Structure of Post Graduate
(ME Computer Science and Engineering)

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

THAPAR INSTITUTE OF ENGINEERING & TECHNIOLOGY
(DEEMED TO BE UNIVERSITY)
PATIALA, PUNJAB, INDIA

COURSES SCHEME & SYLLABUS

M.E. (COMPUTER SCIENCE & ENGINEERING)

ME- COMPUTER SCIENCE AND ENGINEERING (2016-17, 2017-18)

SEMESTER I						
S. NO.	**CODE**	**TITLE**	**L**	**T**	**P**	**Cr**
1	PCL105	STATISTICAL METHODS AND ALGORITHMS	3	0	2	4
2	PCS104	ADVANCED DATA STRUCTURES AND ALGORITHMS	3	0	4	5
3	PCS103	ADVANCED ARTIFICIAL INTELLIGENCE	3	0	2	4
4	PCS105	ADVANCED OPERATING SYSTEM	3	0	2	4
5	PCS106	PARALLEL AND DISTRIBUTED COMPUTING	3	0	2	4
6	PCS107	TECHNOLOGY & INNOVATION	1	0	1	2
		TOTAL	**15**	**0**	**12**	**23**
SEMESTER II						
1	PCS205	BIG DATA AND BUSINESS INTELLIGENCE	3	0	2	4
2	PCS206	MACHINE LEARNING	3	0	2	4
3	PCS292	ENGINEERING DESIGN PROJECT (4 SELF EFFORT HRS)	1	0	4	5
4		ELECTIVE-I	3	0	2	4
5		ELECTIVE-II	3	0	2	4
6		ELECTIVE-III	3	0	2	4
		TOTAL	**16**	**0**	**14**	**25**
ELECTIVE I						
1	PCS204	ADVANCED INFORMATION MANAGEMENT SYSTEMS	3	0	2	4
2	PCS207	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	3	0	2	4
3	PCS213	DATA MINING AND KNOWLEDGE MANAGEMENT	3	0	2	4
4	PSE205	SOFTWARE METRICS AND QUALITY MANAGEMENT	3	0	2	4
ELECTIVE II						
1	PCS209	WEB ANALYTICS AND INTELLIGENCE	3	0	2	4
2	PCS224	NATURAL LANGUAGE PROCESSING	3	0	2	4
3	PCS211	CLOUD INFRASTRUCTURE AND SERVICES	3	0	2	4
4	PCS214	ADVANCED COMPUTER ARCHITECTURE	3	0	2	4
ELECTIVEIII						
1	PCS212	INFORMATION RETRIEVAL	3	0	2	4
2	PCS208	RECOMMENDER SYSTEM	3	0	2	4
3	PIS105	SECURE CODING	3	0	2	4
4	PIS204	NETWORK SECURITY AND ETHICAL HACKING	3	0	2	4
SEMESTER III						
1	PCS391	SEMINAR	-	-	-	4
2	PCS392	CAPSTONE PROJECT (14 SELF EFFORT HOURS)			10	12
3		DISSERTATION (STARTS)	-	-	-	-
		TOTAL				**16**
SEMESTER IV						
1	PCS091	DISSERTATION	-	-	-	16
		TOTAL	**-**	**-**	**-**	**16**
		GRAND TOTAL - FOUR SEMESTER CREDITS				**80**

PCS 103 ADVANCED ARTIFICIAL INTELLIGENCE				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: Assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving particular engineering problems.

Fundamental Issues: Overview of AI problems, Examples of successful recent AI applications, Intelligent behaviour, The Turing test, Rational versus non-rational reasoning, Problem characteristics: Fully versus partially observable, Single versus multi-agent, Deterministic versus stochastic, Static versus dynamic, Discrete versus continuous, Nature of agents: Autonomous versus semi-autonomous, Reflexive, Goal-based, and Utility-based, Importance of perception and environmental interactions, Philosophical and ethical issues.

Basic Search Strategies: Problem spaces (states, goals and operators), Problem solving by search, Factored representation (factoring state into variables), Uninformed search (breadth-first, depth-first, depth-first with iterative deepening), Heuristics and informed search (hill-climbing, generic best-first, A*), Space and time efficiency of search, Constraint satisfaction (backtracking and local search methods).

Advanced Search: Constructing search trees, Dynamic search space, Combinatorial explosion of search space, Stochastic search: Simulated annealing, Genetic algorithms, Monte-Carlo tree search, Implementation of A* search, Beam search, Minimax Search, Alpha-beta pruning, Expect Imax search (MDP-solving) and chance nodes.

Knowledge Representation: Propositional and predicate logic, Resolution in predicate logic, Question answering, Theorem proving, Semantic networks, Frames and scripts, conceptual graphs, conceptual dependencies.

Reasoning under Uncertainty: Review of basic probability, Random variables and probability distributions: Axioms of probability, Probabilistic inference, Bayes' Rule, Conditional Independence, Knowledge representations using Bayesian Networks, Exact inference and its complexity, Randomized sampling (Monte Carlo) methods (e.g. Gibbs sampling), Markov Networks, Relational probability models, Hidden Markov Models, Decision Theory Preferences and utility functions, Maximizing expected utility.

Agents: Definitions of agents, Agent architectures (e.g., reactive, layered, cognitive), Agent theory, Rationality, Game Theory Decision-theoretic agents, Markov decision processes (MDP), Software agents, Personal assistants, and Information access Collaborative agents, Information-gathering agents, Believable agents (synthetic characters, modelling emotions in agents), Learning agents, Multi-agent systems Collaborating agents, Agent teams, Competitive agents (e.g., auctions, voting), Swarm systems and Biologically inspired models. Expert Systems: Architecture of an expert system, existing expert systems: MYCIN, RI. Expert system shells.

Laboratory work:Programming in C/C++/java: programs for Search algorithms- Depth first, breadth first, best first, hill climbing, Implementation of games: 8-puzzle, Tic-tac-toe using heuristic search, Designing expert system using logic in Prolog, implementing an intelligent agent.

Recommended Books:

1. *Rich E., Artificial Intelligence, Tata McGraw Hills (2009).*
2. *George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education Asia (2009).*

3. Patterson D.W, Introduction to AI and Expert Systems, Mc GrawHill (1998).
4. *Shivani Goel, Express Learning- Artificial Intelligence, Pearson Education Asia (2013).*

Course Learning Outcomes (CLOs)

CLO1	To comprehend the applications of artificial intelligence and categorize various problem domains, uninformed and informed search methods.
CLO2	Explore and implement advanced search techniques and algorithms like minimax for game playing
CLO3	Illustrate the importance of probability in knowledge representation for reasoning under uncertainty
CLO4	Express the knowledge using Bayesian networks and Hidden Markov Models.
CLO5	Discuss the architecture for expert system and intelligent agent and implement an intelligent agent/expert system.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS104 ADVANCED DATA STRUCTURES AND ALGORITHMS				
	L	**T**	**P**	**Cr**
	3	**0**	**4**	**5**

Course Objective: To learn the advanced concepts of data structure and algorithms and its implementation .The course has the main ingredients required for a computer science graduate and has all the necessary topics for assessment of data structures and algorithms.

Introduction to Basic Data Structures: Importance and need of good data structures and algorithms, Arrays, Linked lists, Stacks, Queues, Priority queues, Heaps; Strategies for choosing the appropriate data structures.

Advanced Data Structures: AVL Trees, Red-Black Trees, Splay Trees, B-trees, Fibonacci heaps, Data Structures for Disjoint Sets, Augmented Data Structures.
Algorithms Complexity and Analysis: Probabilistic Analysis, Amortized Analysis, Competitive Analysis, Internal and External Sorting algorithms: Linear Search, Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Heap Sort, Merge Sort, Counting Sort, Radix Sort.

Graphs & Algorithms: Representation, Type of Graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism,Graph Coloring, Covering and Partitioning,, Depth- and breadth-first traversals, Minimum Spanning Tree: Prim's and Kruskal's algorithms, Shortest-path Algorithms: Dijkstra's and Floyd's algorithm, Topological sort, Max flow: Ford-Fulkerson algorithm, max flow – min cut.

String Matching Algorithms: Suffix arrays, Suffix trees, tries, Rabin-Karp, Knuth-Morris-Pratt, Boyer-Moore algorithm.

Approximation algorithms: Need of approximation algorithms: Introduction to P, NP, NP-Hard and NP-Complete; Deterministic, non-Deterministic Polynomial time algorithms; Knapsack, TSP, Set Cover, Open Problems.

Randomized algorithms: Introduction, Type of Randomized Algorithms, Quick Sort, Min- Cut, 2-SAT; Game Theoretic Techniques, Random Walks.
Online Algorithms: Introduction, Online Paging Problem, Adversary Models, k-server Problem.

Laboratory Work: To Implement in detail all the data structures and algorithms given above in a high level programming language.

Recommended Books:

1. *Thomas Coremen, "Introduction to Algorithms", Prentice Hall of India (2009).*
2. *Kleinberg J., Tardos E., "Algorithm Design", Pearson (2012).*
3. *Motwani R., Raghavan P., "Randomized Algorithms", Cambridge University Press, (1995).*
4. *Vazirani, Vijay V., "Approximation Algorithms", Springer, (2001).*

Course Learning Outcomes (CLOs)

CLO1	Implement the basic data structures, advanced data structures, Internal and External Sorting algorithms and learn the appropriate algorithmic approach to a problem.
CLO2	Demonstrate the ability to evaluate algorithms, to provide justification for that selection, and to implement the algorithm in a particular context
CLO3	Employ graphs to model a variety of real-world problems, synthesise tree and graph algorithms and analyze them.
CLO4	Implement advance algorithmic techniques such as String Matching Algorithms, Approximation algorithms etc.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS 105 ADVANCED OPERATING SYSTEM				
	L	**T**	**P**	**Cr**
	3	**0**	**0**	**3.0**

Course Objective: To learn the advanced concepts of operating systems and its implementation.

Introduction: Overview, Functions of an Operating System, Design Approaches, Types of Advanced Operating System - Synchronization Mechanisms, Concept of a Process, Concurrent Processes, The Critical Section Problem, Other Synchronization Problems, Language Mechanisms for Synchronization, Axiomatic Verification of Parallel Programs - Process Deadlocks - Preliminaries, Models of Deadlocks, Resources, System State, Necessary and Sufficient conditions for a Deadlock, Systems with Single-Unit Requests, Consumable Resources, Reusable Resources.

Distributed Operating Systems: Introduction, Issues, Communication Primitives, Inherent Limitations - Lamport's Logical Clock; Vector Clock; Causal Ordering; Global State; Cuts; Termination Detection. Distributed Mutual Exclusion, Non-Token Based Algorithms, Lamport's Algorithm - Token-Based Algorithms, Suzuki-Kasami's Broadcast Algorithm, Distributed Deadlock Detection, Issues, Centralized Deadlock-Detection Algorithms - Distributed Deadlock-Detection Algorithms. Agreement Protocols, Classification - Solutions, Applications.

Distributed Resource Management: Distributed File systems, Architecture, Mechanisms, Design Issues, Distributed Shared Memory, Architecture, Algorithm, Protocols - Design Issues. Distributed Scheduling, Issues, Components, Algorithms.

Failure Recovery and Fault Tolerance: Basic Concepts-Classification of Failures, Basic Approaches to Recovery; Recovery in Concurrent System; Synchronous and Asynchronous Check pointing and Recovery; Check pointing in Distributed Database Systems; Fault Tolerance; Issues - Two-phase and No blocking Commit Protocols; Voting Protocols; Dynamic Voting Protocols

Multiprocessor and Database Operating Systems: Structures, Design Issues, Threads, Process Synchronization, Processor Scheduling, Memory Management, Reliability / Fault Tolerance; Database Operating Systems, Introduction, Concurrency Control, Distributed Database Systems, Concurrency Control Algorithms.

Recommended Books:

1. Mukesh Singhal and N. G. Shivaratri, "Advanced Concepts in Operating Systems", McGraw- Hill, (2000)

2. Abraham Silberschatz, Peter B. Galvin, G. Gagne, "Operating System Concepts", Sixth Addison n Wesley Publishing Co., (2003).

3. Andrew S. Tanenbaum, "Modern Operating Systems", Addison Wesley (2001).

Course Learning Outcomes (CLOs)

CLO1	Get familiar with the basics of advanced operating systems, concurrency, and various deadlock models.
CLO2	Comprehend the primitives of distributed operating systems with issues pertaining related to the deadlock detection.
CLO3	Explore the diverse protocols available for the resource management and, fault recovery and tolerance in the distributed system.
CLO4	Proverbial with the primitives and algorithms available for managing the database operating systems.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS106 PARALLEL AND DISTRIBUTED COMPUTING				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To learn the advanced concepts of Parallel and Distributed Computing and its implementation for assessment of understanding the course by the students

Introduction: Scope, issues, applications and challenges of Parallel and Distributed Computing

Parallel Programming Platforms: Implicit Parallelism: Trends in Microprocessor Architectures, Dichotomy of Parallel Computing Platforms, Physical Organization, Communication Costs in Parallel Machines, Routing Mechanisms for Interconnection Networks, GPU, co-processing.

Principles of Parallel Algorithm Design: Decomposition Techniques,Characteristics of Tasks and Interactions,Mapping Techniques for Load Balancing.

CUDA programming model: Overview of CUDA, Isolating data to be used by parallelized code, API function to allocate memory on parallel computing device, to transfer data, Concepts of Threads, Blocks, Grids, Developing a kernel function to be executed by individual threads, Execution of kernel function by parallel threads, transferring data back to host processor with API function.
Analytical Modelling of Parallel Programs:Sources of Overhead in Parallel Programs,Performance Metrics for Parallel Systems,The Effect of Granularity on Performance,Scalability of Parallel Systems,Minimum Execution Time and Minimum Cost-Optimal Execution Time

Dense Matrix Algorithms: Matrix-Vector Multiplication,Matrix-Matrix Multiplication, Issues in Sorting on Parallel Computers, Bubble Sort and Variants, Quick Sort,Other Sorting Algorithms

Graph Algorithms: Minimum Spanning Tree: Prim's Algorithm,Single-Source Shortest Paths: Dijkstra's Algorithm,All-Pairs Shortest Paths,Transitive Closure,Connected Components,Algorithms for Sparse Graph

Search Algorithms for Discrete Optimization Problems: Sequential Search Algorithms,Parallel Depth-First Search,Parallel Best-First Search,Speedup Anomalies in Parallel Search Algorithms

Laboratory Work : To Implement the algorithms with the help of CUDA programming using parallel and distributed programming techniques

Recommended Books:

1. A Grama, A Gupra, G Karypis, V Kumar. Introduction to Parallel Computing (2nd Ed.). Addison Wesley(2003).

2. C Lin, L Snyder. Principles of Parallel Programming. USA: Addison-Wesley Publishing Company(2008).

3. J Jeffers, J Reinders. Intel Xeon Phi Coprocessor High-Performance Programming. Morgan Kaufmann Publishing and Elsevier(2013).

4. *T Mattson, B Sanders, B Massingill. Patterns for Parallel Programming. Addison-Wesley Professional(2004).*

Course Learning Outcomes (CLOs)

CLO1	Learn the concepts, issues and tasks in parallel and distributed computing along with different parallel architectures
CLO2	To demonstrate the principles for Parallel Algorithm Design.
CLO3	Explore the parallel programming models and algorithms for common operations.
CLO4	To analyze the application of parallel algorithms to solve the complex computational problems.
CLO5	Implement various parallel algorithms with CUDA.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS204 ADVANCED INFORMATION MANAGEMENT SYSTEMS				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To learn the advanced concepts of database information and management and its implementation for assessment of understanding the course by the students

Transaction Processing and Concurrency Control Techniques: Introduction to Transaction Processing, Properties and states of Transactions, Scheduling of transactions, Serializability of Schedules, Locking Techniques for Concurrency Control, Two phase locking techniques.

Database Recovery Techniques: Recovery Concepts, Recovery Techniques Based on Deferred Update, Techniques Based on Immediate Update.

Distributed DBMS: Introduction, functions and architecture of a DDBMS, distributed relational database design, Transparencies in a DDBMS, Distributed transaction management, distributed concurrency control, distributed deadlock management, distributed database recovery.

Object-Oriented DBMS and NoSQL: Advanced database applications, weakness of RDBMS, next-generation database systems, OODBMS perspectives, persistence, advantages and disadvantages of OODBMS, Object-oriented database design, Object oriented extensions in Oracle, Comparison of ORDBMS and OODBMS.

Need of NoSQL and Its Data Models: Key- value data model, Document data model, Column family data model, Graph data models, CAP Theorem

Data Warehousing Concepts, OLAP and Data mining: Evolution of data warehousing, data warehousing concepts, benefits and problems of data warehousing, comparison of OLTP systems and data warehousing, On-Line Analytical Processing, Introduction to data mining.

Laboratory Work: To Implement Different concepts of Advanced Information Management Systems through sample programs and small projects to understand the techniques in a practical manner.

Recommended Books:

1. Thomas Connolly, Carolyn Begg, "Database Systems", Pearson Education, (2005)
2. Pramod J Sadalage and Martin Fowler, "NoSQL Distilled", Pearson, (2012)
3. Hoffer, Prescott, Mcfadden, "Modern Database Management", Pearson Education Asia, (2007)
4. Ivan Bayross, "SQL and PL/SQL", BPB Publication, (2010)

Course Learning Outcomes (CLOs)

CLO1	To comprehend techniques of Transaction Processing, Concurrency Control and Database Recovery Technique.
CLO2	To design Distributed database and apply concurrency control and recovery of data on distributed database.
CLO3	To comprehend the concept of Object-Oriented DBMS and NoSQL data models.
CLO4	To comprehend the need of Data Warehousing Concepts, OLAP and Data mining.
CLO5	To demonstrate use of PL/SQL to develop database centric applications.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS 205 BIG DATA ANALYTICS AND BUSINESS INTELLIGENCE				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To have an advanced level of understanding of most recent advancements in Big Data and using insights, statistical models, visualization techniques for its effective application in Business intelligence.

Introduction to Data Analytics: Data and Relations, Data Visualization, Correlation, Regression, Forecasting, Classification, Clustering.

Big Data Technology Landscape: Fundamentals of Big Data Types, Big data Technology Components, Big Data Architecture, Big Data Warehouses, Functional vs. Procedural Programming Models for Big Data.

Introduction to Business Intelligence: Business View of IT Applications, Digital Data, OLTP vs. OLAP, BI Concepts, BI Roles and Responsibilities, BI Framework and components, BI Project Life Cycle, Business Intelligence vs. Business Analytics.
Big Data Analytics: Big Data Analytics, Framework for Big Data Analysis, Approaches for Analysis of Big Data, ETL in Big Data, Introduction to Hadoop Ecosystem, HDFS, Map-Reduce Programming, Understanding Text Analytics and Big Data, Predictive analysis on Big Data, Role of Data analyst.

Business implementation of Big Data: Big Data Implementation, Big Data workflow, Operational Databases, Graph Databases in a Big Data Environment, Real-Time Data Streams and Complex Event Processing, Applying Big Data in a business scenario, Security and Governance for Big Data, Big Data on Cloud, Best practices in Big Data implementation, Latest trends in Big Data, Latest trends in Big Data, Big Data Computation, More on Big Data Storage, Big Data Computational Limitations.

Laboratory Work: Introduction, use and assessment of most recent advancements in Big Data technology along with their usage and implementation with relevant tools and technologies.

Recommended books:

1. *Minelli M., Chambers M., Dhiraj A., Big Data, Big Analytics: Emerging Business*
2. *Intelligence and Analytic Trends for Today's Businesses, Wiley CIO Series (2013),*
3. *White T., Hadoop: The Definitive Guide, O' Reilly Media (2012).*

Course Learning Outcomes (CLOs)

CLO1	To comprehend the concepts of big data, architecture and environment, digital data types, structure and its implementation.
CLO2	Explore the advanced level of understanding of the usage of Big Data in present World.
CLO3	To comprehend the concepts of Map-Reduce, HDFS command and Hadoop services and its implementation.
CLO4	Analyze big data, create statistical models, and identify insights that can lead to actionable results
CLO5	To Use software tools such as R and Hadoop, in text analytics.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS 206 MACHINE LEARNING

L	T	P	Cr
3	0	2	4

Course Objectives: This course provides an advanced level of understanding to machine learning and statistical pattern recognition. It offers some of the most cost-effective approaches to automated knowledge acquisition in emerging data-rich disciplines and focuses on the theoretical understanding of these methods, as well as their computational implications.

Introduction: Well-Posed learning problems, Basic concepts, Designing a learning system, Issues in machine learning. Types of machine learning: Learning associations, Supervised learning (Classification and Regression Trees, Support vector machines), Unsupervised learning (Clustering), Instance-based learning (K-nearest Neighbor, Locally weighted regression, Radial Basis Function), Reinforcement learning (Learning Task, Q-learning, Value function approximation, Temporal difference learning).

Decision Tree Learning: Decision tree representation, appropriate problems for decision tree learning, Univariate Trees (Classification and Regression), Multivariate Trees, Basic Decision Tree Learning algorithms, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.

Bayesian Learning: Bayes theorem and concept learning, Bayes optimal classifier, Gibbs algorithms, Naive Bayes Classifier, Bayesian belief networks, The EM algorithm.

Artificial Neural Network: Neural network representation, Neural Networks as a paradigm for parallel processing, Linear discrimination, Pairwise separation, Gradient Descent, Logistic discrimination, Perceptron, Training a perceptron, Multilayer perceptron, Back propagation Algorithm. Recurrent Networks, Dynamically modifying network structure.

Genetic Algorithms: Basic concepts, Hypothesis space search, Genetic programming, Models of evolution and learning, Parallelizing Genetic Algorithms.
Inductive and Analytical Learning: Learning rule sets, Comparison between inductive and analytical learning, Analytical learning with perfect domain theories: Prolog-EBG. Inductive-Analytical approaches to learning, Using prior knowledge to initialize hypothesis (KBANN Algorithm), to alter search objective (Tangent Prop and EBNN Algorithm), to augment search operators (FOCL Algorithm).

Design and Analysis of Machine Learning Experiments: Guidelines for machine learning experiments,Factors, Response, and Strategy of experimentation, Cross-Validation and Resampling methods, measuring classifier performance, Hypothesis testing, Assessing a classification algorithm's performance, Comparing two classification algorithms, Comparing multiple algorithms: Analysis of variance, Comparison over multiple datasets.

Laboratory Work: It is concerned with the design, analysis, implementation, and applications of programs that learn from experience. Learning algorithms can also be used to model aspects of human and animal learning.

Recommended Books

1. Mitchell T.M., Machine Learning, McGraw Hill (1997).
2. Alpaydin E., Introduction to Machine Learning, MIT Press (2010).
3. Bishop C., Pattern Recognition and Machine Learning, Springer-Verlag (2006).
4. Michie D., Spiegelhalter D. J., Taylor C. C., Machine Learning, Neural and Statistical

Classification. Overseas Press (2009).

Course Learning Outcomes (CLOs)

CLO1	Demonstrate in-depth knowledge of methods and theories in the field of machine learning.
CLO2	Demonstrate the use Bayesian perspective on machine learning, Artificial neural networks, back propagation algorithm
CLO3	Assess the learning algorithms modelled after biological evolution, including genetic algorithms and genetic programming.
CLO4	To demonstrate the ability to critically evaluate and compare different learning models and learning algorithms.
CLO5	To design new algorithms after combining some of the key elements of existing machine learning algorithms.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS207 SOFTWARE ENGINEERING AND PROJECT MANAGEMENT				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To learn the advanced concepts of Software Engineering and Project Management and its implementation for assessment of understanding the course by the students.

Principles and Motivations: History; definitions; why engineered approach to software development; Software development process models from the points of view of technical development and project management: waterfall, rapid prototyping, incremental development, spiral models, Agile Software Development, Emphasis on computer-assisted environments. Selection of appropriate development process.

Software Development Methods: Formal, semi-formal and informal methods; Requirements elicitation, requirements specification; Data, function, and event-based modelling; Some of the popular methodologies such as Yourdon's SAD, SSADM etc.; CASE tools-classification, features, strengths and weaknesses; ICASE; CASE standards.

Software Project Planning, Estimation and Management: Characteristics of a software project, Software scope and feasibility, resources, the SPM plan, Size/scope estimation, Decomposition techniques, WBS., Sizing, Function point, LOC, FP vs LOC, GANTT Charts, Activity networks, PERT/CPM networks, COCOMO I, COCOMO II models. Quality control, Quality assurance, Formal Technical Reviews, The SQA Plan, ISO and CMM standards., Reactive vs. proactive Risk strategies, Risk projection, Risk Refinement, Risk Monitoring, Monitoring and management, RMMM plan., Earned Value Analysis., Team structures: hierarchical, Egoless, chief programmer, mixed; Team software Process; Resource levelling, Building a team: Skill sets.

Configuration Management: Baselines, Configurable items, SCM repository, SCM process, version control change control, configuration audit

Software Quality Management: Quality control, quality assurance and quality standards with emphasis on ISO 9000; Functions of software QA organization does in a project; interactions with developers; Quality plans, quality assurance towards quality improvement; Role of independent verification& validation; Total quality management; SEI maturity model; Software metrics.

Recommended Books:

1. Software Project Management, Bob Hughes and Mike Cotterell, Tata McGraw Hill, (2009)

2. 2. A practitioner's Guide to Software Engineering, Roger Pressman, Tata McGraw Hill (2014)

3. *3. Head First PMP: A Brain Friendly Guide To Passing The Project Management Professional Exam(2013)*

Course Learning Outcomes (CLOs)

CLO1	To comprehend the need for engineering approach to software development. To understand various processes of requirements analysis for software engineering problems.
CLO2	To assess the various concepts ofsoftware engineering models and apply methods for Design and Development of software projects
CLO3	To appreciate and apply various techniques, metricsand strategies for Testing software projects
CLO4	To comprehend the principles, processes and main knowledge areas for Software Project Management including Software Quality Management, Risk Management and Software Configuration Management
CLO5	Apply the standards, CASE tools and techniques for engineering software projects efficient ways.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS 208 RECOMMENDER SYSTEM				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To develop state-of-the-art recommender systems that automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations

Introduction: Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.

Content-based recommendation: High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.

Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centred metrics.

Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group recommender systems.

Laboratory Work: To implement algorithms and techniques given above using relevant tools or high level language. To design recommendation system for a particular application domain.

Recommended Books:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011).

2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2011).

3. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013)

Course Learning Outcomes (CLOs)

CLO1	To comprehend the design of recommender systems: the underlying concepts, design space, and tradeoffs.
CLO2	To analyze the recommender systems based on collaborative filtering methods, Content based filtering approach and knowledge based approach.
CLO3	Explore construction and implementation of a hybrid recommender system.
CLO4	Evaluate the quality of recommendation systems through various evaluation parameters.
CLO5	Compare the user and community behaviour of recommendation systems and its implementation.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS209 WEB ANALYTICS AND INTELLIGENCE				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To Assess that how website visitors view and interact with a site's pages and features, and business intelligence, which would allow using data on customer purchasing patterns, demographics, and demanding trends to make effective strategic decisions.

Introduction: Definition, Process, Key terms: Site references, Keywords and Key phrases; building block terms: Visit characterization terms, Content characterization terms, Conversion metrics; Categories: Offsite web, On site web; Web analytics platform, Web analytics evolution, Need for web analytics, Advantages, Limitations.

Data Collection: Clickstream Data: Web logs, Web Beacons, JavaScript tags, Packet Sniffing; Outcomes Data: E-commerce, Lead generation, Brand/Advocacy and Support; Research data: Mindset, Organizational structure, Timing; Competitive Data: Panel-Based measurement, ISP-based measurement, Search Engine data.

Qualitative Analysis: Heuristic evaluations: Conducting a heuristic evaluation, Benefits of heuristic evaluations; Site Visits: Conducting a site visit, Benefits of site visits; Surveys: Website surveys, Post-visit surveys, Creating and running a survey, Benefits of surveys.

Web Analytic fundamentals: Capturing data: Web logs or JavaScript's tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding clickstream data quality, Identifying unique page definition, Using cookies, Link coding issues.

Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non e-commerce sites): Improving bounce rates, Optimizing AdWords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Web analytics 2.0: Web analytics 1.0, Limitations of web analytics 1.0, Introduction toanalytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data, ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities.

Google Analytics: Brief introduction and working, AdWords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Relevant technologies: Internet & TCP/IP, Client / Server Computing, HTTP (Hypertext Transfer Protocol), Server Log Files & Cookies, Web Bugs.

Laboratory Work: Tto analyzing the web for various functionalities given in the subject and using various tools and technologies to do the experimentation. It also involves installation and working on tools and technologies in this domain.

Recommended Books:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc. (2010)
2. Kaushik A., Web Analytics 2.0 the Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. (2010).

3. *Sterne J., Web Metrics: Proven methods for measuring web site success, John Wiley and Sons (2002)*

Course Learning Outcomes (CLOs)

CLO1	Apply basic concepts of web analytics, its goals, key terminologies, various data collection methods for the purpose of analysis.
CLO2	Perform qualitative analysis using heuristic evaluation, site visits and surveys.
CLO3	Explore various web metrics and understand how to implement them for success.
CLO4	Explore the limitations of web 1.0, web analytic 2.0 etc.
CLO5	Acquire knowledge about Google analytics and how it works.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS-224 NATURAL LANGUAGE PROCESSING				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objectives: To understand the advanced concepts of Natural Language Processing and to be able to apply the various concepts of NLP in other application areas.

Introduction: Origin of Natural Language Processing (NLP), Challenges of NLP, NLP Applications, Processing Indian Languages.

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields, Scope Ambiguity and Attachment Ambiguity resolution.

Machine Translation: Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule-BasedMachine Translation, Knowledge Based MT System, Statistical Machine Translation, UNL Based Machine Translation, Translation involving Indian Languages.

Meaning: Lexical Knowledge Networks, WorldNet Theory; Indian Language Word Nets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors.

Speech Recognition: Signal processing and analysis method, Articulation and acoustics, Phonology and phonetic transcription, Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Other Applications: Sentiment Analysis; Text Entailment; Question Answering in Multilingual Setting; NLP in Information Retrieval, Cross-Lingual IR.

Laboratory Work: To implement Natural language concepts and computational linguistics concepts using popular tools and technologies. To implement key algorithms used in Natural Language Processing.

Recommended Books:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).

2. Allen J., Natural Language understanding, Benjamin/Cunnings, (1987).

3. Jensen K., Heidorn G.E., Richardson S.D., Natural LanguageProcessing: The PLNLP Approach, Springer (2013).

4. *Roach P., Phonetics, Oxford University Press (2012).*

Course Learning Outcomes (CLOs)

CLO1	To comprehend the concept of Natural Language Processing (NLP), its challenges and applications.
CLO2	To process words and word forms of the language by considering its morphology, paradigms and named entities.
CLO3	To demonstrate and implement the use of machine translation by using rule-based MT, Knowledge Based MT and Statistical Machine Translation etc.
CLO4	To comprehend the concepts of WorldNet, Semantic Roles and Word Sense Disambiguation
CLO5	To demonstrate the use of NLP in speech recognition and other emerging applications like Sentiment Analysis, Information Retrieval etc.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS211 CLOUD INFRASTRUCTURE AND SERVICES				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To learn the advanced concepts of cloud infrastructure and services and its implementation for assessment of understanding the course by the students.

Introduction and Evolution of Computing Paradigms: Overview of Existing Hosting Platforms, Cluster Computing, Grid Computing, Utility Computing, Autonomic Computing, mesh, Introduction to Cloud Computing, Cloud Computing history and evolution, practical applications of cloud computing for various industries, economics and benefits of cloud computing.

Cloud Issues and Challenges: Cloud computing issues and challenges like Security, Elasticity, Resource management and scheduling, QoS (Quality of Service) and Resource Allocation, Cost Management, Big Data.

Data Center : Classic Data Center, Virtualized Data Center (Compute, Storage, Networking and Application), Business Continuity in VDC

Cloud Computing Architecture: Cloud Architecture model, Types of Clouds: Public Private & Hybrid Clouds, Cloud based services: Iaas, PaaS and SaaS

Classification of Cloud Implementations: Amazon Web Services, The Elastic Compute Cloud (EC2), The Simple Storage Service (S3), The Simple Queuing Services (SQS), Google AppEngine - PaaS, Windows Azure, Aneka, A Comparison of Cloud Computing Platforms .

Virtualization: Virtualization, Advantages and disadvantages of Virtualization, Types of Virtualization: Resource Virtualization i.e. Server, Storage and Network virtualization, Migration of processes, VMware cloud – IaaS

Cloud based Data Storage: Introduction to Map Reduce for Simplified data processing on Large clusters, Design of data applications based on Map Reduce in Apache Hadoop, Task Partitioning,Data partitioning, Data Synchronization, Distributed File system, Data Replication, Shared access to weakly consistent to data stores, introduction to Python.

Laboratory Work: To implement Cloud, Apache and Hadoop framework and related services. To understand various concepts practically about virtualization, data storage. To implement few algorithms with the help of MapReduce and some high level language.

Recommended Books:

1. Raj Kumar Buyya, James Broberg, Andrezei M.Goscinski, Cloud Computing: Principles and paradigms (2011)

2. Michael Miller, Cloud Computing, Que Publishing (2008).

3. Cloud Computing: A practical Approach Anthony Velte, Toby Velte and RobertElsenpeter by Tata McGrawHill

4. *Judith Hurwitz, Robin Bllor, Marcia Kaufman, Fern Halper, Cloud Computing for dummies (2009).*

Course Learning Outcomes (CLOs)

CLO1	To assess existing hosting platforms and computing paradigms currently being used in industry and academia.
CLO2	To comprehend need of data centre, its virtualization techniques and types of clouds.
CLO3	To demonstrate the implementation of cloud by using Amazon Web Services, Azure, Aneka etc. and its virtualization.
CLO4	To implement cloud based data storage by considering issues of task partitioning, data partitioning, data synchronization, distributed file system, data replication etc.
CLO5	To demonstrate the use of Hadoop framework, virtualization, data storage and MapReduce.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS 212 INFORMATION RETRIEVAL				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objectives: To have an advanced level of understanding of common and emerging methods of organizing, summarizing, and analyzing large collections of unstructured and lightly-structured text.

Introduction: Text analysis, Types of text analysis, Information retrieval, IR system architecture: Text processing, Indexes and query matching, Text processing: Text format, Tokenization, stemming, lemmatization, Language modeling, Examples of open source IR Systems.

Informational Retrieval: Query processing models. Probabilistic models (Binary independence model, Robertson/Spark Jones weighting formula, Two-Poisson model), Relevance feedback (Term selection, Pseudo relevance feedback); Language models: Unigram, Bigram language models, Generating queries from documents, Language models and smoothing, Ranking with language models, Kullback Leibler divergence, Divergence from randomness, Passage retrieval and ranking.

Management of Information Retrieval Systems: Knowledge management, Information management, Digital asset management, Network management, Search engine optimization, Records compliance and risk management, Version control, Data and data quality, Information system failure.

Types of information retrieval systems: Web retrieval and mining, Semantic web, XML information retrieval, Recommender systems and expert locators, Knowledge management systems, Decision support systems, Geographic information system(GIS).
Indexing: Inverted indices, Index components and Index life cycle, Interleaving Dictionary and Postings lists, Index construction, Query processing for ranked retrieval, Compression: General-purpose data compression, Symbol-wise data compression, Compressing posting lists, Compressing the dictionary.

Information categorization and filtering: Classification, Probabilistic classifiers, linear classifiers, Similarity-based classifiers, Multi category ranking and classification, learning to rank, Introduction to the clustering problem, Partitioning methods, Clustering versus classification, Reduced dimensionality/spectral methods.

Sentiment Analysis: Introduction to sentiment analysis, Document-level sentiment analysis, Sentence-level sentiment analysis, Aspect-based sentiment analysis, Comparative sentiment analysis, baseline algorithm, Lexicons, Corpora, Tools of Sentiment analysis, Applications.

Laboratory Work: In Laboratory Assignments students can learn search engines and common open-source software to perform common methods of exploratory and predictive analysis and apply text analysis techniques discussed in class to solve problems of data analysis.

Recommended Books

1. *Butcher S., Clarke C.L.A., CormackG. Information Retrieval, MIT (1964).*
2. *Bates M.J., Understanding Information Retrieval Systems, CRC press (2010).*
3. *Manning C.D., Raghavan P. and Schütze H. Introduction to Information Retrieval, Cambridge University Press (2008).*
4. *Baeza-Yates R., Ribeiro-Neto B., Modern Information Retrieval, Addison-Wesley (1999).*

Course Learning Outcomes (CLOs)

CLO1	Familiarization with IR system architecture, probabilistic and language modeling approaches and characteristics of text.
CLO2	Recognize management and decision process addressing issues related to search engines, knowledge management, information management and its risk.
CLO3	Explore the techniques for document categorization and filtering, including basic machine learning algorithm for classification.
CLO4	Analyze the algorithms for building and accessing indices, which are appropriate for document collections.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS 213 DATA MINING AND KNOWLEDGE MANAGEMENT				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objectives: To have an advanced level of knowledge to extract latent, potentially useful information from stored data, display it to the final user in a comprehensible manner and incorporate it into an intelligent decision-making system.

Introduction to Big Data Analytics: Big Data Overview, State of the Practice in Analytics, the Data Scientist, Big Data Analytics in Industry Verticals, Data Analytics Lifecycle.

Review of the Basic Data Analytic Methods using R: Introduction to R – look at the data, Analyzing and Exploring the Data, Statistics for Model Building and Evaluation.

Data mining: Introduction, association rulesmining, Naive algorithm, Apriori algorithm, direct hashing and pruning (DHP), Dynamic Item set counting (DIC), Mining frequent pattern without candidate generation(FP, growth), performance evaluation of algorithms,Mining Customer values: From Association rule to direct mining: A case study.

Classification: Introduction, decision tree, tree induction algorithm – split algorithm based on information theory, split algorithm based on Gini index; naïve Bayes method; estimating predictive accuracy of classification method; classification software, software for association rule mining; case study; KDD Insurance Risk Assessment: A Case study.

Cluster analysis: Introduction, partitional methods, hierrarchical methods, density based methods, dealing with large databases, cluster software; Efficient Clustering of Very Large Document Collections: A case study.

Web data mining: Web Terminology and Characterstics, Locality and Hirarchy in the web, Web Content Mining, Web Usage Mining, Web Structure Mining, Web mining Software.

Search engines: Characterstics of Search engines, Search Engine Functionality, Search Engine Architecture, Ranking of web pages, The search engine history, Enterprise Search, Enterprise Search Engine Software.

Data warehousing: Introduction, Operational data stores, ETL, Datawarehouses – design guidelines for data warehouse implementation,Data warehouse metadata; OLAP – introduction, Characteristics, Multidimensional viewand data cube, Data cube operations, Data Warehouse Governance: Best Practices at Blue Cross and Blue Shield of North Carolina: A Case Study.

Laboratory Work: The laboratory will cover the most important data mining techniques-classification, clustering, and association rule mining and exploring advanced data mining tools.

Recommended Books:

1. Han J., Kamber M. and Pei J., Data mining concepts and techniques, Morgan Kaufmann Publishers (2011).

2. Pudi V., Krishana P.R., Data Mining, Oxford University press, (2009) .

3. Adriaans P., Zantinge D., Data mining, Pearson education press (1996).

4. *Pooniah P., Data Warehousing Fundamentals, Willey inderscience Publication, (2001).*

Course Learning Outcomes (CLOs)

CLO1	To comprehend the need of big data and to access current state of practices used for data analytics.
CLO2	To comprehend and demonstrate association mining techniques for market basket analysis.
CLO3	To perform classification of data by using decision tree, split algorithm based on information theory, Gini index and Naïve Bayes.
CLO4	To demonstrate clustering of data by using partitioned methods, hierarchical methods and density based methods.
CLO5	To comprehend the techniques and use of web data mining and search engine.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS214 ADVANCED COMPUTER ARCHITECTURE

L	T	P	C
3	0	2	4

Course Objectives: To learn the fundamental aspects of computer architecture design and analysis, with a focus on processor design, pipelining, superscalar, out-of-order execution, caches (memory hierarchies), virtual memory, storage systems, and simulation technique

Introduction To Parallel Processing: Instruction set architecture, RISC-CISC, single cycle processors, hardwired and micro-coded FSM processors, Parallelism in uniprocessor system, uniprocessor architecture, balancing of sub system bandwidth, multiprogramming and time sharing, parallel computer structures, pipeline computers, array computers, multiprocessor systems, dataflow computer concept, architectural classification scheme: multiplicity of instruction-data streams, parallelism versus pipelining, parallel processing applications, productive modeling simulation, engineering design and automation.

Principles of Pipelining and Vector Processing: Pipelining- an overlapped parallelism, multi-core processors, clock period, efficiency, throughput, classification of pipeline processors, general pipeline and reservation tables, detecting and resolving structural, data, control and name hazards; analyzing processor performance, pipeline efficiency, linear pipelining; Instruction level parallelism and instruction pipelines

Principles of Designing Pipeline Processors: Effect of branching, data buffering and bussing structures, internal forwarding and register tagging, job sequencing and collision prevention, reservation and latency analysis, collision free scheduling, state diagram, greedy cycle, pipeline schedule optimization, Arithmetic pipelines; Pipeline control methods; and pipeline chaining, Loop unrolling, software pipelining and trace scheduling techniques for exposing instruction level parallelism, Dynamic scheduling algorithms, exploiting ILP using static scheduling and dynamic scheduling, hardware based speculation, multiple issues, and speculation

Structure And Algorithm for Array Processors: SIMD array processor, SIMD computer organization, inter –PE communication, SIMD interconnection network, static versus dynamic networks, cube interconnection network, shuffle-exchange omega networks, parallel algorithms and SIMD matrix multiplication, Vector processing characteristics and requirements, pipelined vector processing, vectorization methods, examples of vector processing, Array processing,communication between PEs, SIMD interconnection networks, algorithms for array processing, Data and control parallelism, concurrency, scalability, speedup and Amdahl's law, PRAM model of parallel computation

Multiprocessor Architecture And Scheduling: Functional structure, loosely coupled and tightly coupled multiprocessor, deterministic scheduling strategy, deterministic scheduling model, control flow versus data flow computer, data flow graphs and languages, memory technology; memory addressing modes, direct-mapped, associative cache; write through and write-back caches; single-cycle, pipelined cache; analyzing memory performance, memory Hierarchy, Cache design issues, Virtual memory addressing, memory protection mechanisms, Multiprocessor memory architecture, Multi Core Architectures, Multiprocessors and multi-computers; Processor organizations: mesh, binary tree, hypercube; Shared memory and message passing systems; Mapping and Scheduling: Embedding of task graphs in processor graphs, dilation and loading, load balancing, models for static and dynamic scheduling, Using MPI and Open MP

Recommended Books

1. *Kai Hwang, Computer Architecture, TMH*
2. *Richard Y. Kain, Advanced computer architecture: a systems design, PHI*

3. J.L. Hennessy, and D.A. Patterson, Computer Architecture: A quantitative approach, Morgan Kaufman Publication (2012)
4. Quinn, "Parallel Programming in C with MPI and Open MP", TMH

Course Learning Outcomes (CLOs)

CLO 1	Understand different processor architectures, system-level design processes, components and operation of a memory hierarchy
CLO 2	Get an insight into how applications and performance issues influence a range of design choices of computer-based systems
CLO 3	Develop system's programming skills in the context of computer system design and organization
CLO 4	Able to understand the principles of I/O in computer systems, including viable mechanisms for I/O and secondary storage organization

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS391: SEMINAR				
	L	**T**	**P**	**Cr**
	0	**0**	**0**	**4**
Course Objectives: This course is designed to help the student obtain skills to discuss or present something within a group. Seminar Course is an outcome of six months of study, exploration, survey and analysis of a particular topic. It is designed to test the skills of the candidate in making a good presentation, Audience Engagement, Communication Skills. It also helps in buildinglifelong learning as a skill in the candidate.				

Course Learning Outcomes (CLOs)

CLO1	Identification of a domain specific scholarly topic
CLO2	Investigate and tabulate details and history about the selected topic
CLO3	Application of the selected topic in domain or real life
CLO4	Technical report writing
CLO5	Demonstrating the communication skills by good presentation and engaging the audience.

Evaluation Scheme:

- Presenting a topic to an audience in a given time with a professionally prepared content.
- Literature Survey/Content: This includes the depth knowledge of the related work done by others related to Seminar Topic
- Viva(answer to the queries)
- Report Writing
- Reflective Diary
- Poster Presentation
- Video Presentation
- Peer Review

Final Seminar Assessment : 70 Marks
Continuous Assessment : 30 Marks

PCS392: CAPSTONE PROJECT				
	L	**T**	**P**	**Cr**
	0	**0**	**10**	**12**
Course Objectives: This course is designed to encourage experiential and wholesome projects where students take what they've learned throughout the program and apply it to examine a specific idea. It aims to provide the students an exposure to gain proficiency in modelling, implementing and testing nontrivial software applications. It must include a design component, User interface and usefulness for the society or the profession.				

Course Learning Outcomes (CLOs)

CLO1	Investigate and identify real world problems
CLO2	Design, develop and implement a domain specific project
CLO3	Application of different skills learned in the program
CLO4	Technical report writing
CLO5	Demonstrating and communicating the working and impact of the project

Evaluation Scheme:

- Progress Evaluation :

Every month, there will regular progress evaluation of the project based on various parameters like problem definition, design etc.

- Final Evaluation :

1.Project report
2.Presentation (may include demonstration)
3.Demonstration of the project
4. Viva (answers to the queries)
5. Reflective diary
6. Poster presentation
7. Video presentation
8. Peer review

Final Evaluation : 60 Marks
Continuous Evaluation: 40 Marks (At least spread in two evaluations)

PCS091: THESIS				
	L	**T**	**P**	**Cr**
	0	**0**	**16**	**16**
Course Objectives: This course is designed to help the student obtain research skills which includes a thorough survey of a particular domain, finding a research problem and presenting a methodology to resolve the problem; with adequate experimental results to strengthen the contribution. The students are also given an exposure where they learn to write research papers and presenting the work in the conferences. Students are also supposed to learn about communicating the impact of their work by different tools which includes video, poster and presentation.				

Course Learning Outcomes (CLOs)

CLO1	Identification, formulation and analysis of domain specific scholarly research problems
CLO2	Design and implementation of identified research problem.
CLO3	Technical report writing and Publication of research work in referred journals, National and international conferences of Repute
CLO4	Ability to foresee how their current and future work will influence/impact the economy, society and the environment.
CLO5	Ability to communicate and present the work to the relevant audience

Evaluation Scheme:

- Subject matter of Presentation
- Literature Review
- Discussion of Results and Inferences drawn
- Presentation Structuring
- Response to Questions
- Usefulness/Contribution to the profession
- Overall Perception
- Reflective Diary
- Publication
- Poster
- Video Presentation

PCS292 ENGINEERING DESIGN PROJECT				
	L	**T**	**P**	**Cr**
	1	**0**	**4**	**5**
Course Description: The design project is a post-graduate level course generally consisting of a team-based semester long project and emphasizes on both technical and managerial skills. The computer science is very fundamental core discipline with having balanced execution of theoretical and practical concepts of all computer subjects and hence there is an emphasis on hands-on development, process, and usage of various fundamental tools in addition to theory and basic concepts. Students will be involved in examining; analysing and reporting different target oriented projects. In this project student can get more exposure to work in various advanced areas of algorithms, database, artificial intelligence, big data, parallel computing, machine learning, natural learning processing, predictive analysis, business intelligence etc.				

Course Learning Outcomes (CLOs):

CLO1	Learn the Application of advanced programming techniques, tools and methodologies
CLO2	Encourage group working and project planning.
CLO3	Learn the principles of software systems design including user interface design.
CLO4	Analyze the design and optimize it with respect to requirements.
CLO5	To be skilful the requirements of project documentation.
CLO6	Demonstrate, professional report writing skills, communication skills and team skills.

Evaluation Scheme:

- Progress Evaluation :

Every month, there will regular progress evaluation of the project based on various parameters like problem definition, design etc.

- Final Evaluation :

1.Project report
2.Presentation (may include demonstration)
3.Demonstration of the project
4. Viva (answers to the queries)
5. Reflective diary
6. Poster presentation
7. Video presentation
8. Peer review

Final Evaluation : 60 Marks
Continuous Evaluation: 40 Marks (At least spread in two evaluations)

PSE205 SOFTWARE METRICS AND QUALITY MANAGEMENT				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objectives: This course aims to equip students with the knowledge and techniques of professional practices in software processes and activities.It prepares students to manage the development of high quality software using proven techniques and established standards in software quality management. It will also inculcate knowledge of different metrics associated with Software Development and evaluation.

Software Metrics: Measurement in software engineering, software metrics, Metrics data collection and analysis.

Measuring internal product attributes: Aspects of software size, length, functionality and complexity, measuring structure, types of structural measures, control-flow structure, and modularity and information flow attributes, data structures.

Measuring external product attributes: Modeling software quality, software reliability, software reliability problem, parametric reliability growth models, predictive accuracy, recalibration of software-reliability growth predictions, importance of operational environment, and wider aspects of software reliability.

Metrics for object-oriented systems and component-based system: object-oriented metrics and its characteristics various object-oriented, MOOD metrics; component-based metrics and its characteristics and various component-based suites.

Dynamic Metrics: Runtime Software Metrics, Extent of Class Usage, Dynamic Coupling, Dynamic Cohesion, and Data Structure Metrics.

Software Quality: Concepts of software quality, software quality control and software quality assurance, evolution of SQA, major SQA activities and issues, zero defect software.
Software Quality Assurance: SQA techniques; Management review process, technical review process, walkthrough, software inspection process, configuration audits, and document verification.
Error Reporting, Trend Analysis and Corrective Action: Identification,Analysisand Correction of defect, implementation of correction, regression testing; Categorization of defect w.r.t development phases; Error quantity, error frequency, program unit complexity, compilation frequency; Corrective action and documenting the corrective action, periodic review of actions taken.

Case Studies: CASE tools, Quality management standards, Quality standards with emphasis on ISO approach, Capability Maturity Models-CMM and CMMI, TQM Models, Bootstrap methodology, The SPICE project, ISO/IEC 15504, Six Sigma Concept for Software Quality.

Lab Work: To Work on small projects, build metrics and analyze, check the quality of the projects and do a comparative study with other projects

Recommended Books

1. Practical Guide to Software Quality Management (Artech House Computing Library)(2003)
2. Quality Software Management, Volume 1: Systems Thinking, Dorset House Publishing(2011)
3. Metrics and Models in Software Quality Engineering , Pearson, (2003).
4. *Applied Software Measurement by Capers Jones, Tata McGraw Hill, (2008)*

Course Learning Outcomes (CLOs)

CLO1	Acquired basic knowledge of Software quality models
CLO2	Exemplify Quality measurement and metrics, Quality plan and implementation
CLO3	Articulate Quality control and reliability of quality process and Quality management system models
CLO4	Articulate Complexity metrics and Customer Satisfaction and International quality standards – ISO, CMM
CLO5	Control and Manage the project and processes, apply configuration management on the basis of collected metrics.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PIS105 SECURE CODING				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

Introduction: Security, CIA Triad, Viruses, Trojans, and Worms In a Nutshell, Security Concepts- exploit, threat, vulnerability, risk, attack. Malware Terminology: Rootkits, Trapdoors, Botnets, Key loggers, Honeypots.Active and Passive Security Attacks. IP Spoofing, Tear drop, DoS, DDoS, XSS, SQL injection, Smurf, Man in middle, Format String attack. Types of Security Vulnerabilities- buffer overflows, Invalidated input, race conditions, access-control problems, weaknesses in authentication, authorization, or cryptographic practices. Access Control Problems.

Proactive Security development process: Secure Software Development Cycle (S-SDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code – Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline.

Threat modelling process and its benefits: Identifying the Threats by Using Attack Trees and rating threats using DREAD, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization. Defence in Depth and Principle of Least Privilege.

Secure Coding Techniques: Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks, Insecure Coding Practices In Java Technology. ARP Spoofing and its countermeasures. Buffer Overrun- Stack overrun, Heap Overrun, Array Indexing Errors, Format String Bugs. Security Issues in C Language: String Handling, Avoiding Integer Overflows and Underflows and Type Conversion Issues- Memory Management Issues, Code Injection Attacks, Canary based countermeasures using Stack Guard and Propolice. Socket Security, Avoiding Server Hijacking, Securing RPC, ActiveX and DCOM

Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check Versus Time of Use and its protection mechanisms. Validating Input and Interprocess Communication, Securing Signal Handlers and File Operations. XSS scripting attack and its types – Persistent and Non persistent attack XSS Countermeasures and Bypassing the XSS Filters.

Testing Secure Applications: Security code overview, secure software installation. The Role of the Security Tester, Building the Security Test Plan. Testing HTTP-Based Applications, Testing File-Based Applications, Testing Clients with Rogue Servers

Laboratory work: consists of using network monitoring tools, implementing different types of attacks and some protection schemes.

Recommended Books

1. Michael Howard and David LeBlanc, Writing Secure Code, Microsoft Press, (2004)
2. Jason Deckard, Buffer Overflow Attacks: Detect, Exploit, Prevent by Syngress, (2005)
3. Frank Swiderski and Window Snyder, Threat Modelling, Microsoft Professional, (2004)

Course Learning Outcomes (CLOs)

CLO1	To implement security as a culture and show mistakes that make applications vulnerable to attacks.
CLO2	To analyze various attacks like DoS, buffer overflow, web specific, database specific, web-spoofing attacks.
CLO3	To demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications.
CLO4	To identify the nature of the threats to software and incorporate secure coding practices throughout the planning and development of the product.
CLO5	To properly handle application faults, implement secure authentication, authorization and data validation controls used to prevent common vulnerabilities.

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PIS204:NETWORK SECURITY AND ETHICAL HACKING				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objectives: This course is designed to impart a critical theoretical and detailed practical knowledge of a range of computer network security technologies as well as network security tools and services related to ethical hacking.

Introduction: Security, Functionality and ease of use Triangle, Essential Terminology, Elements of Security, Difference between Penetration Testing and Ethical Hacking, Deliverables ethics and legality, Computer Crimes and Implications.

Reconnaissance: Information Gathering Methodology, Locate the Network Range, Active and Passive reconnaissance

Scanning: Scanning, Elaboration phase, active scanning, scanning tools NMAP, hping2. Enumeration, DNS Zone transfer. Detecting live systems on the network, Discovering services running /listening on target systems, Understandingport scanning techniques, Identifying TCP and UDP services running on the network, Active and passive fingerprinting

Trojans and Backdoors: Effect on Business, Trojan, Overt and Covert Channels, Working of Trojans, Different Types of Trojans, Different ways a Trojan can get into a system, Indications of a Trojan Attack, Some famous Trojans and ports used by them

Sniffers: Definition of sniffing, Sniffer working, Passive Sniffing, Active Sniffing, Ethreal tool, Man-in-the-Middle Attacks, Spoofing and Sniffing Attacks, ARP Poisoning and countermeasures. Denial of Service:Goal of DoS (Denial of Service), Impact and Modes of Attack.

Social Engineering: Social Engineering, Art of Manipulation, Human Weakness, Common Types of Social Engineering, Human Based Impersonation, Example of Social Engineering, Computer Based Social Engineering, Reverse Social Engineering, Policies and Procedures, Security Policies-checklist

Session Hijacking: Understanding Session Hijacking, Spoofing vs Hijacking, Steps in Session Hijacking, Types of Session Hijacking, TCP Concepts 3 Way and shake, Sequence numbers

Ethical Hacking: System Hacking and Hacking Wireless Networks: Aspect of remote password guessing, Role of eavesdropping, Various methods of password cracking, Keystroke Loggers, Understanding Sniffers, Comprehending Active and Passive Sniffing, ARP Spoofing and Redirection, DNS and IP Sniffing, HTTPS Sniffing. Introduction to 802.11, Role of WEP, Cracking WEP Keys, Sniffing Traffic, Wireless DOS attacks, WLAN Scanners, WLAN Sniffers, Hacking Tools, Securing Wireless Networks.

Laboratory work: deals with launching different types of attacks and creating a network blueprint of an organization.

Recommended Books

1. *Eric Core, Hackers Beware, EC-Council Press, (2003)*
2. *William Stallings, Network Security Essentials, Prentice Hall, (2013)*
3. *William R. Cheswick and Steven M. Bellovin, Firewalls and Internet Security, Addison-Wesley Professional, (2003.)*
4. W. Stallings, Cryptography and Network Security, Prentice Hall (2010)

Course Learning Outcomes (CLOs)

CLO1	Demonstrate knowledge of various vulnerabilities in network applications.
CLO2	Practice awareness of various malicious content and guiding ways for protection against the same.
CLO3	Demonstrate knowledge of various forms of attacks.
CLO4	Recall judicious and ethical use of various tools.
CLO5	Expertise in the techniques of system hacking and hacking over a wireless network.

Evaluation Scheme:

S.No.	**Evaluation Elements**	**Weightage (%)**
1.	MST	20
2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCL105: Statistical Methods and Algorithms				
	L	**T**	**P**	**Cr**
	3	**0**	**2**	**4**

Course Objective: To learn, understand and implement different techniques related to probability distributions and statistical models.

Introduction: Nature and objectives of research, Study and formulation of research problem. Scope and formulation of hypothesis. Preparation and presentation of research proposal using statistical package.

Review of Probability: Appraisal of axiomatic approach of probability, Conditional probability, Bayes' rule, Conditional distributions, and conditional expectations. (CO1)
Markov chains: Basics of Markov chains, Finite state space, Markov chains, Transition and stationary Markov chains. Continuous time Markov process: continuous time branching processes, Kolmogorov, Forward and backward equations, Pure birth, Pure death, Birth and death process.

Analysis of variance: One Way Classification: ANOVA for fixed effect model, ANOVA for Random Effect Model, Two-way Classification (one observation per cell): ANOVA for fixed effect model, ANOVA for Random Effect Model.

Design of Experiments: Completely Randomised Design, Randomised Block Design, Latin Square Design, their statistical analysis and variance of estimates, Analysis of Covariance.

Multivariate Data Analysis: Introduction, multivariate normal distributions, Mean vector, Variance-covariance matrix, Correlation matrix and their estimation for multivariate data. Step wise regression, Selection of best set of variables, Classification and discrimination problems. Factor analysis and principal component analysis.Illustrative examples and Multivariate data analysis using statistical package

Time Series and forecasting: Components of time series, Analysis of time series, Measurement of trend, Measurement of seasonal variations, Measurement of cyclic variations, Auto-Regression Analysis, Auto-correlation, Random component in time series.

Recommended Books

1. *Medhi, J., Stochastic Processes, New Age International*
2. *Montgomery, Introduction to Statistical Quality Control, John Wiley and Sons*
3. *Populis, A., Random Variables and Stochastic Processes, Tata McGraw Hill (2002).*
4. Bhuyan K.C., Multivariate Analysis and Its Applications, New Central Book Agency (2002).

COURSE LEARNI NG OUTCOMES(CLOs)

CLO1	Basic understanding of probability distributions and statistical data analysis techniques.
CLO2	Know the properties and characteristics of Markov Chain Model
CLO3	Understand data classification techniques using fixed effect and random effect models
CLO4	Understand time series data analysis

Evaluation Scheme:

S.No.	Evaluation Elements	Weightage (%)
1.	MST	20

2.	EST	40
3.	Sessionals (May include Assignments/Projects/Tutorials/Quizzes/Lab Evaluations)	40

PCS107: TECHNOLOGY & INNOVATION

L	T	P	Cr
1	0	2*	1.5

Course Description: This course introduces the fundamentals of technology entrepreneurship. Students will learn the process technology entrepreneurs use to start companies while bringing revolutionary products and services to market. It involves taking a technology idea and finding a high-potential commercial opportunity, gathering resources such as talent and capital, figuring out how to sell and market the idea, and managing rapid growth. The key objectives of this course is to excite the students about challenging as well as highly rewarding world of entrepreneurship and develop their passion for creating a technical enterprise.

To gain practical experience, students will form teams and work on startup projects in those teams.

Course Learning Outcomes (CLO):
Upon successful completion of the course, the students should be able to:

CLO1: Articulate the different aspects and challenges associated with establishing a new technical venture
CLO2: Possess **understanding** of various steps involved in the process of taking a technology idea and finding a high-potential commercial opportunity while creating a technical enterprise.
CLO3: Demonstrate an ability to design a business model for a technology based venture.
CLO4: Exhibit competency in **constructing** a business plan to launch a technical enterprise.

Course Outline

Creativity: Fundamentals, Stimulating creativity and creative idea generation
Innovation: Fundamentals, challenges, application in organizational setting
Entrepreneurship: Technical Entrepreneurship, Concept of Intrapreneurship, Entrepreneurial mind-set in organizations/individuals
Entrepreneurial Personality: Role of Personality in Entrepreneurial Process, Traits and Qualities for becoming successful entrepreneur.
Entrepreneurial Process: Steps in Entrepreneurial Process, Role of Organization and Context in Entrepreneurial Process.
Product-Market Dynamics: Product development as a solution to customer/societal need, identifying a market for the product/solution, marketing challenges for technical ventures
Business Model: Fundamentals of Business Models and their application for a technology enterprise
Business Plan: Formulating a Business Plan for a technology enterprise
New Product Development: Cycle, challenges & how to overcome them
Intellectual Property Management: How to protect intellectual property?
E-Business: Development, formulation and execution of E-business Strategy
Business Models in the new world: Cyber services, Selling on the Web: Revenue Models and Building a Web Presence
Forms of Business Organizations: Introduction to business entity ownership structures
Financing a Start-up: Various Sources of Raising Finance for a start up organization that lacks tangible assets: seed capital, angel investor, venture capital, crowd funding.
Pitching: Elevator Pitch and Business Pitching
Leading and Managing: How to design and lead a technical venture

* 2 hour lab in alternate week

Recommended Books:

- Christensen, Clayton M. Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harvard University Press.
- Chesbrough, Henry. Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard University Press.
- Roy, Rajeev (2011). Entrepreneurship, Oxford Higher Education (2nd Edition).
- Wagner & Napier (2005). Creating a Winning E – Business, Cengage Learning
- Moore, Geoffrey Crossing the Chasm
- Grove, Andrew S Only the Paranoid Survive

Suggested Readings:

- Kachru, Upendra, India Land of a Billion Entrepreneurs, Pearson
- Agarwal, Varun (2012). "How I Braved Anu Aunty and Co-Founded A Million Dollar Company"
- Bagchi, Subroto, (2008). Go Kiss the World: Life Lessons For the Young Professional
- Bagchi, Subroto, (2012). MBA At 16: A Teenager's Guide to Business
- Bansal, Rashmi, Stay Hungry Stay Foolish, CIIE, IIM Ahemdabad
- Bansal, Rashmi, (2013). Follow Every Rainbow, Westland,
- Mitra, Sramana Entrepreneur Journeys (Volume 1)
- Abrams, R. (2006). Six-week Start-up, Prentice-Hall of India
- Verstraete, T. and Laffitte, E.J. (2011). A Business Model of Entrepreneurship, Edward Elgar

Evaluation

1. Continuous Evaluation (Quiz/Viva Voce/Assignments) 25 marks
2. Lab Assignments: 45 Marks
3. Technological Innovation Project: 20 Marks
    a. Business Model Canvas
    b. Pitching / Presentation
4. Report on Technology Innovation Project 10 Marks

* 2 hour lab in alternate week

COMPUTER SCIENCE AND ENGINEERING DEPARTMENT
ME- COMPUTER SCIENCE AND ENGINEERING (2015-16)

Semester I						
S. No.	**Course No.**	**Course Name**	**L**	**T**	**P**	**Cr**
1	PCL105	Statistical Methods and Algorithms	3	0	2	4
2	PCS104	Advanced Data Structures and Algorithms	3	0	4	5
3	PCS103	Advanced Artificial Intelligence	3	0	2	4
4	PCS105	Advanced Operating System	3	0	2	4
5	PCS106	Parallel and Distributed Computing	3	0	2	4
		Total	**15**	**0**	**12**	**21**
Semester II						
S. No.	**Course No.**	**Course Name**	**L**	**T**	**P**	**Cr**
1	PCS205	Big Data and Business Intelligence	3	0	2	4
2	PCS206	Machine Learning	3	0	2	4
3	PCS292	Engineering Design Project (4 Self Effort Hours)	1	0	4	5
4		Elective-I	3	0	2	4
5		Elective-II	3	0	2	4
6		Elective-III	3	0	2	4
		Total	**16**	**0**	**14**	**25**
Semester III						
S. No.	**Course No.**	**Course Name**	**L**	**T**	**P**	**Cr**
1	PCS391	Seminar	-	-	-	2
2	PCS392	Capstone Project (14 Self Effort Hours)			6	10
3		Dissertation (Starts)	-	-	-	-
		Total				**12**
Semester IV						
S. No.	**Course No.**	**Title**	**L**	**T**	**P**	**Cr**
1	PCS091	Dissertation	-	-	-	20
		Total	**-**	**-**	**-**	**20**
Total Number of Credits: 78						
List of Electives						
S. No.	**Course No.**	**Course Name**	**L**	**T**	**P**	**Cr**
Electives I						
1	PCS204	Advanced Information Management Systems	3	0	2	4
2	PCS207	Software Engineering and Project Management	3	0	2	4

3	PCS213	Data Mining and Knowledge Management	3	0	2	4
4	PSE205	Software Metrics and Quality Management	3	0	2	4
Electives II						
1	PCS209	Web Analytics and Intelligence	3	0	2	4
2	PCS210	Natural Language Processing	3	0	2	4
3	PCS211	Cloud Infrastructure and Services	3	0	2	4
4	PCS214	Advanced Computer Architecture	3	0	2	4
Electives III						
1	PCS212	Information Retrieval	3	0	2	4
2	PCS208	Recommender System	3	0	2	4
3	PIS105	Secure Coding	3	0	2	4
4	PIS204	Network security and Ethical hacking	3	0	2	4

COMPUTER SCIENCE AND ENGINEERING DEPARTMENT
ME- COMPUTER SCIENCE AND ENGINEERING (2014-15)

Semester I

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS103	Advanced Artificial Intelligence	3	1	2	4.0
2.	PCS104	Advanced Data Structures and Algorithms	3	0	2	4.0
3.	PCS105	Advanced Operating System	3	0	0	3.0
4.	PCS106	Parallel and Distributed Computing	3	0	2	4.0
5.	PCL105	Statistical Methods and Algorithms	3	0	2	4.0
6.		Elective- I	3	0	2	4.0
		Total	**18**	**0**	**10**	**23**

Semester II

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS204	Advanced Information Management Systems	3	0	2	4.0
2.	PCS205	Big Data and Business Intelligence	3	0	2	4.0
3.	PCS206	Machine Learning	3	0	2	4.0
4.	PCS207	Software Engineering and Project Management	3	0	0	3.0
5.		Elective- I	3	0	2	4.0
6.		Elective- II	3	0	2	4.0
		Total	**18**	**0**	**10**	**23**

Semester III

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS391	Seminar	-	-	-	2.0
2.	PCS392	Capstone Project	-	-	-	12.0
		Dissertation (Starts)	-	-	-	-
		Total	**-**	**-**	**-**	**8.0**

Semester IV

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS091	Dissertation (Continued)	-	-	-	12.0
		Total	**-**	**-**	**-**	**12.0**
		Grand Total of Four Semester Credits				**66.0**

List of Electives

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS208	Recommender System	3	0	2	4.0
2.	PCS209	Web Analytics and Intelligence	3	0	2	4.0
3.	PCS210	Natural Language Processing	3	0	2	4.0
4.	PCS211	Cloud Infrastructure and Services	3	0	2	4.0
5.	PCS 212	Information Retrieval	3	0	2	4.0

6.	PCS213	Data Mining and Knowledge Management	3	0	2	4.0
7.	PSE105	Software Design and Construction	3	0	2	4.0
8.	PSE202	Software Verification and Validation Testing	3	0	2	4.0
9.	PSE204	Advanced Topics in Software Engineering	3	0	2	4.0
10.	PIS105	Secure Coding	3	0	2	4.0
11.	PIS106	Advanced Computer Networks	3	0	2	4.0
12.	PIS205	Forensics and Cyber laws	3	0	2	4.0

PCS104 ADVANCED DATA STRUCTURES AND ALGORITHMS

L	T	P	Cr
3	0	4	5.0

Course Objective: To learn the advanced concepts of data structure and algorithms and its implementation .The course has the main ingredients required for a computer science graduate and has all the necessary topics for assessment of data structures and algorithms.

Introduction to Basic Data Structures: Importance and need of good data structures and algorithms, Arrays, Linked lists, Stacks, Queues, Priority queues, Heaps; Strategies for choosing the appropriate data structures.

Advanced Data Structures: AVL Trees, Red-Black Trees, Splay Trees,B-trees, Fibonacci heaps, Data Structures for Disjoint Sets, Augmented Data Structures.

Algorithms Complexity and Analysis: Probabilistic Analysis, Amortized Analysis, Competitive Analysis, Internal and External Sorting algorithms:Linear Search, Binary Search, Bubble Sort, Selection Sort, Insertion Sort, Shell Sort, Quick Sort, Heap Sort, Merge Sort, Counting Sort, Radix Sort.

Graphs & Algorithms: Representation, Type of Graphs, Paths and Circuits: Euler Graphs, Hamiltonian Paths & Circuits; Cut-sets, Connectivity and Separability, Planar Graphs, Isomorphism, Graph Coloring, Covering and Partitioning, , Depth- and breadth-first traversals, Minimum Spanning Tree: Prim's and Kruskal's algorithms, Shortest-path Algorithms: Dijkstra's and Floyd's algorithm, Topological sort, Max flow: Ford-Fulkerson algorithm, max flow – min cut.

String Matching Algorithms: Suffix arrays, Suffix trees, tries, Rabin-Karp, Knuth-Morris-Pratt, Boyer-Moore algorithm.

Approximation algorithms: Need of approximation algorithms: Introduction to P, NP, NP-Hard and NP-Complete; Deterministic, non-Deterministic Polynomial time algorithms;Knapsack, TSP, Set Cover, Open Problems.

Randomized algorithms: Introduction,Type of Randomized Algorithms, Quick Sort, Min- Cut, 2-SAT; Game Theoretic Techniques, Random Walks.

Online Algorithms: Introduction,Online Paging Problem, Adversary Models, k-server Problem.

Laboratory Work: To Implement in detail the data structures and algorithms given above in a high level programming language.

Recommended Books:

1. Thomas Coremen, "Introduction to Algorithms", Third edition, Prentice Hall of India (2009).
2. Kleinberg J., Tardos E., "Algorithm Design", 1st Edition, Pearson, 2012.
3. Motwani R., Raghavan P., "Randomized Algorithms", Cambridge University Press, 1995.
4. **Vazirani,** Vijay V., "Approximation Algorithms", Springer, 2001.

PCS204 ADVANCED INFORMATION MANAGEMENT SYSTEMS

L	T	P	Cr
3	0	2	4.0

Course Objective: To learn the advanced concepts of database information and management and its implementation for assessment of understanding the course by the students

Transaction Processing and Concurrency Control Techniques: Introduction to Transaction Processing, Properties and states of Transactions, Scheduling of transactions, Serializability of Schedules, Locking Techniques for Concurrency Control, Two phase locking techniques.

Database Recovery Techniques:Recovery Concepts, Recovery Techniques Based on Deferred Update, Techniques Based on Immediate Update.

Distributed DBMS: Introduction, functions and architecture of a DDBMS, distributed relational database design, Transparencies in a DDBMS, Distributed transaction management, distributed concurrency control, distributed deadlock management, distributed database recovery.

Object-Oriented DBMS and NoSQL: Advanced database applications, weakness of RDBMS, next-generation database systems, OODBMS perspectives, persistence, advantages and disadvantages of OODBMS, Object-oriented database design, Object oriented extensions in Oracle, Comparison of ORDBMS and OODBMS.

Need of NoSQL and Its Data Models: Key- value data model, Document data model, Column family data model, Graph data models, CAP Theorem

Data Warehousing Concepts, OLAP and Data mining: Evolution of data warehousing, data warehousing concepts, benefits and problems of data warehousing, comparison of OLTP systems and data warehousing, On-Line Analytical Processing, Introduction to data mining.

Laboratory Work: To Implement Different concepts of Advanced Information Management Systems through sample programs and small projects to understand the techniques in a practical manner.

Recommended Books:

1. Thomas Connolly, Carolyn Begg, "Database Systems", Pearson Education, 4th Edition, 2005
2. Pramod J Sadalage and Martin Fowler, "NoSQL Distilled", Pearson, 2012
3. Hoffer, Prescott, Mcfadden, "Modern Database Management", Pearson Education Asia, 2007
4. Ivan Bayross, "SQL and PL/SQL", BPB Publication , 4th Edition, 2010

PCS 206 MACHINE LEARNING				
	L	T	P	Cr
	3	0	2	4.0

Course Objectives: This course provides an advanced level of understanding to machine learning and statistical pattern recognition. It offers some of the most cost-effective approaches to automated knowledge acquisition in emerging data-rich disciplines and focuses on the theoretical understanding of these methods, as well as their computational implications.

Introduction: Well-Posed learning problems, Basic concepts, Designing a learning system, Issues in machine learning. Types of machine learning: Learning associations, Supervised learning (Classification and Regression Trees, Support vector machines), Unsupervised learning (Clustering), Instance-based learning (K-nearest Neighbor, Locally weighted regression, Radial Basis Function), Reinforcement learning (Learning Task, Q-learning, Value function approximation, Temporal difference learning).

Decision Tree Learning: Decision tree representation, appropriate problems for decision tree learning, Univariate Trees (Classification and Regression), Multivariate Trees, Basic Decision Tree Learning algorithms, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.

Bayesian Learning: Bayes theorem and concept learning, Bayes optimal classifier, Gibbs algorithms, Naive Bayes Classifier, Bayesian belief networks, The EM algorithm.

Artificial Neural Network: Neural network representation, Neural Networks as a paradigm for parallel processing, Linear discrimination,Pairwise separation, Gradient Descent, Logistic discrimination, Perceptron, Training a perceptron, Multilayer perceptron, Back propagation Algorithm. Recurrent Networks, Dynamically modifying network structure.

Genetic Algorithms: Basic concepts, Hypothesis space search, Genetic programming, Models of evolution and learning, Parallelizing Genetic Algorithms.

Inductive and Analytical Learning: Learning rule sets, Comparison between inductive and analytical learning, Analytical learning with perfect domain theories: Prolog-EBG. Inductive-Analytical approaches to learning, Using prior knowledge to initialize hypothesis (KBANN Algorithm), to alter search objective (TangentProp and EBNN Algorithm), to augment search operators (FOCL Algorithm).

Design and Analysis of Machine Learning Experiments: Guidelines for machine learning experiments, Factors, Response, and Strategy of experimentation, Cross-Validation and Resampling methods, measuring classifier performance, Hypothesis testing, Assessing a classification algorithm's performance, Comparing two classification algorithms, Comparing multiple algorithms: Analysis of variance, Comparison over multiple datasets.

Laboratory Work: It isconcerned with the design, analysis, implementation, and applications of programs that learn from experience. Learning algorithms can also be used to model aspects of human and animal learning.

Recommended Books

1. Mitchell T.M., Machine Learning, McGraw Hill (1997) 2nd ed.
2. Alpaydin E.,Introduction to Machine Learning, MIT Press (2010) 2nd ed.
3. Bishop C., Pattern Recognition and Machine Learning, Springer-Verlag (2006) 2nd ed.
4. Michie D., Spiegelhalter D. J., Taylor C. C., Machine Learning, Neural and Statistical Classification. Overseas Press (2009) 1st ed.

PCS207 SOFTWARE ENGINEERING AND PROJECT MANAGEMENT				
	L	**T**	**P**	**Cr**
	3	**0**	**0**	**3**

Course Objective: To learn the advanced concepts of Software Engineering and Project Management and its implementation for assessment of understanding the course by the students.

Principles and Motivations: History; definitions; why engineered approach to software development; Software development process models from the points of view of technical development and project management: waterfall, rapid prototyping, incremental development, spiral models, Agile Software Development, Emphasis on computer-assisted environments. Selection of appropriate development process.

Software Development Methods: Formal, semi-formal and informal methods; Requirements elicitation, requirements specification; Data, function, and event-based modelling; Some of the popular methodologies such as Yourdon's SAD, SSADM etc.; CASE tools-classification, features, strengths and weaknesses; ICASE; CASE standards.

Software Project Planning, Estimation and Management: Characteristics of a software project, Software scope and feasibility, resources, the SPM plan, Size/scope estimation, Decomposition techniques, WBS., Sizing, Function point, LOC, FP vs LOC, GANTT Charts, Activity networks, PERT/CPM networks, COCOMO I, COCOMO II models. Quality control, Quality assurance, Formal Technical Reviews, The SQA Plan, ISO and CMM standards., Reactive vs. proactive Risk strategies, Risk projection, Risk Refinement, Risk Monitoring, Monitoring and management, RMMM plan., Earned Value Analysis., Team structures: hierarchical, Egoless, chief programmer, mixed; Team software Process; Resource levelling, Building a team: Skill sets.

Configuration Management: Baselines, Configurable items, SCM repository, SCM process, version control change control, configuration audit

Software Quality Management: Quality control, quality assurance and quality standards with emphasis on ISO 9000; Functions of software QA organization does in a project; interactions with developers; Quality plans, quality assurance towards quality improvement; Role of independent verification& validation; Total quality management; SEI maturity model; Software metrics.

***Recommended Books**:*

1. Software Project Management, Bob Hughes and Mike Cotterell, Tata McGraw Hill, (2009)

2. 2. A practitioner's Guide to Software Engineering, Roger Pressman, Tata McGraw Hill (2014)

3. *3. Head First PMP: A Brain Friendly Guide To Passing The Project Management Professional Exam(2013)*

PSE 105 SOFTWARE DESIGN AND CONSTRUCTION				
	L	T	P	Cr
	3	0	2	4.0

Course Objective: To gain knowledge of software construction fundamentals, managing construction and practical considerations related to the domain of software design and construction.

Software Design: Design concepts, design model, software architecture, architectural design, data design, component level design, and user interface design.

Object Modeling and Design: OMT, visual modeling, UML, Rational Rose Tool, Classes, objects, relationships, key abstractions, common mechanisms, diagrams, class diagrams, advanced classes, advanced relationships, interfaces, types, roles, packages, instances, object diagrams, interactions, use cases, use case diagrams, interaction diagrams, activity diagrams, events and signals, state machines, processes, threads, state chart diagrams, components, deployment, collaborations, patterns and frameworks, component diagrams, systems and models, code generation and reverse engineering.

Software Construction: Object-oriented approach, object-oriented programming and languages, Scope of class members-public, private, protected. Class constructor, destructor, copy constructor, virtual destructor. Derived classes, scope of derivation-public, private, protected. Virtual functions, Function overloading. Friend functions and friend classes, Operator overloading, dynamic memory allocation to classes and class members, new and delete operators. Overloading new and delete operators. Explicit type conversion operators. Input output streams, Stream class hierarchies, standard I/O objects: cin, cout, cerr, overloading <<, >> operators, File Streams, opening, reading, writing to file. File pointers and their manipulators, Introduction to templates and container classes.

Laboratory Work : Design and Modeling with Rational Rose, implementation-using Object oriented programming.

Recommended Books

1. Object-Oriented Analysis and Design with Applications, Grady Booch 3rd Edition, 2007
2. The Unified Modeling Language User Guide, Grady Booch, James Rumbaugh, Ivar Jacobson, Addison-Wesley Professional, 2nd ed, 2005

PSE 202 SOFTWARE VERIFICATION AND VALIDATION TESTING

L	T	P	Cr
3	0	2	4.0

Course Objectives: This course makes students understand the concepts and theory related to software testing. Understand different testing techniques used in designing test plans, developing test suites, and evaluating test suite coverage. Understand how software developers can integrate a testing framework into code development in order to incrementally develop and test code.

Introduction: Terminology, evolving nature of area, Errors, Faults and Failures, Correctness and reliability, Testing and debugging, Static and dynamic testing, Exhaustive testing: Theoretical foundations: impracticality of testing all data, impracticality of testing all paths, no absolute proof of correctness.

Software Verification and Validation Approaches and their Applicability: Software technical reviews; Software testing: levels of testing - module, integration, system, regression; Testing techniques and their applicability-functional testing and analysis, structural testing and analysis, error-oriented testing and analysis, hybrid approaches, integration strategies, transaction flow analysis, stress analysis, failure analysis, concurrency analysis, performance analysis; Proof of correctness; simulation and prototyping; Requirement tracing.

Test Generation: Test generations from requirements, Test generation pats, Data flow analysis, Finite State Machines models for flow analysis, Regular expressions based testing, Test Selection, Minimizations and Prioritization, Regression Testing.

Program Mutation Testing: Introduction, Mutation and mutants, Mutation operators, Equivalent mutants, Fault detection using mutants, Types of mutants, Mutation operators for C and Java.

Laboratory Work: To Use various verification and validation testing tools and to apply these tools on few examples and case studies

Recommended Books

1. Software Verification and Validation: An Engineering and Scientific Approach, Marcus S. Fisher, Springer, 2007
2. Foundations of Software Testing, Aditya P. Mathur,Pearson Education, 2008
3. Software Testing: Principles and Practices,SrinivasanDesikan, Gopalaswamy Ramesh, Pearson Education India,2006

PSE 204 ADVANCED TOPICS IN SOFTWARE ENGINEERING				
	L	T	P	Cr
	3	0	2	4.0

Course Objectives: To apply advance topics in software engineering. To specify, abstract, verify and validate solutions to large-size problems, to plan, develop and manage large software using state-of-the-art methodologies and learn emerging trends in software engineering

Formal Methods: Basic concepts, mathematical preliminaries, Applying mathematical notations for formal specification, formal specification languages, using Z to represent an example software component, the ten commandments of formal methods, formal methods- the road ahead.

Cleanroom Software Engineering: approach, functional specification, design and testing.

Component-Based Software Engineering: CBSE process, domain engineering, component-based development, classifying and retrieving components, and economics of CBSE.

Client/Server Software Engineering: Structure of client/server systems, software engineering for Client/Server systems, analysis modeling issues, design for Client/Server systems, testing issues.

Web Engineering: Attributes of web-based applications, the WebE process, a framework for WebE, formulating, analyzing web-based systems, design and testing for web-based applications, Management issues.

Reengineering: Business process reengineering, software reengineering, reverse reengineering, restructuring, forward reengineering, Economics of reengineering.

Computer-Aided Software Engineering: Building blocks for CASE, taxonomy of CASE tools, integrated CASE environments, integration architecture, CASE repository, case Study of tools like TCS Robot.

Mobile Development Process: Model View Controller, Presentation Abstraction Control, UML based development, Use cases, Testing: Mobile infrastructure, Validating use cases, Effect of dimensions of mobility on testing, Case study: IT company, Requirements, Detailed design, Implementation.

Real Time Operating Systems: Real-time and non-real time applications. Classification of Real-Time Task scheduling algorithms, Event-driven scheduler- Simple priority-based, Rate Monotonic Analysis, Earliest Deadline First, The simplest of Task assignment and scheduling, priority scheduling, characteristics of tasks, task assignment and multi-tasking.

Software Engineering Issues in Embedded Systems: Characteristics of embedded systems I/O, Embedded systems/real time systems. Embedded software architecture, control loop, interrupts control system, co-operating multitasking, pre-emptive multitasking, Domain analysis, Software element analysis, requirement analysis, Specification, Software architecture, Software analysis design, implementation, testing, validation, verification and debugging of embedded systems.

Laboratory Work: To implement the advance concepts in the lab using related tools and to develop the project using related technologies

Recommended Books

1. Software Engineering a Practitioners Approach, Roger S. Pressman, McGraw-Hill , 8th Edition, 2014
2. Formal Specification and Documentation using Z - A Case Study Approach, J.Bowan , International Thomson Computer Press, 2003
3. Software Engineering for Embedded Systems: Methods, Practical Techniques, and Applications,RobertOshana, Mark Kraeling, Newnes Publisher, 2013

PIS106 ADVANCED COMPUTER NETWORKS

L	T	P	Cr
3	0	2	4.0

Course Objective: This course aims to provide advanced background on relevant computer networking topics to have a comprehensive and deep knowledge in computer networks.

Review of Computer Networks, Devices and the Internet: Internet, Network edge, Network core, Access Networks and Physical media, ISPs and Internet Backbones, Delay and Loss in Packet-Switched Networks, Networking and Internet - Foundation of Networking Protocols: 5-layer TCP/IP Model, 7-Layer OSI Model, Internet Protocols and Addressing. Multiplexers, Modems and Internet Access Devices, Switching and Routing Devices, Router Structure. The Link Layer and Local Area Networks-Link Layer, Introduction and Services, Error- Detection and Error-Correction techniques, Multiple Access Protocols, Link Layer Addressing, Ethernet, Interconnections: Hubs and Switches, PPP: The Point-to-Point Protocol, Link Virtualization

Data-link protocols: Ethernet, Token Ring and Wireless (802.11). Wireless Networks and Mobile IP: Infrastructure of Wireless Networks, Wireless LAN Technologies, IEEE 802.11 Wireless Standard, Cellular Networks, Mobile IP, Wireless Mesh Networks (WMNs), Multiple access schemes

Routing and Internetworking: Network–Layer Routing, Least-Cost-Path algorithms, Non-Least-Cost-Path algorithms, Intra-domain Routing Protocols, Inter-domain Routing Protocols, Congestion Control at Network Layer. Logical Addressing: IPv4 Addresses, IPv6 Addresses - Internet Protocol: Internetworking, IPv4, IPv6, Transition from IPv4 to IPv6 – Multicasting Techniques and Protocols: Basic Definitions and Techniques, Intra-domain Multicast Protocols, Inter-domain Multicast Protocols, Node-Level Multicast algorithms

Transport and Application Layer Protocols: Client-Server and Peer-To-Peer Application Communication, Protocols on the transport layer, reliable communication. Routing packets through a LAN and WAN. Transport Layer, Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Mobile Transport Protocols, TCP Congestion Control. Principles of Network Applications, The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, Domain Name System (DNS), P2P File Sharing, Socket Programming with TCP and UDP, Building a Simple Web Server

Laboratory Work: consists of creating simulated networks and passing packets through them

using different routing techniques. It has different Lab Practical related to advanced computer networks.

Recommended Books

1. Computer Networking: A Top-Down Approach, James F. Kuros and Keith W. Ross,Pearson, 6th Edition,2012
2. A Practical Guide to Advanced Networking , Jeffrey S. Beasley and PiyasatNilkaew,Pearson, 3rd Edition,2012
3. Computer Networks , Andrew S. Tanenbaum, David J. Wetherall,Prentice, 5th Edition,2010

PIS205 FORENSICS AND CYBER LAW				
	L	T	P	Cr
	3	0	2	4.0

Course Objectives: To maintain an appropriate level of awareness, knowledge and skill required to minimize the occurrence and severity of incidents related to forensics and cyber law.

Introduction to Forensics and Cyber Crime: Fundamentals of computer, Internet Technology, E-Governance & E - Business ,Crime, criminology, origin, source, recent trends.Emergence of information based society, economic, administration, social, dependence of use of information, accession, threats, civil society and global society, Overview of computer forensics and Investigative Techniques, Computer forensic tools, activities of forensic investigations and testing methodology.

Types and Categories of Cyber Crime Categories of Cyber Crime: Personal, Business, Financial, Office Security, Cyber Crime – Complete transparency, hacking/cracking, denial of service, IP piracy, phrasing, hetaerism etc. Cyber Attack – cyber attackers.

Role of Computers and Internet in Cyber crime, penetration testing and auditing : Computer as witness, evidence, act, defining evidence, computer forensics, computer storage, media of electric record for use of course of law.Customers and legal agreements, Router penetration testing, Firewalls penetration testing, Intrusion detection system penetration testing, Wireless networks penetration testing, Password cracking penetration testing, Social engineering penetration testing, Application penetration testing, Policies and controls testing. Penetration testing report and documentation writing , Policies and procedures Security Policies-checklist.

Cyber Security: The concept of cyber security , meaning, scope and the frame work, basic structure development and management, Rules, Regulations, Act, Legislation - Meaning, Scope, Difference between Rules.

Need for a Cyber Act: The Indian Context , Need for a Cyber Act , Information Technology Act , Scope and further Development , Information Technology Act (Amendment) , coverage of Cyber Security and Cyber Crime Indian cyber Laws vs. cyber laws of U.S.A , similarities , scope and coverage , Effectiveness.

Laboratory work: consists of gathering information, evidence with tools like WinHex, Metasploit and Social Engineering toolkit.

Recommended Books

1. Cyber Forensics: from Data to Digital Evidence , Albert J. Marcella Jr., Wiley,1st Edition,2012
2. Hack I.T. - Security Through Penetration Testing, T. J. Klevinsky, Scott Laliberte and Ajay Gupta, Addison-Wesley, 1st Edition,2002
3. Computer Forensics: Cybercriminals, Laws, And Evidence , Marie-Helen Maras, Jones & Bartlett Learn ,1st Edition ,2011
4. Computer Forensics: Investigating Network Intrusions and Cyber Crime, EC Council Press Series, Cengage Learning , 2010

COMPUTER SCIENCE AND ENGINEERING DEPARTMENT
ME- COMPUTER SCIENCE AND ENGINEERING (2013-14)

Semester I

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS101	Advanced Data Structures	3	1	2	4.5
2.	PSE102	Software Design and Construction	3	0	4	5.0
3.	PCL105	Statistical Methods and Algorithms	3	0	2	4.0
4.	PSE101	Software Engineering Concepts and Methodologies	3	1	0	3.5
5.	PCS102	Advanced Computer Architecture	3	1	0	3.5
		Total	**14**	**4**	**6**	**20.5**

Semester II

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS201	Parallel and Distributed Computing	3	1	0	3.5
2.	PCS202	Advanced Database Systems	3	0	2	4.0
3.	PCS203	Soft Computing	3	1	2	4.5
4.	PSE004	Software Project Management	3	0	2	4.0
5.		Elective-I	3	1	0	3.5
6.	PCS391	Seminar	-	-	-	2.0
		Total	**15**	**4**	**4**	**21.5**

Semester III

Sr.No.	Course No.	Title	L	T	P	Cr
1.		Elective – II	3	0	2	4.0
2.		Elective – III	3	1	0	3.5
3.		Minor Project	-	-	-	4.0
4.	PCS091	Dissertation (Starts)	-	-	-	-
		Total	**6**	**1**	**2**	**11.5**

Semester IV

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS091	Dissertation (Continued)	-	-	-	12.0
		Total	**-**	**-**	**-**	**12.0**

Total Number of Credits: 65.5

List of Electives – I

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS211	Machine Learning	2	1	2	3.5
2.	PCS212	Digital Communication and Computer Networks	2	1	2	3.5
3.	PSE203	Software Metrics	3	1	0	3.5
4.	PSE213	Real Time Software and Systems	3	1	0	3.5
5.	HU501	E-Business	3	1	0	3.5

List of Electives – II

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS321	Network System Design	3	0	2	4.0
2.	PSE321	Client-Server Based IT Solution	3	0	2	4.0
3.	PCS322	Web Services	3	0	2	4.0
4.	PCS323	Advanced Operating System	3	0	2	4.0
5.	PCS324	Software Engineering for Embedded Systems	3	0	2	4.0
6.	PSE322	Aspect Oriented Programming	3	0	2	4.0

List of Electives–III

Sr.No.	Course No.	Title	L	T	P	Cr
1.	PCS331	Grid Computing	3	1	0	3.5
2.	PCS332	Network Security	3	1	0	3.5
3.	PCS333	Meshups	2	1	2	3.5
4.	PCS334	Image and Video Processing	3	1	0	3.5
5.	PSE332	Component Based Development	3	1	0	3.5

PSE101 SOFTWARE ENGINEERING CONCEPTS AND METHODOLOGIES				
	L	T	P	Cr
	3	0	2	4.0

Course Objectives: To apply principles of software development and evolution. To specify, abstract, verify and validate solutions to large-size problems, to plan, develop and manage large software and learn emerging trends in software engineering.

Principles and Motivations: History; definitions; Engineered approach to software development; Software development process models from the points of view of technical development and project management: waterfall, rapid prototyping, incremental development, spiral models, Aspect Software Development, Agile Software Development, Emphasis on computer-assisted environments. Selection of appropriate development process.

Software Development Methods: Formal, semi-formal and informal methods; Requirements elicitation, requirements specification; Data, function, and event-based modeling; Popular methodologies such as Yourdons SAD, SSADM; Managing the Software Projects

Software Engineering Tools and Environments: upper and lower CASE tools, evolution of CASE tools-classification, features, strengths and weaknesses; ICASE; CASE standards. Role of the repository for supporting incremental development, software reuse

Software Quality Assurance:SQA Tasks, Goals and Metrics, Software ReviewTechniques: Informal reviews-Formal Technical Reviews, Software Reliability, Software risk management, Case Studies. Real Time Systems

Configuration Management: Need, Configuration management functions and activities; Configuration management techniques; Case studies.

Software Testing Fundamentals: Basic Terminology, Testing Techniques and strategies. Brief introduction to various standards related to Software Engineering.

Recommended Books

1. Pressman, Roger, Software Engineering - A Practitioners Approach, McGraw Hill ,2014 8thed.
2. WamanJawadekar, Software Engineering: Principles & Practices, 1st edition 2004
3. Sommerville, Ian, Software Engineering, Addison-Wesley Publishing Company, 2006 8thed.
4. Jalote, Pankaj, An integrated Approach to Software Engineering, Narosa, 2005.