaces in java collection framework and utility classes.
4	To understand the concepts of GUI programming using AWT and Swing controls.

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply the usage of abstract classes
CO2	Write multi threaded programs with synchronization
CO3	Implement real world applications using Java collection frame work and I/O classes
CO4	Write the Event driven GUI programs using AWT/Swing

UNIT – I

Object Oriented System Development: understanding object oriented development, understanding object oriented concepts, benefits of object oriented development.

Java Programming Fundamentals: Introduction, overview of Java, data types, variables and arrays, operators, control statements, classes, methods, inheritance, packages and interfaces.

UNIT – II

Exceptional Handling, Multithreaded Programming, I/O Basics, Reading Console Input and Output, Reading and Writing Files, Print Writer Class, String Handling.

UNIT – III

Exploring Java.Lang, Collections Overview, Collection Interfaces, Collection Classes, Iterators, Random Access Interface, Maps, Comparators, Arrays, Legacy Classes and Interfaces, String Tokenizer, Bitset, Date, Calendar, Observable Timer

UNIT – IV

GUI Programming & Event Handling: Event Handling Mechanisms, The Delegation Event Model, Event Classes, Source of Events, Event Listener Interfaces, Handling mouse and keyboard events, Adapter classes, Inner classes, Anonymous Inner classes, Introduction, AWT classes working with Graphics, Understanding Layout Managers, Flow Layout, Border Layout, Grid Layout, Card Layout, Grid Bag Layout.

Java Swing: Basics of Swing, Difference between AWT & Swing, MVC Architecture, Components and Container, Exploring Swing Controls- JLabel and Image Icon, JText Field, The Swing Buttons-JButton, JToggle Button, JCheck Box, JRadio Button, JTabbed Pane, JScroll Pane, JList, JCombo Box, Swing Menus, Dialogs.

UNIT – V

Java I/O Classes and Interfaces, Files, Stream and Byte Classes, Character Streams, Serialization.

Suggested Reading:

1	Herbert Schildt, *The Complete Reference JAVA*, Tata McGraw Hill, 7th Edition, 2005.
2	James M Slack, *Programming and Problem Solving with JAVA*, Thomson Learning, 2002.
3	C.Thomas Wu, *An Introduction to Object-Oriented Programming with Java*, Tata McGraw Hill, 5th Edition, 2005.

OE 601 EC	**EMBEDDED SYSTEMS**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To gain knowledge to design embedded systems
2	To understand the processor selection criteria for Embedded System Design.
3	To gain the knowledge of ARM Cortex on Zynq for embedded systems.
4	To gain the knowledge of tool chain for embedded systems.
5	To understand the importance of RTOS in building real time systems

Course Outcomes On completion of this course, the student will be able to	
CO1	Design an embedded system and Distinguish between RISC and CISC
CO2	Use the ARM Cortex for design of embedded system
CO3	Use Embedded Software Development Tools for Designing Embedded System applications
CO4	Apply their understanding in building real time systems

UNIT – I

Introduction To Embedded Systems: The Embedded Design Life Cycle - Product Specification, Hardware/Software Partitioning, Iteration and Implementation, Detailed Hardware and Software Design, Hardware/Software Integration, Product Testing And Release, Maintenance and Upgradation.

UNIT – II

Embedded processing with ARM CORTEX on Zynq: Fundamentals of FPGA, types of FPGA, case study of Xilinx FPGA, Processing System, programmable logic, programmable logic interfaces, security, Zynq 7000 family members, Zynq versus standard FPGA, Zynq versus standard processor

UNIT – III

Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution, and Locator Maps. Getting Embedded Software into Target System: PROM programmer, ROM emulator, In Circuit- Emulators, Monitors, Testing on Your Host Machine - Instruction Set Simulators, Logic Analyzers

UNIT – IV

Introduction to Real Time Operating Systems: Tasks and task states, tasks and Data, Semaphores and shared data.

UNIT – V

Operating system services: Message queues, mailboxes and pipes, timer functions, events, memory management, Interrupt routines in an RTOS environment

Suggested Reading:

1	Arnold S Berger, "*Embedded Systems Design*", South Asian edition, CMP Books, 2005
2	Andrew Sloss, Dominic Symes, Chris Wright, *ARM "System Developer's Guide: Designingand Optimizing System Software*", Elsevier, 2004.
3	Louise H Crockett, Ross. A. Elliot et al, "*The Zynq Book*", Edition 1, Strathclyde academic media, July 2014
4	David E Simon, "*An Embedded software primer*", Pearson, 2012

OE 602 EC	**DIGITAL SYSTEM DESIGN USING VERILOG HDL**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To familiarize with various modeling styles: structural, behavioral modeling and dataflow using Verilog HDL
2	To understand various ICs available and their usage and to design them using Verilog HDL.
3	To learn to develop applications such as adders, multipliers, Divider, ALU and DSP filter. their function using Verilog HDL

Course Outcomes On completion of this course, the student will be able to	
CO1	Implement and distinguish different Verilog HDL modeling styles.
CO2	Choose among various ICs available in the market (combinational and sequential)
CO3	Develop Verilog HDL modeling and test bench for digital systems for the given specifications

UNIT – I

Structural modeling: Overview of Digital Design with Verilog HDL, modules and ports, gate-level modeling and design examples. **Dataflow modeling:** dataflow modeling, operands and operators. Switch Level Modeling: CMOS switches and bidirectional switches and design examples. Introduction to test bench design

UNIT – II

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules and design examples.

UNIT – III

Digital Integrated Circuits: Classification of Integrated Circuits, Comparison of Various Logic Families Combinational Logic ICs – Specifications and Applications of TTL-74XX & Code Converters, Decoders, De-multiplexers, LED & LCD Decoders with Drivers, Encoders, Priority Encoders, Multiplexers, De-multiplexers, Priority Generators/Checkers, Parallel Binary Adder/Subtractor and Magnitude Comparators.

UNIT – IV

Sequential Logic IC's and Memories: Familiarity with commonly available TTL 74XX, CMOS 40XX Series ICs – All Types of Flip-flops, Asynchronous and synchronous Counters, Decade Counters, Shift Registers. **Memories -** ROM Architecture, Types of ROMS & Applications, RAM Architecture and applications, Static & Dynamic RAMs.

UNIT – V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Reading:

1	Samir Palnitkar, "Verilog HDL A Guide to Digital Design and Synthesis," 2nd Edition, Pearson Education, 2006
2	R.P.Jain, "Modern Digital Electronics", Tata McGraw Hill, 4th Edition, 2009.
3	Ming-Bo Lin, "Digital System Designs and Practices: Using Verilog HDL and FPGA," Wiley India Edition, 2008.
4	J. Bhasker, "A Verilog HDL Primer," 2nd Edition, BS Publications, 2001.

OE 601 EE	**RELIABILITY ENGINEERING**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To understand the concepts of different types of probability distributions. importance of reliability evaluation of networks.
2	To make the students understand about Reliability, availability model of Power Systems and markov modeling of Power Plants. with identical and non-identical units.

Course Outcomes On completion of this course, the student will be able to	
CO1	Understand the meaning of discrete and continuous random variables and their significance, causes of failures of a system.
CO2	Acquire the knowledge of different distribution functions and their applications.
CO3	Able to develop reliability block diagrams and evaluation of reliability of different systems.

UNIT – I
Discrete and continuous random variables. Probability density function and Cumulative distribution function. Mean and variance. Binomial, Poisson, Exponential and WeibulI distributions

UNIT – II
Discrete and continuous random variables. Probability density function and Cumulative distribution function. Mean and variance. Binomial, Poisson, Exponential and WeibulI distributions**.**

UNIT – III
Reliability block diagram. Series and parallel systems. Network reduction technique, Examples. Evaluation of failure rate, MTTF and reliability, Active and Standby Redundancy, r out of n configuration. Non-series - parallel systems. Path based and cut set methods.

UNIT – IV
Availability, MTTR and MTBF, Markov models and State transition matrices. Reliability models for single component. two components, Load sharing and standby systems. Reliability and availability models of two unit parallel systern with repair and standby systems with repair.

UNIT – V
Repairable Systems. maintainability. Preventive maintenance, Evaluation of reliability and J1TTF. Overhauling and replacement. Optimum maintenance policy. Markov model of a power plant with identical units and non-identical units. Capacity outage probability table. Frequency of failures and Cumulative frequency.

Suggested Reading:

1	Charles E. Ebeling. *Reliability and Maintainability Engineering*, McGraw Hill International Edition, 1997.
2	Balaguruswamy, *Reliability Engineering*, Tata McGraw Hill Publishing Company Ltd, 1984.
3	R.N. Allan. *Reliability Evaluation of Engineering Systems*, Pitman Publishing, 1996.
4	Endrenyi. *Reliability Modeling in Electric Power Systems*. John Wiley & Sons, 1978.

OE 601 ME	**INDUSTRIAL ROBOTICS**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To understand Various types of industrial robots
2	To impart knowledge on Various types of industrial robots
3	To Understand and control the programming of robots

Course Outcomes On completion of this course, the student will be able to	
CO1	Undertake the design of the motion planning of the robot
CO2	Undertake repair and maintenance and rectify mechanical operations
CO3	Plan the motion design for each particular activity

UNIT – I

Safety, introduction to industrial robotics, components of the robot, controller/logic function, teach pendant/interface, manipulator, degrees of freedom, and axis numbering, base types. Classification of robots: power source, geometry of the work envelope, drive systems: classification and operation, so classification, end-of-arm tooling: multiple tooling, positioning of EOAT.

UNIT – II

Programming and file management: planning, subroutines, writing the program, testing and verifying, normal operation, file maintenance, automation sensors: limit switches, proximity switches, tactile and impact sensors, temperature sensors, fluid sensors, position sensors, sound sensors, connection to the robot, sensor selection criteria; vision systems: components of a vision system, image analysis, lighting**.**

UNIT – III

Integration and networking: types of networks, communication protocols,, integration,; programmable logic controllers (PLCS) and human-machine interfaces (HMIS)L basic components of the PLC, operation of the PLC, human–machine interfaces, maintenance and troubleshooting: preventive maintenance, arc flash, troubleshooting, crash recovery, repair tips, parts swapping versus fixing the problem, precautions before running the robot.

UNIT – IV

Robot handling: The handling task, Robot characteristics for handling.- Robot assembly.-case studies Application characteristics., Robot welding : The spot welding process - 6.3 Robot spot welding- 6.4. The robot task- The arc welding process - Robot MIG welding- Machining with robots : Application characteristics - Spray painting applications: The spray painting process - Spray painting robot anatomy and characteristics - Programming techniques - Innovative robot applications in the automation of manufacturing processes, assembly automation - applications in inspection.

UNIT – V

Lean Manufacturing With Robotics for Low Volume, Small Batch Runs: Changeover for Small Batches, the Design of a Robotic Work-Cell, Automating the machining process, Automating the welding process and Automating the material removal process for small batch runs.

Lean Manufacturing With Robotics for Low Volume, Small Batch Runs: Changeover for Small Batches, the Design of a Robotic Work-Cell, Automating the machining process, Automating the welding process and Automating the material removal process for small batch runs.

Suggested Reading:

1	Keith Dinwiddie Industrial Robotics / Edition 1 by , Publisher: Cengage Learning
2	Rex Miller, Mark R. Miller Robots and Robotics: Principles, Systems, and Industrial Applications
3	Groover M P , Industrial Robotics Technology, Programming &Application, Tata McGraw Hill Education
4	Larry T. Ross, Stephen W. Fardo, and Michael F. Walach Industrial Robotics Fundamentals: Theory and Applications, 3rd Edition, 2010.
5	Andrew Glaser, Industrial Robotics, Industrial Press publisher.

OE 602 ME	**MATERIAL HANDLING**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	To know about the working principle of various material handling equipments.
2	To understand the Material handling relates to the loading, unloading and movement of all types of materials.
3	To understand the estimation of storage space and maintenance of material handling equipments.

Course Outcomes On completion of this course, the student will be able to	
CO1	understand various conveying systems that available in industry
CO2	understand various bulk solids handling systems and their design features
CO3	understand various bulk solids handling systems and their design features
CO4	calculate number of MH systems required, storage space, cost and maintenance.

UNIT – I
Mechanical Handling Systems: Belt Conveyors and Desing, Bucket Elevators, Package conveyors, Chain and Flight Conveyors, Screw Conveyors, Vibratory Conveyors, Cranes and Hoists.

UNIT – II
Pneumatic and Hydraulic Conveying Systems: Modes of Conveying and High pressure conveying systems, Low Velocity Conveying System. Components of Pneumatic Conveying Systems: General Requirements, Fans and Blowers, Boots-Type Blowers, Sliding-Vane Rotary Compressors, Screw Compressors, Reciprocating Compressors, Vacuum Pumps.

UNIT – III
Bulk Solids Handling: Particle and Bulk Properties. Adhesion, Cohesion and Moisture Content. Gravity Flow of Bulk Solids: Static and Dynamic Pressure Distribution in Bulk Solids. Modes of Flow: Mass Flow, Funnel Flow and Expanded Flow from Hoppers, Bins and Silos.

UNIT – IV
Modern Material Handling Systems: Constructional features of (i) AGV (ii) Automated storage and retrieval systems. Sensors used in AGVs and ASRS. Bar code systems and RFID systems: Fundamentals and their integration with computer-based information systems

UNIT – V
Modern Material Handling Systems: Constructional features of (i) AGV (ii) Automated storage and retrieval systems. Sensors used in AGVs and ASRS. Bar code systems and RFID systems: Fundamentals and their integration with computer-based information systems.

Suggested Reading:

1	Dr. Mahesh Varma, "Construction Equipment and its Planning & Application", Metropolitan Book Co.(P) Ltd., New Delhi, India 1997
2	James M. Apple, "Material Handling Systems Design", The Ronald Press Company, New York, USA, 1972
3	Woodcock CR. and Mason J.S., "Bulk Solids Handling: An Introduction to Practice Technology", Leonard Hill USA, Chapman and Hall, New York.
4	M P Groover et al, "Industrial Robotics", Mc Graw Hill, 1999.

OE 601 LA	**INTELLECTUAL PROPERTY RIGHTS**					
Prerequisites			**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**30 Marks**	**SEE**		**70 Marks**	

Course Objectives	
1	Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
2	Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
3	Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Course Outcomes On completion of this course, the student will be able to	
CO1	Understand the concept of intellectual property rights.
CO2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO5	Apply the patents and demonstration of case studies.

UNIT – I

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

UNIT – IV

Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

UNIT – V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1	Halbert, ―Resisting Intellectual Property‖, Taylor & Francis Ltd, 2007.
2	Mayall, ―Industrial Design‖, McGraw Hill,1992
3	Niebel, ―Product Design‖, McGraw Hill,1974.
4	Asimov, ―Introduction to Design‖, Prentice Hall,1962.
5	Robert P. Merges, Peter S. Menell, Mark A. Lemley, ―Intellectual Property in New Technological Age‖,2016
6	T. Ramappa, ―Intellectual Property Rights Under WTO‖, S. Chand,2008

PC 651 AI	**MACHINE LEARNING LAB**					
Prerequisites			**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**
Evaluation	**CIE**	**25 Marks**	**SEE**		**50 Marks**	

Course Objectives	
1	Demonstration of different classifiers on different data
2	Demonstrate ensembling of classifiers for solving real world problems
3	Make use of real world data to implement machine learning models.

Course Outcomes On completion of this course, the student will be able to	
CO1	Apply machine learning algorithms: dataset preparation, model selection, model building
CO2	Evaluate various Machine Learning approaches.
CO3	Use scikit-learn, Keras and Tensorflow to apply ML. techniques. 5. Design and develop solutions to real world problems using ML. techniques.
CO4	Apply unsupervised learning and interpret the results.

List of Experiments

1. Basic Data Preprocessing
   a. Installation of python environment/Anaconda IDE for machine learning installing python modules/Packages like scikit-learn, Keras and Tensorflow.
   b. Programs involving pandas, Numpy and Scipy libraries.
2. Programs for classification
   a. Build models using linear regression and logistic regression and apply it to classify a new instance.
   b. Write a program to demonstrate the following classifiers. Use an appropriate data set for building the model. Apply the model to classify a new instance.
      i) Decision tree
      ii) K nearest neighbour
      iii) Naïve bayes
      iv) Support vector machine
3. Demonstration of Clustering algorithms using
   a. K-means
   b. Hierarchical algorithms
4. Demonstrate ensemble techniques like boosting, bagging, random forests
5. Build a classifier, compare its performance with an ensemble technique like random forest.
6. Evaluate various classification algorithms performance on a dataset using various measures like True Positive rate, False positive rate, precision, recall.
7. Demonstrate GA for optimization (minimization or maximization problem)
8. Case study on supervised/unsupervised learning algorithm:
   a) Handwritten digits classification using CNN
   b) Text classification using python libraries.

PC 652 AI	**COMPUTER NETWORKS LAB**					
Prerequisites			**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Evaluation	**CIE**	**25 Marks**	**SEE**		**50 Marks**	

Course Objectives	
1	To familiarize POSIX: IPC
2	To use socket interface to write client-server network applications
3	To effectively use sockets to write simple network monitoring tools

Course Outcomes On completion of this course, the student will be able to	
CO1	Write concurrent programs using message queues and semaphores
CO2	Use connection-oriented , connectionless and Asynchronous sockets
CO3	Implement networked applications in TCP/IP protocol Suite

List of Programs

1. Examples using IPC
2. Echo Server using TCP (Concurrent or Iterative) and UDP
3. Time of the day server
4. Talker and Listener
5. Ping routine
6. Trace route
7. Mini DNS

Note: The above experiments [2-7] have to be carried out using socket programming interface. Multi-threading has to be employed wherever it is required.

PC653 AI	MINI PROJECT					
Prerequisites			**L**	**T**	**P**	**C**
			0	**0**	**3**	**3**
Evaluation	**SEE**	**--**	**CIE**		**50 Marks**	

Course Objectives

1	To develop capability to analyze and solve real world problems with an emphasis on applying/integrating knowledge acquired.
2.	To learn the communication and presentation of the project work

Course Outcomes

After completion of the course , Student will be able to	
CO-1	Analyze and solve real world problems.
CO-2	Implement the system using SQL, data structures, C/C++, JAVA, Python and different software engineering models.

The department can initiate the project allotment procedure at the end of V semester and finalize it in the first two weeks of VI semester.
The department will appoint a project coordinator who will coordinate the following: Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries) Grouping of students (max 3 in a group)

Allotment of project guides

The aim of mini project to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems.
To get awareness on current problems and solution techniques, the first Two (2) weeks of VI semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions.
After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.
Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.
Each group will be required to:
1. Submit a one page synopsis before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Mini Project to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

*Problem definition and specification
*Literature survey
*Broad knowledge of available techniques to solve a particular problem.
*Planning of the work, preparation of bar (activity) charts
*Presentation- oral and written.

PW 961 AI	**SUMMER INTERNSHIP**					
Prerequisites			**L**	**T**	**P**	**C**
			-	**-**	**-**	**-**
Evaluation	**SEE**	**-**	**CIE**		**-**	

Course Objectives:

1.	To train and provide hands-on experience in analysis, design, and programming of information systems by means of case studies and projects.
2.	To expose the students to industry practices and team work.
3.	To provide training in soft skills and also train them in presenting seminars and technical report writing.

Course Outcomes:	
After completion of this course student will be able to do:	
CO-1	Get Practical experience of software design and development, and coding practices within Industrial/R&D Environments.
CO-2	Gain working practices within Industrial/R&D Environments.
CO-3	Prepare reports and other relevant documentation

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Computer Industry/Software Companies/R&D Organization for a period of 8 weeks.

This will be during the summer vacation following the completion of the III year Course. One faculty coordinator will also be attached to the group of Three (3) students to monitor the progress and to interact with the industry co-ordinate (person from industry). After the completion of the project, student will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the Department.

Award of sessionals are to be based on the performance of the students, to be judged by a committee constituted by the department. One faculty member will co-ordinate the overall activity of Industry Attachment Program.

Students have to undergo summer internship of Six Weeks duration at the end of semester VI and the credits will be awarded after evaluation in VII semester