DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Scheme of Instruction

and

Syllabi of

M.TECH. (PARALLEL AND DISTRIBUTED SYSTEMS)

AICTE Model Curriculum

2021-2022

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
OSMANIA UNIVERSITY
HYDERABAD – 500 007, TELANGANA

SCHEME OF INSTRUCTION
M.TECH. (PARALLEL AND DISTRIBUTED SYSTEMS)

S.No	Type of Course	Course Code	Course Name	Contact hours per Week			Scheme of Examination		Credits
				L	T	P	CIE	SEE	
SEMESTER-I									
1	Core-I	CS101	Mathematical Foundations of Computer Science	3	0	0	30	70	3
2	Core-II	CS102	Advanced Data Structures	3	0	0	30	70	3
3	Professional Elective-I	CS301	Machine Learning	3	0	0	30	70	3
		CS112	Distributed Computing						
		CS211	Grid Computing						
		CS114	Advanced Operating Systems						
		CS115	Mobile Computing						
		CS111	Digital Forensics						
4	Professional Elective-II	CS121	Natural Language Processing	3	0	0	30	70	3
		CS122	Information Retrieval Systems						
		CS312	Data Mining						
		CS323	Web Engineering						
		CS125	Object Oriented Software Engineering						
		CS221	Software Reuse Techniques						
		CS222	Software Quality and Testing						
		CS223	Reliability and Fault Tolerance						
5	MC	CS100	Research Methodology in Computer Science	3	0	0	30	70	3
6	Audit Course- I	AC031	English for Research Paper Writing	2	0	0	30	70	0
		AC032	Disaster Management						
		AC033	Sanskrit for Technical Knowledge						
		AC034	Value Education						
7	Core Lab-I	CSXXX	Core Lab-I	0	0	3	50	0	1.5
8	Elective Lab-I	CSXXX	Elective Lab-I	0	0	3	50	0	1.5
			TOTAL	**17**	**0**	**6**	**280**	**420**	**18**

SEMESTER – II									
S.No	Type of Course	Course Code	Course Name	Contact hours per Week			Scheme of Examination		Credits
				L	T	P	CIE	SEE	
1	Core-III	CS201	Parallel Computer Architecture	3	0	0	30	70	3
2	Core-IV	CS202	Parallel Programming	3	0	0	30	70	3
3	Professional Elective-III	CS131	Image Processing	3	0	0	30	70	3
		CS103	Advanced Algorithms						
		CS132	Cyber Security						
		CS133	Network Security						
		CS134	Cloud Computing						
		CS135	Hardware and Software Co-design						
		CS212	Performance Evaluation of Computing						
		CS213	Multimedia Technologies						
4	Professional Elective-IV	CS141	Advanced Databases	3	0	0	30	70	3
		CS332	Sentiment Analysis						
		CS104	Artificial Intelligence						
		CS144	Artificial Neural Networks						
		CS215	Real Time Systems						
		CS216	Soft Computing						
		CS343	Web Mining						
		CS148	Software Engineering for RTS						
5	Audit Course-II	AC035	Constitution of India	2	0	0	30	70	0
		AC036	Pedagogy Studies						
		AC037	Stress Management by Yoga						
		AC038	Personality Development through Life Enlighten Skills						
6		CS 070	Mini Project	0	0	6	50*	0	3
7	Core Lab-II	CSXXX	Core Lab-II	0	0	3	50	0	1.5
8	Elective Lab-II	CSXXX	Elective Lab-II	0	0	3	50	0	1.5
			TOTAL	**14**	**0**	**12**	**300**	**350**	**18**

SEMESTER-III									
1	Professional Elective-V	CS151	Simulation & Modelling	3	0	0	30	70	3
		CS152	Software Project Management						
		CS153	Secure Coding Principles						
		CS154	Storage Management						
		CS217	Parallel and Distributed Databases						
		CS155	Social Media Analytics						
		CS218	Scripting Languages For Design Automation						
2	Open Elective	OE941	Business Analytics	3	0	0	30	70	3
		OE942	Industrial Safety						
		OE943	Operations Research						
		OE944	Cost Management of Engineering Projects						
		OE945	Composite Materials						
		OE946	Waste to Energy						
		OE947	Cyber Security						
		OE948	Internet of Things (IoT)						
3	Dissertation	CS181	Major Project Phase-I	0	0	20	100**		10
TOTAL				**6**	**0**	**20**	**160**	**140**	**16**
SEMESTER-IV									
1	Dissertation	CS182	Major Project Phase-II	0	0	32	0	200	16
TOTAL				**0**	**0**	**32**	**0**	**200**	**16**
GRAND TOTAL									68

*** Major Project Phase I Evaluation: 50 marks to be awarded by Supervisor and 50 marks to be awarded by Viva-Voce committee comprising Head, Supervisor and an Examiner.*

L: Lecture T: Tutorial P: Practical
CIE: Continuous Internal Evaluation SEE: Semester End Examination

CS 101

MATHEMATICALFOUNDATIONS OF COMPUTER SCIENCE

Instruction: (3L) hrs per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

COURSE OBJECTIVES:

- To understand the mathematical fundamentals that are pre requisite for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.
- To develop the understanding of the mathematical and logical basis of various modern techniques in information technology like machine learning, programming language design, and concurrency.
- To study various sampling and classification problems.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

1. Understand the basic notions of discrete and continuous probability.
2. Apply the methods of statistical inference, and learn application of sampling distributions in Data mining and Machine Learning.
3. Apply statistical analysis to algorithmic problems of simple to moderate complexity in different domains.
4. Model different applications of Computer science as graph theory problems

UNIT-I

Probability mass, density, and cumulative distribution functions, parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains.

UNIT-II

Random samples, sampling distributions of estimators**,** Methods of Moments and Maximum Likelihood**.**

UNIT-III

Statistical inference**,** Introduction to multivariate statistical models: regression and classification problems, principal component analysis**,** The problem of over fitting model assessment.

UNIT-IV

Graph Theory: Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition.Specialized techniques to solve combinatorial enumeration problems.

UNIT-V

Number Theory: Elementary number theory, fundamental theorem of arithmetic, gcd, unique factorization, Euler's function, modular arithmetic, Fermat's little theorem, Chinese remainder theorem, modular exponentiation, RSA public key encryption.

Suggested Readings

1. John Vince, Foundation Mathematics for Computer Science, Springer, 2015.
2. K. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Wiley, 2001.
3. M. Mitzenmacher and E. Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, 2005.
4. Alan Tucker, Applied Combinatorics, Wiley, 2012.

CS 102

ADVANCED DATA STRUCTURES

Instruction**:** (3L) hrs per week
CIE**:** 30 marks
Credits: 3

Duration of SEE**:** 3 hours
SEE**:** 70 marks

Course Objectives:

- Understand the ADT/libraries, and use it to design algorithms for a specific problem.
- Understand the necessary mathematical abstraction to solve problems.
- To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.
- Analysis of efficiency and proofs of correctness.

Course Outcomes:

After completion of the Course Students will be able to:

1. Understand the implementation of symbol table using hashing techniques.
2. Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
3. Develop algorithms for text processing applications.
4. Identify suitable data structures and develop algorithms for computational geometry problems.

UNIT-I

Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.

Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

UNIT-II

Skip Lists: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists.

UNIT-III

Trees: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees, Splay Trees.

UNIT-IV

Text Processing: Sting Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

UNIT-V

Computational Geometry: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quad trees, k-D Trees.

Recent Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem.

Suggested Readings

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

CS301

MACHINE LEARNING

Instruction**:** (3L) hrs per week
CIE**:** 30 marks
Credits: 3

Duration of SEE**:** 3 hours
SEE**:** 70 marks

Course objectives:

- To understand the basic concepts of machine learning and range of problems that can be handled by machine learning.
- To learn the concepts of instance based learning and decision tree induction.
- To explore the concepts of linear separability, Perceptron and SVM.
- To apply the concepts of probabilistic inference, graphical models and evolutionary learning.
- To gain the knowledge on the concepts of ensemble learning, dimensionality reduction and clustering.

Course Outcomes:

After Completion of the course Students will be able to:

1. Explain the strengths and weaknesses of many popular machine learning approaches.
2. Recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.
3. Design and implement various machine learning algorithms in a range of real-world applications.

UNIT-I

Introduction: Learning, Types of Machine Learning.
Concept learning: Introduction, Version Spaces and the Candidate Elimination Algorithm. **Learning with Trees:** Constructing Decision Trees, CART, Classification Example.

UNIT-II

Linear Discriminants: The Perceptron, Linear Separability, Linear Regression
Multilayer Perceptron (MLP): Going Forwards, Backwards, MLP in practices, Deriving back **Propagation SUPPORT Vector Machines**: Optimal Separation, Kernels.

UNIT-III

Some Basic Statistics: Averages, Variance and Covariance, The Gaussian, The Bias-Variance Tradeoff Bayesian learning: Introduction, Bayes theorem. Bayes Optimal Classifier, Naive Bayes Classifier.
Graphical Models: Bayesian networks, Approximate Inference, Making Bayesian Networks, Hidden Markov Models, The Forward Algorithm.

UNIT-IV

Evolutionary Learning: Genetic Algorithms, Genetic Operators, Genetic Programming
Ensemble learning: Boosting, Bagging
Dimensionality Reduction: Linear Discriminant Analysis, Principal Component Analysis.

UNIT-V

Clustering: Introduction, Similarity and Distance Measures, Outliers, Hierarchical Methods, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes, Comparison.

Suggested Readings

1. Tom M. Mitchell, *Machine Learning*, Mc Graw Hill, 1997
2. Stephen Marsland, *Machine Learning - An Algorithmic Perspective*, CRC Press, 2009
3. Margaret H Dunham, *Data Mining*, Pearson Edition., 2003.
4. Galit Shmueli, Nitin R Patel, Peter C Bruce, *Data Mining for Business Intelligence*, Wiley India Edition, 2007.
5. Rajjan Shinghal, *Pattern Recognition*, Oxford University Press, 2006.

CS 112

DISTRIBUTED COMPUTING

Instruction: 3L hrs per week Duration of SEE: 3 hours
CIE: 30 Marks SEE: 70 Marks
Credits: 3

Course Objectives:

- To understand fundamental concepts of distributed computing and its design.
- To know different protocols involved in communication.
- To gain the knowledge on process model.
- To develop the understanding of distributed object based & distributed multimodal systems.

Course Outcomes:

After Completion of the course Students will be able to:

1. Describe the concept behind a distributed system, the challenges in its design and use the solutions suggested to design distributed system for a specific problem.
2. Explain the necessary structures and alternative approaches to design solutions.
3. Come up with analysis of efficiency and proofs of correctness for multiple aspects in design of distributed systems.

UNIT -I

Introduction: Definition of Distributed Systems, Goals: Connecting Users and Resources, Transparency, Openness, Scalability, Hardware Concepts: Multiprocessors, Homogeneous Multicomputer systems, Heterogeneous Multicomputer systems, Software Concepts: Distributed Operating Systems, Network Operating Systems, Middleware, The client-server model: Clients and Servers, Application Layering, Client-Server Architectures.

UNIT II

Communication: Layered Protocols, Lower-Level Protocols, Transport Protocols, Higher-Level Protocols, Remote Procedure Call: Basic RPC Operation, Parameter Passing, Extended RPC Models, Remote Object Invocation: Distributed Objects, Binding a Client to an Object; Static verses Dynamic Remote Method Invocations, Parameter Passing, Message Oriented Communication: Persistence and synchronicity in Communication, Message-Oriented Transient Communication, Message-Oriented' Persistent Communication, Stream Oriented Communication: Support for Continuous Media, Streams and Quality of Service, Stream Synchronization.

UNIT -III

Process: Threads: Introduction to Threads, Threads in Distributed Systems, Clients: user Interface-:, Client-Side Software for Distribution Transparency, Servers: General Design Issues, Object Servers, Software Agents: Software Agents in Distributed Systems, Agent Technology, Naming: Naming Entities: Names, Identifiers, and Address, Name Resolution, The Implementation of a Name System, Locating Mobile Entities: Naming verses Locating Entities, Simple Solutions, Home-Based Approaches, Hierarchical Approaches.

UNIT -IV

Distributed Object Based Systems: CORBA: Overview of CORBA, Communication, Processes, Naming, Synchronization, Caching and Replication, Fault Tolerance, Security, Distributed COM: Overview of DCOM, Communication, Processes, Naming, Synchronization, Replication, Fault Tolerance, Security, GLOBE: Overview of GLOBE, Communication, Process, Naming, Synchronization, Replication, Fault Tolerance, Security, Comparison of CORBA, IDCOM.

Globe: Philosophy, Communication, Processes, Naming, Synchronization, Caching and Replication Fault Tolerance, Security, MTN.

UNIT-V

Distributed Multimedia Systems: Introduction, Characteristics of Multimedia Data, Quality of Service Management: Quality of Service negotiation, Admission Control, Resource Management Resource Scheduling.

Suggested Readings

1. Andrew S. Tanenbaum and Marteen Van Steen, *Distributed System*s: *Principles and Paradigms*, Pearson Prentice Hall, 2nd Edition, 2010.
2. Colouris G., Dollimore Jean, Kindberg Tim, *Distributed Systems Concepts and Design*, 3rd Edition Pearson Education, 5th Edition, 2011.

CS 211

GRID COMPUTING

Instruction: 3L hrs per week
CIE: 30 Marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 Marks

Course Objectives:

- To introduce the fundamentals of grid computing.
- Discuss the basics of grid monitoring.
- To introduce the concepts of grid security and resource management.

Course Outcomes:

After completion of the Course Students will be able to:

1. Understand the fundamentals of grid computing.
2. Describe the basics of grid monitoring
3. Explain the concepts of grid security and resource management.
4. Understanding the concepts of grid portals
5. Understanding the advanced grid middleware

UNIT-I

Introduction to Grid Computing: Grid Computing Concept, History of Distributed Computing, Computational Grid Applications, Grid Computing Infrastructure Development, Grid Computing Software Interface.

Job Submission: Introduction, Globus Job Submission. Transferring Files.

UNIT-II

Schedulers: Scheduler Features, Scheduler Examples, Grid Computing Meta-Schedulers Distributed Resource Management Application (DRMAA).

Security Concepts: Introduction, Symmetric Key Cryptography, Asymmetric Key Cryptography (Public Key Cryptography), Public Key Infrastructure. Systems/Protocols Using Security Mechanisms.

Grid Security: Introduction, Grid Security Infrastructure (GSI), Delegation, Higher-Level Authorization Tools.

UNIT-III

System Infrastructure I: Web Services: Service-Oriented Architecture, Web Services and Web Service Implementation.

System Infrastructure II: Grid Computing Services: Grid Computing and Standardization Bodies, Interacting Grid Computing Components, Open Grid Services Architecture (OGSA), WSRF.

User-Friendly Interfaces: Introduction, Grid Computing Workflow Editors, Grid Portals.

UNIT-IV

Grid-Enabling Applications: Introduction, Parameter Sweep, Using an Existing Program on Multiple Grid Computers, Writing an Application Specifically for a Grid, Using Multiple Grid Computers to Solve a Single Problem.

UNIT-V

Case Studies: Globus-Overview of Globus Toolkit 4, Installation of Globus, GT4 Configuration, Main Components and programming Model using Globus.

gLite: Introduction, Internal Workings of gLite, Logging and Bookkeeping (LB), Security Mechanism Using gLite, Resource management using Gridway and Gridbus Scheduling using Condor, SGE, PBS, LSF Grid scheduling with QoS.

Suggested Readings

1. Barry Wilkinson, *Grid Computing Techniques and Applications*, CRC Press, 2010.
2. Frederic Magoules, Jie Pan, Kiatan Tan, Abhinit Kumar, *Introduction to Grid Computing*, CRC Press, 2009.
3. Vladimir Silva, *Grid Computing for Developers*, Dreamtech Press, 2006.
4. Ian Foster, and Carl Kesselman, *The Grid 2: Blueprint for a new computing Infrastructure*, Elsevier Series, 2004
5. Fran Berman, Geoffrey Fox, Anthony J.G Hey, Grid *Computing: Making the Global Infrastructure a Reality*, Wiley Publishers, 2003.
6. Joshey Joseph, Craig Fellenstein, *Grid Computing*, IBM Press, 2004.

CS114

ADVANCED OPERATING SYSTEMS

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To introduce the Theoretical Foundations of Distributed Systems.
- To introduce deadlock detection and mutual exclusion.
- To study Algorithms for Distributed memory implementation.
- To study fault tolerance and recovery concepts.
- To learn the concepts of Multi-processor and database operating systems.

Course Outcomes:

After Completion of the course Students will be able to:

1. Understand the concept behind a distributed system, the challenges in it's design and use the solutions suggested to design Operating System necessary in building a distributed system.
2. Understand the necessary structures, Different algorithmic solutions and alternative approaches to design solutions.
3. Familiarize with advanced paradigms, architectures & protocols necessary in solve the challenges in design of advanced operating systems.
4. Come up with analysis of efficiency and proofs of correctness for multiple aspects in design of Advanced Operating Systems.

UNIT-I

Architecture of Distributed Systems: Types, Distributed Operating System, Issues in Distributed Operating Systems, Theoretical Foundations: Global Clock, Lamport's Logical Clock, Vector Clocks, Global State, and Termination Detection.

UNIT-II

Distributed Mutual Exclusion: Classification, requirement, performance, non-token based algorithms, Lamport's algorithm, the Richart-Agarwala algorithm, token-based algorithm-Suzuki liasamil's broadcast algorithm, Singhals heuristic algorithm.

Deadlock Detection: Resource Vs Communication deadlock, A graph- theoretic model, prevention, avoidance, detection, control organization, centralized deadlock-detection algorithm, the completely centralized algorithm, the HO-Ramamoorthy algorithm. Distributed deadlock detection algorithm - path - pushing, edge-chasing, hierarchical deadlock detection algorithm, menace-muntz and Ho-Ramamoorthy algorithm. Agreement Protocols: The system model, the Byzantine agreement, and the consensus problem.

UNIT-III

Distributed File System: Mechanisms, Design Issues.

Case Studies: Sun NFS, Sprite File System, DOMAIN, Coda File System.

Distributed Shared Memory: Algorithms for Implementing DSM, Memory Coherence, Coherence Protocols, and Design Issues.

Case Studies: IVY, Mirage, Clouds.

Distributed Scheduling: Issues in Load Distribution, Components of Algorithm, Stability Load Distributing Algorithm, Performance.

UNIT IV

Failure Recovery: Backward, Forward Error Recovery in Concurrent Systems, Consistent Set of Check Points, Synchronous and Asynchronous Check Pointing and Recovery.

Fault Tolerance: Commit Protocols, Non-Blocking Commit Protocols, Voting Protocols. Protection and Security: Access Matrix, Private Key, Public key, and Kerberos System.

UNIT -V

Multiprocessor Operating Systems: Motivation, Basic Multiprocessor System Architecture, Interconnection Networks for Multiprocessor Systems, Caching, Hypercube Architecture. Threads, Process Synchronization, Processor Scheduling, and Memory Management.

Database Operating System: Concurrence Control, Distributed Databases, and Concurrency Control Algorithms.

Suggested Readings

1. Singhal M, Shivaratri N.G, *Advanced Concepts in Operating Systems*, McGraw-Hill Intl., 1994.
2. Pradeep K Sinha, Distributed *Operating Systems Concepts and Design*, PHI, First Edition, 2002.
3 Andrew S. Tanenbaum, *Distributed Operating Systems*, Pearson Education India, First Edition, 2011.

CS 115

MOBILE COMPUTING

Instruction : 3L hrs per week
Duration of SEE : 3 hours
CIE : 30 Marks
SEE : 70 Marks
Credits: 3

Course Objectives:

- To learn the basics of wireless voice and data communication technologies.
- To study the working principles of wireless LANs and standards, principles of adhoc networks and routing.
- To gain knowledge on integration of mobile networks into Internet.
- To build working knowledge on various telephone and satellite network & skills in working with wireless application protocols to develop mobile applications.

Course Outcomes:

After Completion of the course Students will be able to:

1. Understand about Adhoc Network Routing protocols.
2. Implement and learn about tracking, localization and routing in wireless networks.
3. Implement file transfer, access and authentication-based applications for mobile computing.
4. Explain the structure and components for Mobile IP and Mobility Management.
5. Design and implement mobile applications to realize location-aware computing.

UNIT-I

Introduction: Wireless Transmission, Frequencies for Radio Transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulations, Spread Spectrum, MAC, SOMA, FDMA, TDMA, CDMA, Cellular Wireless Networks.

UNIT-II

Telecommunication Systems: GSM, GPRS, Satellite Networks, Basics, Parameters and Configurations, Capacity Allocation, FAMA and DAMA, Broadcast Systems, DAB, DVB, CDMA and 3G.

UNIT-III

Wireless LAN: IEEE 802.11 Architecture, Services, MAC – Physical Layer, IEEE 802.11a – 802.11b standards, Bluetooth.

UNIT-IV

Routing Ad-hoc Network Routing Protocols: Ad-hoc Network Routing Protocols, Destination Sequenced Distance Vector Algorithm, Cluster Based Gateway Switch Routing, Global State Routing, Fish-eye state Routing, Dynamic Source Routing, Ad-hoc on-demand Routing, Location Aided Routing, Zonal Routing Algorithm.

Mobile IP - Dynamic Host Configuration Protocol.

Traditional TCP - Classical TCP Improvements – WAP, WAP 2.0.

UNIT-V

Publishing & Accessing Data in Air: Pull and Push Based Data Delivery models, Data Dissemination by Broadcast, Broadcast Disks, Directory Service in Air, Energy Efficient Indexing scheme for Push Based Data Delivery.

File System Support for Mobility: Distributed File Sharing for Mobility support, Coda and other Storage Manager for Mobility Support.

Mobile Transaction and Commerce: Models for Mobile Transaction, Kangaroo and Joey transactions, Team Transaction, Recovery Model for Mobile Transactions, Electronic Payment and Protocols for Mobile Commerce.

Suggested Readings

1. Jochen Schiller, *Mobile Communications*, Pearson Education, 2nd Edition, 2009.
2. Kurnkum Garg, *Mobile Computing*, Pearson Education, 2010
3. Asoke K Talukder, Roopa R Yavagal, *Mobile Computing*, TMH 2008.
4. Raj Kamal, *Mobile Computing*, Oxford, 2009.
5. "*A Survey of Mobile Transactions appeared in Distributed and Parallel databases*" 16,193-230, 2004, Kluwer Academics Publishers.
6. S. Acharya, M. Franklin and S. Zdonil, "*Balancing Push and Pull for Data Broadcast, Proceedings of the ACM SIGMOD*", Tuscon, AZ, May 1997.
7. S.Acharya, R. Alonso, M.Franklin and S.Zdonik, "*Broadcast Disks: Data Management for Assymetric Communication Environments, Proceedings of the ACM SIGMOD Conference*", San Jose, CA, May 1995.

CS 111

DIGITAL FORENSICS

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives:

- To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
- To understand how to examine digital evidences such as the data acquisition, identification analysis.

Course Outcomes:

After completion of course Student will be able to:

1. Know how to apply memory analysis tools and file system analysis techniques to detect anti forensics.
2. Understand privacy issues and able to use live/Online forensic tools.
3. Analyze windows registry, Linux server configurations and Apache server to identify incidents.
4. Analyze SQL databases and reconstruct activities by using SQL server toolkits.
5. Use Network Traffic analysis tools and collect evidences from network devices.

UNIT - I

File Systems: FAT/NTFS file Systems; Parsing FAT/NTFS file systems, Prefetchand Superfetch, Shortcuts and Jumplists

Adversary and Malware hunting: Malware detection, Malware analysis

Memory Forensics: Memory acquisition, Memory analysis, memory analysis tools, Advanced Recycle bin, Server Logs, Google forensics.

Anti-Forensics Detection: detection methodologies, Volume shadow copy, ESE databases, Advanced Registry, Thumbnail cache.

UNIT- II

Computer crime and legal issues: Privacy issues, Intellectual property .

Incident Response: Threat and Adversary Intelligence, Financial crime analysis

Live/Online Forenics: Live Digital Forensics Investigation.

Tools: BitTorrent, Sleuthkit toolset, Windows Forensics. Tool chest Moot court: Moot court case.

UNIT-III

Networking overview: Windows Networks, Users and Groups, Introduction to Network investigations

Windows and Linux servers: Server roles, Server analysis, Windows Registry, Event logs

Linux Forensics: Linux File systems, Linux server configurations, Linux artifacts, Apache server forensics, LAMP forensics, SMB and Linux file shares.

UNIT- IV

IIS and Microsoft Exchange server: IIS server, Mailserver, Windows root kits, Compromised server analysis

SQL server and Data bases: Microsoft SQL server, SQL server permission and encryption,

SQL server Forensics Acquisition and analysis: SQL server forensics and traditional windows forensics, SQL server artifacts, Resident and non-resident artifact's Collecting SQL

data bases, Creating an analysis database, Importing evidence, Activity Reconstruction, Data recovery, SQL server rootkits

UNIT- V

Network Traffic Analysis: Network addressing, DNS poisoning, ARP table analysis, DHCP analysis, Wire shark analysis.

Network Device Forensics: management of switches and routers, Diagramming physical networks, Securing and isolating physical devices, Collecting Volatile/Non-volatile evidences from the routers, Volatile/Non-volatile.

Suggested Readings:

1. H. Carvey, "Windows Forensics Analysis DVD Toolkit", Syngress publishers 2009.
2. S. Anson, S. Bunting, R. Johnson, S. Perason, "Mastering Windows Network Forensics and Investigations", Sybex publishers K. Fowler, SQL Server Forensic Analysis, Addison Wesley 2012.
3. K. Mandia, M. Pepe , J. Luttgens, "*Incident Response & Computer Forensics*", Third Edition 2014.
4. M.H. Ligh, A. Case, J. Levy, A. waters, "*The art of memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory*", Wiley 2014.
5. S. Davidoff, J. Ham, "*Network Forensics: Tracking Hackers through Cyberspace*", Prentice Hall 2012.

CS121

NATURAL LANGUAGE PROCESSING

Instruction**:** (3L) hrs per week Duration of SEE: 3 hours
CIE**:** 30 marks SEE: 70 marks
Credits: 3

Course Objectives:

- To gain knowledge on NLP.
- To deals with morphological processing, syntactic parsing, information extraction.
- To understand probabilistic NLP and classification of text using Python's NLTK Library.

Course Outcomes:

After Completion of the course Students will be able to:

1. Write Python programs to manipulate and analyze language data.
2. Demonstrate key concepts from NLP and linguistics to describe and analyze language.
3. Understand the data structures and algorithms that are used in NLP.
4. Classify texts using machine learning and deep learning.

UNIT-I

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

UNIT-II

Processing Raw Text: Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation, Formatting: From Lists to Strings.

UNIT-III

Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word.

UNIT-IV

Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers
Deep Learning for NLP: Introduction to Deep Learning, Convolutional Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning.

UNIT-V

Extracting Information from Text

Information Extraction, Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction.

Analyzing Sentence Structure

Some Grammatical Dilemmas, What's the Use of Syntax. Context-Free Grammar, Parsing with Context-Free Grammar.

Suggested Readings

1. Natural Language Processing with Python. Steven Bird, Ewan Klein, and Edward Lope, O'Reily, 2009
2. Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Akshay Kulkarni, Adarsha Shivananda, Apress, 2019
3. Allen James, Natural Language Understanding, Benjamin/Cumming, 1995.
4. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

CS 122

INFORMATION RETRIEVAL SYSTEM

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To understand indexing and querying in information retrieval systems.
- To learn the different models for information retrieval.
- To expose the students to text classification and clustering.
- To learn about web searching.

Course Outcomes:

After Completion of the course Students will be able to:

1. Understand the algorithms and techniques for information retrieval (document indexing and retrieval, query processing).
2. Quantitatively evaluate information retrieval systems.
3. Classify and cluster documents.
4. Understand the practical aspects of information retrieval such as those in web search engines.

UNIT- I

Boolean Retrieval: example information, Building an inverted index, processing Boolean queries, the extended Boolean model versus ranked retrieval.

The term vocabulary and postings lists: Document delineation and character sequence decoding, determining the vocabulary of terms, faster postings list intersection via skip pointers, Positional postings, and Phrase queries.

Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, spelling correction.

Index Construction: Hardware basics, Blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, dynamic indexing, other types of indexes.

UNIT-II

Index Compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression.

Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, The vector space model for scoring, and Variant tf-idf functions.

Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.

Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

UNIT-III

Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

XML retrieval: Basic XML concepts, Challenges in XML retrieval, a vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval.
Probabilistic information retrieval: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model.
Language models for information retrieval: Language models, the query likelihood model.

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

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

Suggested Readings
1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, An Introduction to Information Retrieval, Cambridge University Press, Cambridge, England, 2008.
2. David A. Grossman, Ophir Frieder, Information Retrieval – Algorithms and Heuristics, Springer, 2nd Edition (Distributed by Universities Press), 2004.
3. Gerald J Kowalski, Mark T Maybury. Information Storage and Retrieval Systems, Springer, 2000.
4. Soumen Chakrabarti, Mining the web: Discovering knowledge from Hypertext Data, Morgan-Kaufmann Publishers, 2020.

CS 312

DATA MINING

Instruction : 3L hrs per week
Duration of SEE : 3 hours
CIE : 30 Marks
SEE : 70 Marks
Credits: 3

Course Objectives:

- To introduce the basic concepts of data mining and its applications.
- To understand different data mining concepts like classification, clustering and Frequent Pattern mining.
- To introduce current trends in data mining.

Course Outcomes:

After Completion of the course Students will be able to:

1. Explain different data mining tasks and the algorithms.
2. Evaluate models/algorithms with respect to their accuracy.
3. Conceptualize a data mining solution to a practical problem
4. Develop hypotheses based on the analysis of the results obtained and test them.

UNIT-I

Introduction: Why Data Mining? What is Data Mining? What kinds of data can be mined? What kinds of patterns can be mined? Which technologies are used? Which kinds of applications are targeted? Major issues in Data Mining. Getting to know your data: Data objects and attributed types. Basic statistical descriptions of data. Data visualization, Measuring data similarity and dissimilarity.

UNIT-II

Mining frequent patterns, Associations and correlations, Basic concepts and methods, Basic concepts, Frequent Item set Mining Methods, Which patterns are interesting? Pattern evaluation methods.

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Suggested Readings

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

CS 323

WEB ENGINEERING

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To provide students with conceptual and practical knowledge, and skills required to develop web applications and web services.
- To gain knowledge on web metrics and quality.
- To focus on web resource management.
- To know web evolution and its maintenance and web intelligence.

Course Outcomes:

After Completion of the course Students will be able to:

1. Define different classes of web applications.
2. Describe Web lifecycle process model and Modified Prototyping Method (MPM) for Web application development.
3. Understand the technology and management requirements trade-offs in the Web application development.
4. Use Relationship Analysis (RA) to find relationships in application domain.
5. Describe modular approach for building evolvable location-based services.
6. Understand different dimensions of architectural metrics for Internet businesses.

UNIT-I

Web Engineering: Concepts and Reference Model, Introduction and Perspectives, Web Engineering Resources Portal (WEP): A Reference Model and Guide.

UNIT-II

Web Application Development: Methodologies and Techniques, Web Application Development Methodologies, Relationship Analysis: A Technique to Enhance Systems Analysis for Web Development, Engineering Location-Based Services in the Web.

UNIT-III

Web Metrics and Quality: Models and Methods, **Architectural Metrics for E-Commerce:** A Balance between Rigor and Relevance, The Equal Approach to the Assessment of E-Commerce Quality: A Longitudinal Study of Internet Bookstores, Web Cost Estimation: An Introduction.

UNIT-IV

Web Resource Management: Models and Techniques, Ontology Supported Web Content Management, Design Principles and Applications of XRML.

UNIT-V

Web Maintenance and Evolution: Techniques and Methodologies, Program Transformations for Web Application Restructuring, the Requirements of Methodologies for Developing Web Applications. A Customer Analysis-Based Methodology for Improving Web Business Systems.

Web Intelligence: Techniques and Applications, Analysis and Customization of Web-Based Electronic Catalogs, Data Mining using Qualitative Information on the Web.

Suggested Readings

1. Woojong Suh, *Web Engineering Principles and Techniques*, Idea Group Publications 2005.

CS 125

OBJECT ORIENTED SOFTWARE ENGINEERING

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To know basic concepts for developing a system.
- Analyse different models and diagrams.
- To understand specific operations which are involved in design a model.

Course Outcomes:

After Completion of the course Students will be able to:

1. Describe the concepts involved in object-oriented modeling and their benefits.
2. Demonstrate the concepts of use-case model, sequence model, state chart model for a given problem.
3. Translate the requirements into object-oriented design for implementation.
4. Choose an appropriate design pattern to facilitate system development.

UNIT-I

Information Systems: Problems in Information systems Development, Project life cycles, Managing Information System Development, User Involvement and Methodological Approaches, Basic Concepts and Origins of Object Orientation Modelling Concepts.

UNIT-II

Requirement Capture, User Requirements, Requirements Capture and Modelling, Requirement Analysis, Use Case Realization, the Class Diagram, Assembling the Analysis Class Diagram, Refining the Requirement Models, Component-based Development, Software Development Patterns, Object Interaction, Object Interaction and Collaboration, Interaction Sequence Diagrams, Collaboration Diagrams, Model Consistency.

UNIT-III

Specifying Operations, The Role of Operation Specifications, Contracts, Describing Operation Logic, Object Constraint Language, Creating an Operation Specification, Specifying Control, States and Events, Basic Notation, Further Notation, Preparing a Statechart, Consistency Checking, Quality Guidelines, Moving Into Design, Logical and Physical Design, System Design and Detailed Design, Qualities and Objectives of Analysis and Design, Measurable Objectives in Design, Planning for Design, System Design, The Major Elements of System Design, Software Architecture, Concurrency, Processor Allocation, Data Management Issues, Development Standards, Prioritizing Design Trade-offs, Design for Implementation.

UNIT-IV

Object design, Class Specification, Interfaces, Criteria for Good Design, Designing Associations, Integrity Constraints, Designing Operations, Normalization, Design Patterns, Software Development Patterns, Documenting Patterns-Pattern Templates, Design Patterns, How to use Design Patterns, Benefits and Dangers of Using Patterns, Human Computer

Interaction, The User Interface, Approaches to User Interface Design, Standards and Legal Requirements, Designing Boundary Classes, The Architecture of the Presentation Layer, Prototyping the User Interface, Designing Classes, Designing Interaction with Sequence Diagrams, The Class Diagram Revisited, User Interface Design Patterns, Modelling the Interface Using Statecharts.

UNIT-V

Data Management Design, Persistence, File Systems, Database Management Systems, Designing for Relational Database Management Systems, Designing for Object Database Management Systems, Distributed Databases, Designing Data Management Classes, Implementation, Software Implementation, Component Diagrams, Deployment Diagrams, Software Testing, Data Conversion, User Documentation and Training, Implementation Strategies, Review and Maintenance, Reusable Components, Planning a Strategy for Reuse, Commercially Available Component ware, Managing Object Oriented Projects, Resource Allocation and Planning, Managing Iteration, Dynamic Systems Development Method, Extreme Programming, Software Metrics, Process Patterns, Legacy Systems, System Development Methodologies, 'Method' and 'Methodology', A Brief Historical Review, The Unified Software Development Process, Participative Design Approaches, Issues in Choosing a Methodology, Hard versus Soft Methodologies.

Suggested Readings

1. Simon Benett, Steve McRobb and Ray Farmer, *Object Oriented System Analysis and Design using UML*, McGraw-Hill Education, 2010.
2. Grady Booch, James Rumbaugh, Ivar Jacobson, *The Unified Modeling language-User guide*, Pearson Education India, 2nd Edition, 2005.
3. Subhash Mehta, Suresh K. Basandra, *Object Oriented Software Engineering*, Galgotia, 2004.

CS 221

SOFTWARE REUSE TECHNIQUES

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To introduce Software engineering and its reusability techniques to work with different design patterns.

Course Outcomes:

After Completion of the course Students will be able to:

1. Understand different design patterns and analyse them to enhance software reusability.
2. Evaluate Structural patterns and behavioural patterns.
3. Use Different Architectural patterns.

UNIT-I

Software Reuse Success Factors, Reuse Driven Software Engineering Business, Object Oriented Software Engineering, Applications and Component Subsystem, Use case Components, Object Components.

UNIT-II

Design Patterns: Introduction, **Creational Patterns:** Factory, Factory Method, Abstract Factory, Singleton, Builder Prototype.

UNIT-III

Structural Patterns: Adapter, Bridge, Composite, Decorator, Fiacade, Flyweight, Proxy.
Behavioral Patterns: Chain of Responsibility, Command, Interpreter.

UNIT-IV

Behavioral Patterns: Iterator, Mediator, Momento, Observer, Stazte, Strategy, Template, Visitor, other Design Pattern: Whole Part, Master-Slave, View Handler-reciever, Client-Dispatcher-Server, Publisher-Subscriber.

UNIT-V

Architectural Patterns: Layers, Pipes and Filters, Black Board, Broker, Model View Controller.
Presentation: Abstraction-Control, Micro Kernet, Reflection.

Suggested Readings

1. Ivar Jacobson, Martin Griss, Patrick Kohnson, *Software Resue. Architecture, Process and Organisation for Business for Business Success*, ACM Press, 1997.
2. Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, *Design Patterns*, Pearson Education, 1995.
3. Frank Buschmann, Kevlin Henney, Douglas C. Schmidt, *Pattern Oriented Software Architecture* , Wiley 1996.
4. James W Cooper, *Java Design Patterns, A Tutorial*, Addison Wesley Publishers 2000.

CS 222

SOFTWARE QUALITY AND TESTING

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To understand the challenges of Software Quality and the need for integration of quality activities in project life cycle
- To introduce supporting software quality devices
- To introduce software quality metrics and Quality Assurance models
- To understand the steps in software testing process and taxonomy of testing tools.

Course Outcomes:

After Completion of the course Students will be able to:

1. Describe the role of quality assurance activities in the software process
2. Compare several process improvement models such as CMM, CMMI, PCMM, and ISO9000
3. Describe several process metrics for assessing and controlling a project
4. Describe how available static and dynamic test tools can be integrated into the software development environment.

UNIT-I

The Software Quality Challenge, Introduction Software Quality Factors, The Components of the Software Quality Assurance System – Overview, Development and Quality Plans.

UNIT-II

Integrating Quality Activities in the Project Life Cycle, Assuring the Quality of Software Maintenance Components, CASE Tools and their effect on Software Quality, Procedure and Work Instructions, Supporting Quality Devices, Configuration Management, Documentation Control, Project Progress Control.

UNIT-III

Software Quality Metrics, Costs of Software Quality, Quality Management Standards - ISO 9000 and Companion ISO Standards, CMM, CMMI, PCMM, Malcom Balridge, 3 Sigma, 6 Sigma, SQA Project Process Standards – IEEE Software Engineering Standards.

UNIT-IV

Building a Software Testing Strategy, Establishing a Software Testing Methodology, Determining Your Software Testing Techniques, Eleven – Step Software Testing Process Overview, Assess Project Management Development Estimate and Status, Develop Test Plan, Requirements Phase Testing, Design Phase Testing, Program Phase Testing, Execute Test and Record Results, Acceptance Test, Report Test Results, Test Software Changes, Evaluate Test Effectiveness.

UNIT-V

Testing Client / Server Systems, Testing the Adequacy of System Documentation, Testing Web-based Systems, Testing Off – the – Shelf Software, Testing in a Multiplatform Environment, Testing Security, Testing a Data Warehouse, Creating Test Documentation, Software Testing Tools, Taxonomy of Testing Tools, Methodology to Evaluate Automated Testing Tools, Load Runner, Win Runner and Rational Testing Tools, Java Testing Tools, JMetra, JUNIT and Cactus.

Suggested Readings

1. Daniel Galin, *Software Quality Assurance – From Theory to Implementation*, Pearson Education.2004
2. Mordechai Ben – Menachem / Garry S.Marliss, *Software Quality – Producing Practical, Consistent Software*, BS Publications, 2014
3. William E. Perry, *Effective Methods for Software Testing*, 3 rd Edition, 2006, Wiley.
4. Srinivasan Desikan, Gopalaswamy Ramesh, *Software Testing, Principles and Practices*, 2006. Pearson Education.
5. Dr.K.V.K.K. Prasad, *Software Testing Tool*, Wiley Publishers, 2012.

CS 223

RELIABILITY AND FAULT TOLERANCE

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- Understand the risk of computer failures and their peculiarities compared with other system failures.
- Identify the software reliability in terms of fulfilling the user requirements.
- To introduce the basic concepts of fault tolerance computers.

Course Outcomes:

After Completion of the course Students will be able to:

1. Deal with repairable and non-repairable systems by following reliability.
2. Design the systems with fault avoidance.
3. Analyze the fault types and give the ranking.

UNIT-I

Introduction to Reliability Engineering: Reliability, Repairable and Non-repairable Systems, Maintainability and Availability, Designing, Reliability, Repairable and Non-repairable Systems, MTBF MTBF, MTTF MDT, k out of in systems.

UNIT-II

Software Reliability: Software Reliability, Software Reliability Vs Hardware Reliability, Failures and Faults, Classification of Failures, Counting, System configuration, Components and Operational Models, Concurrent Systems, Sequential Systems, Standby Redundant Systems.

Software Reliability Approaches: Fault Avoidance, Passive Fault Detection, Active Fault Detection, Fault Tolerance, Fault Recovery, Fault Treatment.

UNIT-III

Software Reliability Modeling: Introduction to Software Reliability Modeling, Parameter Determination and Estimation, Model Selection, Markovian Models, Finite and Infinite failure category Models, Comparison of Models, Calendar Time Modeling.

UNIT-IV

Fault Tolerant Computers: General Purpose Commercial Systems, Fault Tolerant Multiprocessor and VLSI based Communication Architecture.

Design – N – Version programming Recovery Block, Acceptance Tests, Fault Trees, Validation of Fault Tolerant Systems.

UNIT-V

Fault Types: Fault Detection and Containment, Redundancy, Data Diversity, Reversal, Reversal Checks, Obtaining Parameter Values, Reliability Models for Hardware Redundancy, Software Error Models, Checks, Fault /Tolerant Synchronization, Synchronization in Software.

Suggested Readings

1. John D. Musa, *Software Reliability*, McGraw Hill, 1995.
2. Patrick O'Connor, *Practical Reliability Engineering*, 4th Edition, John Wesley & Sons, 2003.
3. C.M. Krishna, Kang G. Shin, *Real Time Systems*, McGraw Hill, 1997.

CS 100

RESEARCH METHODOLOGY IN COMPUTER SCIENCE

Instruction**:** (3L) hrs per week
CIE**:** 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Course Objectives:

- To understand the research process.
- To solve unfamiliar problems using scientific procedures.
- To pursue ethical research.
- To use appropriate tools for documentation and analysis of data.

Course Outcomes:

After Completion of the course Students will be able to:

1. Understand the research process
2. Solve unfamiliar problems using scientific procedures
3. Pursue ethical research
4. Use appropriate tools for documentation and analysis of data

UNIT-I

Research Process: Meaning of Research, Objectives and Motivation of Research, Technological Innovation, Types of Research, Research Vs Scientific method, Research Methodology vs Research Methods, Research process.

Research Problem Formulation: Problem solving in Engineering, Identification of Research Topic, Problem Definition, Literature Survey, Literature Review.

Research Design: Research Design: What it is?, Why we need Research Design? Terminology and Basic Concepts, Different Research Designs, Experimental Designs, Important Experimental Designs, Design of Experimental Setup, Use of Standards and Codes.

UNIT-II

Mathematical Modelling: Models in General, Mathematical Model, Model Classification, Modelling of Engineering Systems.

Probability and Distributions: Importance of Statistics to Researchers, Probability Concepts, Probability Distributions, Popular Probability Distributions, Sampling Distributions.

Sample Design And Sampling: Sample design, Types of sample designs, The Standard Error, Sample Size for Experiments, Prior Determination Approach, Use of Automatic Stopping Rule.

Hypothesis Testing and ANOVA: Formulation of Hypothesis, Testing of Hypothesis, Analysis of Variance.

UNIT-III

Design of Experiments and Regression Analysis: Design of Experiments, Planning of Experiments, Multivariate Analysis, Simple Regression and Correlation, Multiple Regression and Correlation

Analysis and Interpretation of Data: Introduction, Data Checking, Data Analysis, Interpretation of Results, Guidelines in Interpretations.

Accuracy, Precision and Error Analysis: Introduction, Repeatability and Reproducibility, Error Definition and Classification, Analysis of Errors, Statistical Analysis of Errors, Identification of Limitations

UNIT-IV

Writing of Papers and Synopsis: Introduction, Audience Analysis,, Preparing Papers for Journals, Preparation of Synopsis of Research Work

Thesis Writing Mechanics: Introduction, Audience for Thesis Report, Steps in Writing the report, Mechanics of Writing, Presentation of graphs, figures and tables.

Structure of Thesis Report: Suggested Framework of the Report, Preliminary Pages, Main Body of Thesis, Summary, Appendices, References, Glossary.

UNIT-V:

Ethics in Research: Importance of Ethics in Research, Integrity in Research, Scientific Misconduct and Consequences.

Spreadsheet tool: Introduction, Quantitative Data Analysis Tools, Entering and preparing your data, Using statistical functions, Loading and using Data Analysis Tool Pack *[Tools: Microsoft Excel / Open office]*

Thesis writing & scientific editing tool. [Tool: Latex]: Introduction, Document Structure, Typesetting Text, Tables, Figures, Equations, Inserting References

Suggested Readings

1. R.Ganesan; Research Methodology for Engineers; MJP Publishers; Chennai, 2011.
2. Paul R Cohen. Empirical Methods in AI. PHI, New Delhi, 2004
3. C.R.Kothari, Research Methodology, Methods & Technique; New age International Publishers, 2004
4. Kumar, Ranjit. Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, Pearson Education, 2005
5. https://arxiv.org/pdf/physics/0601009.pdf
6. https://pdfs.semanticscholar.org/e1fa/ec8846289113fdeb840ff3f32d102e46fbff.pdf
7. LaTEX for Beginners, Workbook, Edition 5, March 2014.
8. Chapter 13, An introduction to using Microsoft Excel for quantitative data analysis: Management Research: Applying the Principles © 2015 Susan Rose, Nigel Spinks & Ana Isabel Canhoto.

AC 031

ENGLISH FOR ACADEMIC AND RESEARCH WRITING

Instruction: 2 periods per week
CIE: 30 marks
Credits: 0

Duration of SEE: 3 hours
SEE: 70 marks

Course Objectives:

- Features of Academic writing; different kinds of Academic writing
- Some academic writing skills; the research process; the structure of a research document.

Course Outcomes:

After completion of the Course Students will be able to:

1. Get Academic writing features; Academic writing kinds; Important academic writing skills
2. Gain the process of research; general research document structure.

UNIT I:
Features of Academic Writing
Language: Clear, Correct, Concise, Inclusive; **Tone**: Formal, Objective, Cautious;
Style: Appropriate, Accurate, Organized; **Ethics**: Honesty, Integrity, Responsibility, Accountability

UNIT II:
Kinds of Academic Writing
Essays, Reports, Reviews, Abstracts, Proposals

UNIT III: Academic Writing Skills
Paraphrasing; Summarizing; Quoting; Rewriting; Expansion

UNIT IV: **Research Process**
Selection of Topic, Formulation of Hypothesis, Collection of Data, Analysis of Data, Interpretation of Data, Presentation of Data

UNIT V: Structure of a Research Document
Title, Abstract, Introduction, Literature Survey, Methodology, Discussion, Findings/Results, Conclusion, Documenting Sources (IEEE style)

Suggested Reading

1. Bailey, S. (2014). Academic writing: A handbook for international students, Routledge.
2. Gillett, A., Hammond, A., & Martala, M. (2009). Inside track: Successful academic writing. Essex: Pearson Education Limited.
3. Griffin, G. (2006). Research methods for English studies. Edinburgh: Edinburgh University Press.
4. Silyn-Roberts, Heather. (2013). Writing for Science and Engineering: Papers, Presentations and Reports (2nd ed.). Elsevier.
5. Lipson, Charles (2011). Cite right: A quick guide to citation styles; MLA, APA, Chicago, the sciences, professions, and more (2nd ed.). Chicago [u.a.]: University of Chicago Press.

AC032

DISASTER MANAGEMENT

Instruction: 2 periods per week Duration of SEE: 3 hours

CIE: 30 marks SEE: 70 marks

Credits: 0

Course Objectives:

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.

Course Outcomes:

After completion of the Course Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction
2. Humanitarian response
3. Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.
4. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

UNIT-I

Introduction

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III

Disaster Prone Areas in India

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

UNIT-IV

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT-VI

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.), "Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L. Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

AC 033

SANSKRIT FOR TECHNICAL KNOWLEDGE

Instruction: 2 periods per week Duration of SEE: 3 hours

CIE: 30 marks SEE: 70 marks

Credits: 0

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects
- enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes:

After completion of the Course Students will be able to:

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT-I

- Alphabets in Sanskrit,
- Past/Present/Future Tense,
- Simple Sentences

UNIT-II

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT-III

- Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Suggested Readings:

1. "Abhyas pustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumb shastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AC 034

VALUE EDUCATION

Instruction: 2 periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 0

Course Objectives

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course Outcomes:

After completion of the Course Students will be able to:

1. Gain knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT-I

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgments

UNIT-II

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline

UNIT-III

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.

UNIT-IV

- Doing best for saving nature
- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence, Humility, Role of Women.
- All religions and same message.
- Mind your Mind, Self-control.
- Honesty, Studying effectively

Suggested Reading:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University, Press, New Delhi.

CS XXX

ADVANCED DATA STRUCTURES LAB

Instruction**:** 3 hrs per week CIE: 50 marks
Credits: 1.5

Course Objectives:

- Write and execute programs to solve problems using data structures such as arrays, linked lists, stacks, queues, trees, hash tables and search trees.
- Learn to implement various text processing.
- Learn to use appropriate data structures for real world problems.

Course Outcomes:

Students will be able to

1. Use appropriate linear data structure in a given application
2. Evaluate the usage of different search algorithms for a given application
3. Use different search trees for practical problems
4. Application string matching algorithms in different domains

1. Write a program that implements stack and Queue operations using
    a. Arrays
    b. linked list

2. Write a program to perform the following operations on singly linked list and doubly linked list
    a. Creation
    b. Insertion
    c. Deletion
    d. Traversal

3. Implement recursive and non recursive (i) Linear search (ii) Binary search

4. Study and Implementation of Different sorting algorithms and Find Time and Space complexities.

5. Implement Recursive functions to traverse the given binary tree in
    a. Preorder
    b. Inorder
    c. Postorder

6. Study and Implementation of different operations on
    a. Binary Search Tree
    b. AVL tree
    c. Red Black Tree

7. perform the following operations
    a. Insertion into a B-tree
    b. Deletion from a B-tree

8. Implement Different Collision Resolution Techniques.

9. Study and Implementation of Following String Matching algorithms:
    a. Rabin-Karp algorithm
    b. Knuth-Morris-Pratt algorithm
    c. Boyer-Moore algorithm

10. Implement the following using java:
    1. Single Source Shortest Path algorithms
    2. All pairs shortest path algorithms
    3. Minimal Spanning Tree algorithms
    4. String and Pattern matching algorithms
    5. Maximum Flow/ Minimum cut algorithms

Note: The students have to submit a report at the end of the semester.

CS XXX

NATURAL LANGUAGE PROCESSING LAB

Instruction**:** 3 hrs per week CIE: 50 marks
Credits: 1.5

Course Objectives:

- To get experimental fundamental knowledge of Natural Language Processing
- To implement standard classification algorithms.

Course Outcomes:

After Completion of the course Students will be able to:

1. Execute basic programming in natural language processing.
2. Implement classifiers, confusion matrix and steps of NLP pipeline.

1) Write a program to display the following words in a given text book
   a) Anagram,
   b) Isogram,
   c) Pangram,
   d) Semordnilap,
   e)Polindrome
   f) Lipogram,
   g) Tautonym,
   h) Antigram,
   i) Ambigram
2) Write a Python Program to demonstrate match(), search() and sub() functions of Regular Expressions.
3) Write a Python program to demonstrate Stemmer (Porter and Lancaster) and Lemmatizer.
4) Python program to demonstrate POS tagging of words in the given text using NLTK in python
5) Write a program to classify the names in Name Corpus into male and female classes. Also calculate the accuracy.
6) Implement Naïve Bayes Classifier.
7) Implement confusion matrix program for the following input and calculate Accuracy, Precision, Recall, F-Measure

	Actual NN	Actual JJ	Actual VB
Predicted NN	7	8	9
Predicted JJ	1	2	3
Predicted VB	3	2	1

8) Implement Chunking and Chinking for NER.
9) Write the Python code to store the following relation information and also to perform a query

   (“What is the national animal of India?”):

   “National Animal of Australia is Kangaroo”

   “National Animal of India is Tiger”

   “National Animal of Morocco is Lion”

   “National Animal of Nepal is Cow”

   “National Animal of Poland is Bison”

   “National Animal of Russia is Bear”
10) Implement all the steps of NLP pipeline using a) NLTK and b) SPACY

SEMESTER – II									
S.No	Type of Course	Course Code	Course Name	Contact hours per Week			Scheme of Examination		Credits
				L	T	P	CIE	SEE	
1	Core-III	CS201	Parallel Computer Architecture	3	0	0	30	70	3
2	Core-IV	CS202	Parallel Programming	3	0	0	30	70	3
3	Professional Elective-III	CS131	Image Processing	3	0	0	30	70	3
		CS103	Advanced Algorithms						
		CS132	Cyber Security						
		CS133	Network Security						
		CS134	Cloud Computing						
		CS135	Hardware and Software Co-design						
		CS212	Performance Evaluation of Computing						
		CS213	Multimedia Technologies						
4	Professional Elective-IV	CS141	Advanced Databases	3	0	0	30	70	3
		CS332	Sentiment Analysis						
		CS104	Artificial Intelligence						
		CS144	Artificial Neural Networks						
		CS215	Real Time Systems						
		CS216	Soft Computing						
		CS343	Web Mining						
		CS148	Software Engineering for RTS						
5	Audit Course-II	AC035	Constitution of India	2	0	0	30	70	0
		AC036	Pedagogy Studies						
		AC037	Stress Management by Yoga						
		AC038	Personality Development through Life Enlighten Skills						
6		CS 070	Mini Project	0	0	6	50*	0	3
7	Core Lab-II	CSXXX	Core Lab-II	0	0	3	50	0	1.5
8	Elective Lab-II	CSXXX	Elective Lab-II	0	0	3	50	0	1.5
			TOTAL	**14**	**0**	**12**	**300**	**350**	**18**

CS 201

PARALLEL COMPUTER ARCHITECTURE

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives:

- To understand basic principles and practices in Parallel Computer Architecture.
- To emphasize hardware and software challenges and their interactions.
- To create exposure to research challenges in the area of Parallel Computer Architecture.

Course Outcomes:

After completion of the Course Students will be able to:

1. Apply the Parallel Processing Techniques for real time applications
2. Analyze the performance of scalar computers
3. Distinguish various parallel architectures and coherence protocols
4. Solve memory inconsistency problem using directory based protocols
5. Analyze the interconnection networks and its performance using latency techniques

UNIT- I

Instruction Level Parallelism: Concepts and challenges, Instruction Pipeline Design, Hardware and software approaches, Dynamic scheduling, Speculation, Compiler techniques for exposing ILP, Branch Handling Techniques.

UNIT-II

Advanced Processor Technologies: CISC and RISC Architectures, Superscalar Processors, and VLIW Architectures.

Memory Hierarchy Design: Cache basics and Cache performance, Reducing miss rate and Miss penalty, multilevel cache hierarchies, Main memory organizations, and Design of Memory Hierarchies.

UNIT-III

Parallel Computer Models: Classification of Parallel Computers, Multiprocessors and Multicomputer, and Multi-vector and SIMD computers.

Shared Memory Multiprocessors: Cache Coherence, Memory Consistency, Snoopy-based Cache coherence protocols (MSI, MESI, and MOESI).

UNIT-IV

Snoopy-based Multi-Processor Design: Single-level Caches with an Atomic Bus, Multi-level Cache Hierarchies, and Split-Transaction Bus.

Directory-Based Cache Coherence: Scalable Cache Coherence, Overview of Directory-based approaches, Design Challenges for Directory Protocols, Memory-Based Directory Protocols, Cache-Based Directory Protocols.

UNIT-V

Interconnection Network Design: Basic Definitions, Basic Communication Performance, Organizational Structure, Interconnection Topologies, Routing, Switch Design, and Flow Control.

Latency Tolerance: Overview of Latency Tolerance, Latency Tolerance in Explicit Message Passing, Latency Tolerance in a Shared Address Space - Block Data Transfer, Proceeding Past Long-Latency Events, Pre communication in a Shared Address Space, and Multithreading.

Suggested Readings

1. John L. Hennessy, David A. Patterson, Computer *Architecture: A Quantitative Approach*, Morgan Kaufmann Publishers Inc., 5th Edition, 2012.
2. Id. Culler, Jaswinder Pal Singh, and Anoop Gupta, *Parallel Computer Architecture: A Hardware/Software Approach*, Morgan Kaufmann, 1999.
3. Kai Hwang, *Advanced Computer Architecture*, Tata McGraw-Hill Education, 2nd Edition, 2011.

CS 202

PARALLEL PROGRAMMING

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives

- To get overview of the architectures and communication networks employed in parallel computers.
- To understand development of efficient parallel algorithms.

Course Outcomes

After Completion of the course Students will be able to:

- Optimize sequential code for fastest possible execution.
- Analyze sequential programs and determine if they are worthwhile to parallelize.
- Develop, analyze, and implement algorithms for parallel computers. This applies both to computers with shared memory and with distributed memory.

UNIT -I

Principles of Parallel Algorithm Design - Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.

UNIT-II

Communication Operations - One-to-All Broadcast and All-to-one Reduction, All-to-all Broadcast and Reduction, All-Reduce and Prefix-sum Operations, All-to-all Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations.

UNIT-III

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,

Asymptotic Analysis of Parallel Programs: Sorting and Graph Algorithms, Search algorithms for discrete optimization problems.

UNIT-IV

Introduction to Parallel Programming: Introduction to Parallel Programming, Introduction to OpenCL, OpenCL Device Architectures, Basic OpenCL Examples, Parallel programming using OpenCL/C++ AMP/CUDA.

UNIT-V

Introduction to OpenCL: Understanding OpenCL's Concurrency and Execution Model, Dissecting a CPU/GPU OpenCL Implementation.

Suggested Readings

1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, *Introduction to Parallel Computing* , 2nd Edition, Pearson Publishers,1994.
2. David Kaeli, Perhaad Mistry, Dana Schaa and Dong Ping Zhang**,** *Heterogeneous Computing with OpenCL 2.0***,** 1st Edition, Mourgan Kaufmann, 2015.
3. Benedict Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, and Dana Schaa, *Heterogeneous Computing with OpenCL™ 1.2***,** Mourgan Kaufmann , 2011
4. Gregory V. Wilson, Practical *Parallel Programming*, PHI, 1998.

CS131

IMAGE PROCESSING

Instruction**:** (3L) hrs per week Duration of SEE**:** 3 hours
CIE**:** 30 marks SEE**:** 70 marks
Credits: 3

Course Objectives:

- To introduce the basics of Image processing, intensity transformations and spatial filtering.
- To Study Filtering in the frequency domain, image restoration, Colour Image Processing and wavelets.

Course Outcomes:

After completion of the Course Students will be able to:

1. Analyze images in the frequency domain using various transforms
2. Design and implement algorithms that perform image processing operations such as histogram equalization, enhancement, restoration, filtering and denoising.
3. Explain color spaces, restoration and enhancement of color images.
4. Develop simple object recognition systems.

UNIT I

Image Processing: Introduction, Examples, Fundamental steps, Components, Elements of visual perception, Light and Electromagnetic Spectrum, Image sensing and Acquisition, Image Sampling and Quantization, Basic relationships between pixels.

Intensity Transformations and Spatial Filtering: Background, Some basic intensity transformation functions, Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Combining Spatial Enhancement Methods.

UNIT II

Filtering in the Frequency Domain: Background, Preliminary concepts, Sampling and Fourier Transform of Sampled Functions, Discrete Fourier Transform (DFT) of one variable, Extension to functions of two variables, Some Properties of the 2-D Discrete Fourier Transform, Basics of Filtering in the Frequency Domain, Image Smoothing, Image Sharpening, Homomorphic Filtering.

Image Restoration: Noise Models, Restoration in the presence of noise only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering.

Linear Degradation, Position-invariant Degradation, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error Filtering, Constrained Least Squares Filtering, Geometric Mean Filter.

UNIT III

Color Image Processing: Color fundamentals, Color models, Pseudocolor Image Processing, Basics of Full-color Image Processing, Color Transformations, Smoothing and Sharpening, Color-based Image Segmentation, Noise in Color Images, Color Image Compression.

Wavelets and Multi resolution Processing: Background, Multire solution Expansions, Wavelet Transforms in One Dimension, The Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets.

UNIT IV

Image Compression: Fundamentals, Image Compression Models, Elements of Information Theory, Error- free Compression, Lossy Compression, Image Compression Standards, Some Basic Compression Methods.

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Some Basic Morphological Algorithms, Some Basic Gray-Scale Morphological Algorithms.

UNIT V

Image Segmentation: Fundamentals, Point, Line and Edge Detection, Thresholding, Region-based Segmentation, Segmentation using Morphological Watersheds, The use of Motion in Segmentation.

Object Recognition: Patterns and Pattern Classes, Recognition based on Decision-theoretic Methods, Structural Methods.

Suggested Readings:

1. Rafael C. Gonzalez and Richard E. Woods, Digital *Image Processing*, PHI Learning Pvt. Limited, 3rd Edition, 2008.
2. William K. Pratt, *Digital Image Processing*, John Wiley & Sons, Inc., 3rd Edition, 2001.

CS 103

ADVANCED ALGORITHMS

Instruction**:** (3L) hrs per week
CIE**:** 30 marks
Credits: 3

Duration of SEE**:** 3 hours
SEE**:** 70 marks

Course Objectives:

- Introduce students to the advanced methods of designing and analyzing algorithms.
- To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
- Understand different classes of problems concerning their computation difficulties.
- To introduce the students to recent developments in the area of algorithmic design.

Course Outcomes:

After Completion of the course Students will be able to:

1. Analyze the complexity/performance of different algorithms.
2. Determine the appropriate data structure for solving algorithmic problems in different domains.
3. Categorize the different problems in various classes according to their complexity.
4. Explain recent developments in the approaches to design algorithms & data structures.

UNIT-I

Sorting: Review of various sorting algorithms, topological sorting,
Graph: Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

UNIT-II

Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.
Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

UNIT-III

Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm.
Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

UNIT-IV

Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming.

Modulo Representation of integers/polynomials: Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.

Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm.

UNIT-V

Linear Programming: Geometry of the feasibility region and Simplex algorithm.

NP-completeness: Examples, proof of NP-hardness and NP-completeness.

Approximation algorithms, Randomized Algorithms, Interior Point Method, Advanced Number Theoretic Algorithm. Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures

Suggested Readings

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein, 4th edition, McGraw Hill, 2009.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman, 2009.
3. "Algorithm Design" by Kleinberg and Tardos, 2013.

CS 132

CYBER SECURITY

Instruction**:** (3L) hrs per week
CIE**:** 30 marks
Credits: 3

Duration of SEE**:** 3 hours
SEE**:** 70 marks

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies

Course Outcomes:

After Completion of the course Student will be able to:

1. Understand the various network threats.
2. Analyse the forensic tools for evidence collection.
3. Apply the firewalls for threat analysis.

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

CS 133

NETWORK SECURITY

Instruction : 3L hrs per week *Duration of SEE : 3 hours*
CIE : 30 Marks *SEE : 70 Marks*
Credits: 3

Course Objectives:

- To understand basics of Cryptography and Network Security.
- To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
- To understand various protocols for network security to protect against the threats in the networks.

Course Outcomes:

After Completion of the course Students will be able to:

1. Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information.
2. Install and configure network devices for network monitoring tasks.
3. Analyze and understand how Network Security Devices (Firewalls, IDS/IPS, NAT, Proxies) works.
4. Building an Internet Security models from the packet flow aspect (i.e. spoofing).
5. Discover and identify abnormalities within the network caused by worms, viruses and Network related security threats.

UNIT-I

Introduction: Attributes of Security, Integrity, Authenticity, Non-repudiation, Confidentiality Authorization, Anonymity, Types of Attacks, DoS, IP Spoofing, Replay, Man-in-the-Middle attacks General Threats to Computer Network, Worms, Viruses, -Trojans.

UNIT-II

Secret Key Cryptography: DES, Triple DES, AES, Key distribution, Attacks

Public Key Cryptography: RSA, ECC, Key Exchange (Diffie-Hellman), Java Cryptography Extensions, Attacks.

UNIT-III

Integrity, Authentication and Non-Repudiation: Hash Function (MD5, SHA5), Message Authentication Code (MAC), Digital Signature (RSA, DSA Signatures), Biometric Authentication.

UNIT-IV

PKI Interface: Digital Certificates, Certifying Authorities, POP Key Interface, System Security using Firewalls and VPN's.

Smart Cards: Application Security using Smart Cards, Zero Knowledge Protocols and their use in Smart Cards, Attacks on Smart Cards.

UNIT-V

Applications: Kerberos, Web Security Protocols (SSL), IPSec, Electronic Payments, E-cash, Secure Electronic Transaction (SET), Micro Payments, Case Studies of Enterprise Security (.NET and J2EE).

Suggested Readings

1. William Stallings, Cryptography and Network Security, 4th Edition. Pearson. 2009.
2. Behrouz A Forouzan, Cryptography and Network Security, TMH, 2009
3. Joseph Migga Kizza, A Guide to Computer Network Security, Springer, 2010
4. Dario Cataiano, Contemporary Cryptology, Springer, 2010.

CS 134

CLOUD COMPUTING

Instruction : 3L hrs per week
Duration of SEE : 3 hours
CIE : 30 Marks
SEE : 70 Marks
Credits: 3

Course Objectives:

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

Course Outcomes:

After completion of the Course Students will be able to:

1. Understand the basic approaches and Core ideas of Cloud Computing.
2. Understand the Challenges and approaches to solving the management of the Cloud environments.
3. Familiarize students with advanced paradigms and solutions necessary for building and managing modern Cloud environments.
4. Envision use of Cloud environment in Enterprise.

UNIT- I

Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning.

UNIT -II

Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage.

UNIT-III

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

UNIT-IV

Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services.

UNIT- V

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

Suggested Readings

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

CS 135

HARDWARE AND SOFTWARE CO-DESIGN

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To introduce data flow modelling and its implementation in Software and Hardware.
- To Study Cycle based bit parallel hardware and finite state machines.
- To Learn design principles of SOC Architectures.
- To Familiarize Hardware software interfaces.
- To Introduce Co Processor Control shell design.

Course Outcomes:

After Completion of the course Students will be able to:

1. Analyze and explain the control-flow and data-flow of a software program and a cycle-based hardware description.
2. Transform simple software programs into cycle-based hardware descriptions with equivalent behavior and vice versa.
3. Partition simple software programs into hardware and software components, and create appropriate hardware-software interfaces to reflect this partitioning.
4. Identify performance bottlenecks in a given hardware-software architecture and optimize them by transformations on hardware and software components.
5. Use simulation software to co-simulate software programs with cycle-based hardware descriptions.

UNIT-I

Nature of Hardware and Software: Introduction to Hardware/Software Co-design, Issues in co-designs, Driving factors in Hardware/Software Co-design,

Data Flow Modelling and Implementation: Need for Concurrent Models, Analyzing Synchronous Data Flow Graphs, Software and Hardware Implementation of Data Flow.

Analysis of Control and Data Flow-Implementing Data and Control Edges and Construction of Data Flow Graphs and Applications.

UNIT-II

Design Space of Custom Architectures: Finite State Machine with Data Path- Cycle based Bit-parallel Hardware, Hardware Modules, Finite Sate machines with data path, Simulation and RTL Synthesis of FSMD, Limitations of Finite State Machines.

Micro programmed Architectures: Micro programmed Control, Encoding, and Data path. Implementing Micro programmed Machine, Interpreters and Pipelining.

UNIT-III

General-Purpose Embedded Cores: Processors, RISC Pipeline, Program Organization and Analysis of quality of Compiled Code.

System on Chip: Concept and Design Principles in SoC Architectures.

UNIT-IV

Hardware/Software Interfaces: On-Chip Busses-Connecting Hardware and Software, OnChip Bus Systems, Bus Transfers, Multimaster Bus Systems, OnChip Networks.
Hardware/Software Interfaces: Synchronization Schemes, Memory-mapped Interfaces, Coprocessor Interfaces and Custom-Instruction Interfaces.

UNIT-V

Co Processor Control Shell Design: Co-Processor Control Shell, Data Design, Control Design, Programmers Model, AES encryption coprocessor.
Case Study: Trivium Crpto-Coprocessor and CORDIC Coprocessor**.**

Suggested Readings

1. Schaumont, Patric R, *A Practical Introduction to Hardware/Software Codesign*, 2nd Edition, Springer publishers, 2013.
2 Jargen Staunstrup, Wayne Wolf, *Hardware/Software Co-Design, Principles and Practice*, Kluwer Academic Publishers, 1997.

CS 212

PERFORMANCE EVALUATION OF COMPUTING

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives:

- To learn principles of system modelling and general measurement principles.
- To learn the concepts of stochastic processes and queuing models.
- To understand the basics of simulation techniques, experimental design and Tools.
- To understand the application of system modelling and simulation techniques to operating systems, database systems and computer communication systems.

Course Outcomes:

After Completion of the course Students will be able to:

1. Describe performance evaluation models, metrics, factors and parameters.
2. Select appropriate evaluation techniques and workloads for a system.
3. Design measurement and simulation experiments.
4. Use simple queuing models to analyze the performance of systems.
5. Compare different systems from performance point of view.

UNIT-I

Fundamental Concepts and Performance Measures

Tiem, Events, Measurements, .Intervals, Response, Independence, Randomness, Workload Problems Encountered in Model Development and Use. A Case Study.
General Measurement Principles, Scheduling Algorithms, Workloads.

UNIT–II

Probability: Random Variables, Jointly Distributed Random Variables, Probability Distributions, Densities Expectation, Some Example Probability Distributions.
Stochastic Processes: Basic Definitions, Poisson Process, Birth-Death Process, Markov Process.

UNIT-III

Queuing Theory: Networks of Queues, Estimating Parameters and Distributions
Computational Methods for Queuing Network Solutions, Simulation Analysis

Simulation Process, Time Control, Systems and Modelling, Simulation Languages, Applications of Simulation.

UNIT-IV

Petri Nets: Basic Notation, Classical Petri Nets, Times Petri Nets, Priority-Based Petri Nets, Colored Pt Nets, Generalized Petri Nets.
Hardware Testbeds, Instrumentation, Measurement, Data Extraction, and Analysis
Derivation of Performance Evaluation parameters, Network performance tests, General Methods of Data Extraction, Tested and Model Workloads, Experimental Design, Data presentation.
System Performance Evaluation Tool Selection and Use: Validation of Results, Conducting Experiments, Performance Metrics, Evaluation

UNIT-V

Analysis of Computer Architectures: Case I: Central Server Computer System
Case II: Multiple Server Computer System
Case III: Petri Net Example

Analysis of Operating System Components

System Architectures, Workloads, Experimental Design and Simulation, Experimental Analysis and Conclusion.

Database Systems Performance Analysis

The Testbed Systems, The Database Systems Tested Performance Analysis Testing, The Results.

Analysis of Computer Networks Components

Analytical Modelling Examples, Simulation Modelling of Local Area Networks.

Suggested Readings

1. Paul. J. Fortier and Howard E. Michel, *Computer Systems Performance Evaluation and Prediction*, 1st Edition, Digital Press, 2002.
2. Raj Jain, *The art of Computer Systems performance analysis, techniques for experimental design, measurement and modeling*, John Wiley & Sons, 1991.
3. Neil J. Gunther, *Analyzing Computer System Performance with Peri::PDQ*, 2nd Edition, Springer, 2011.

CS 213

MULTIMEDIA TECHNOLOGIES

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To learn the properties of multimedia systems, supporting devices and digital representation of analog data.
- To understand the concepts of digital image recognition and transmission techniques.
- To learn data compression techniques and optical storage device standards.
- To explore the issues of QOS and synchronization in multimedia communication and storage systems.
- To understand the concepts of multimedia application development.

Course Outcomes:

After Completion of the course Students will be able to:

1. Describe the media and supporting devices commonly associated with multimedia systems.
2. Describe mechanisms for providing QoS guarantees in Multimedia communication system.
3. Understand the issues of synchronization in the presentations.
4. Understand the data models and indexing structures of multimedia data bases.
5. Describe the steps in multimedia application development.

UNIT-I

Media and Data Streams: Properties of multimedia systems, Data streams characteristics: Digital representation of audio, numeric instruments digital interface Bark concepts, Devices, Messages, Timing Standards Speech generation, analysis and transmission.

UNIT-II

Digital Image: Analysis, recognition, transmission, **Video**: Representation, Digitalization transmission **Animations**: Basic concepts, animation languages, animations control transmission.

UNIT-III

Data Compression Standards: JPEG, H-261, MPEG DVI
Optical storage devices and Standards: WORHS, CDDA, CDROM, CDWO, CDMO.
Real Time Multimedia, Multimedia file System.

UNIT-IV

Multimedia Communication System: Collaborative computing session management, transport subsystem, QOS, resource management.
Multimedia Databases: Characteristics, data structures, operation, integration in a database model. **A Synchronization**: Issues, presentation requirements, reference to multimedia synchronization, MHEG.

UNIT-V

Multimedia Application: Media preparation, Composition, integration communication, consumption, entertainment.

Suggested Readings

1. Ralf Steninmetz, Klara Hahrstedt, Multimedia: Computing, Communication and Applications, PHI PTR Innovative Technology Series, 2004.
2. John F.Koegel Bufford, Multimedia System, Addison Wesley, 1994.
3. Mark Elsom – Cook, Principles of Interactive Multimedia, Tata Mc-Graw Hill, 2001.
4. Judith Jefcoate, Multimedia in Practice: Technology and Application, PHI 1998.

CS 141

ADVANCED DATABASES

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To introduce various advanced data models that are non-relational and extensions to relational model.
- To implement Query processing Module in RDBMS.
- To learn aspects of DBMS on parallel and distributed computing systems.
- To know the concepts of performance tuning and benchmarking.

Course Outcomes:

After Completion of the course Students will be able to:

1. Explain the need for complex types in databases and their implementation using object-oriented databases and persistent programming languages.
2. Able to Model a relational / semi-structured database using XML Schema.
3. Able to do back-of-envelope estimates of I/O operations for different algorithms in query evaluation engine.
4. Describe different concurrency and commit protocols in distributed databases.
5. Demonstrate an understanding of concepts involved in special purpose databases such as Temporal, Spatial, Mobile and Multi-media databases.

UNIT-I

Object Based Databases: Overview, Complex Data Types, Structured Types and Inheritance in SQL, Table Inheritance, Array and Multi-set. Types in SQL, Object-Identity and Reference Types in SQL, Implementing O-R features, Persistent Programming Languages, Object-Relational Mapping, Object-Oriented versus Object-Relational.

UNIT-II

X M L: Motivation, Structure of XML data, XML Document Schema, Querying and Transformation, Application Program Interface to XML, Storage of XML data, XML applications.

UNIT-III

Query Processing: Overview, Measures of Query Cost, Selection Operation, Sorting, join Operation, Other Operations, Evaluation of Expressions.

Query Optimization: Overview, Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans, Materialized Views.

UNIT-IV

Parallel Databases: Introduction,1/0 Parallelism, Interquery Parallelism, Intraquery Parallelism, Intra-operation Parallelism, Interoperation Parallelism, Query Optimization, Design of Parallel Systems.

Distributed Databases: Homogeneous and Heterogeneous Database, Distributed Data Storage, Distributed. Transactions, Commit Protocols, Concurrency Control in Distributed Databases, Availability, Distributed Query Processing, Heterogeneous Distributed Databases, Cloud-Based Databases, and Directory Systems.

UNIT- V

Advanced Application Development: Performance Tuning, Performance Benchmarks Other Issues in Application Development, Standardization.

Spatial and Temporal Data and Mobility: Motivation, Time in Databases, Spatial and Geographic Data, Multimedia Databases, Mobility and Personal Databases.

Suggested Readings:

1. Abraham Silberschatz, Henry F Korth, S Sudarshan, *Database System Concepts*, McGrawHill International Edition, 6th Edition, 2010.
2. Elmasri Navathe, Somayajulu, Gupta , *Fundamentals of Database Systems*, Pearson Education, 4th Edition, 2006.
3. CJ Date, A Kannan, S Swamynathan, *An Introduction to Database Systems*, Pearson Education, 8th Edition, 2006.
4. Raghu Ramakrishnan, and Johannes Gehrke, *Database Managemen*t *Systems*, McGraw-Hill International Edition, 3rd Edition, 2002.

CS 332

SENTIMENT ANALYSIS

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- Understandthe introducing real time problems related to sentiment extraction with an aim to bridge the gap between unstructured and structured data
- To facilitate qualitative and quantitative analysis of opinions
- To discuss the existing techniques for solving real time sentiment extraction problems.

Course Outcomes:

After completion of the course, students would be able to:

1. Understand the problem of sentiment analysis and opinion summarization as mini NLP.
2. Use text classification and ML techniques for sentiment classification of documents.
3. Use rules of sentiment composition in aspect-based sentiment analysis and aspect extraction.
4. Generate sentiment lexicons and analyse comparative opinions.
5. Understand the problem of Intension mining, classification, and able to detect opinion spams.

UNIT – I

Introduction: Sentiment Analysis Applications, Sentiment Analysis Research, Sentiment Analysis as mini NLP.

The Problem of Sentiment Analysis: Definition of Opinion, Opinion Summarization, Affect, Emotion and Mood, Different Types of Opinions.

Document Sentiment Classification: Supervised Sentiment Classification, Unsupervised Sentiment Classification, Sentiment Rating Prediction.

UNIT-II

Document Sentiment Classification: Cross-Domain Sentiment Classification, Cross-Language Sentiment Classification, Emotion classification of Documents.

Sentence Subjectivity and Sentiment Classification: Subjectivity, Sentence Sentiment Classification, Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Cross-language Subjectivity and Sentiment Classification, Using Discourse Information for Sentiment Classification, Emotion classification of sentences.

UNIT-III

Aspect-based Sentiment Analysis: Aspect Sentiment Classification, Rules of sentiment Composition, Negation and Sentiment

Aspect and Entity Extraction: Aspect Extraction, Entity, Opinion Holder and Time Extraction, Co reference Resolution and Word Sense Disambiguation.

UNIT-IV

Sentiment Lexicon Generation: Dictionary-based Approach, Corpus-based Approach, Desirable and Undesirable Facts.

Analysis of Comparative Opinions: Problem Definitions, Identifying the Preferred Entity Set, Entity and Aspect Extraction.

Opinion Summarization and Search: Aspect based opinion summarization, Contrastive view summarization.

UNIT-V

Opinion Summarization and Search: Summarization of Comparative Opinions, Opinion Search, Existing Opinion retrieval Techniques.

Mining Intentions: Problem of Intention Mining, Intention Classification, Fine-Grained Mining of Intentions.

Opinion Spam Detection: Types of Spam and Spamming, Supervised Spam Detection, Unsupervised Spam Detection, Group Spam Detection.

Suggested Readings:

1. Sentiment Analysis – Mining Opinions, Sentiments, and Emotions in Text, Bing Liu, Cambridge University Press, 2015.
2. Sentiment Analysis and Opinion Mining, Bing Liu, Morgan and Claypool Publishers, 2012.
3. Sentiment Analysis in Social Networks by Federico Alberto Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu, Morgan Kaufmann publications, 2017.
4. Foundations of Statistical Natural Language Processing 1st Edition, by Christopher D. Manning, Hinrich Schütze, The MIT Press Cambridge, Massachusetts London, England, 1999
5. Natural Language Processing with Python, by Steven Bird, Ewan Klein and Edward Loper.

CS 104

ARTIFICIAL INTELLIGENCE

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To familiarize the principles of Artificial Intelligence.
- To study the techniques for knowledge representation and inference.
- To learn the techniques involved in the creation of intelligent systems.
- To study different applications like Game Playing Expert Systems, machine learning and natural language processing.

Course Outcomes:

After completion of the Course Students will be able to:

1. Use different logical systems for inference over formal domain representations, and trace how a particular inference algorithm works on a given problem specification.
2. Understand the conceptual and computational trade-offs between the expressiveness of different formal representations.
3. Formalise a given problem in the language/framework of different AI methods (e.g., as a search problem, as a constraint satisfaction problem, as a planning problem, etc).
4. Design and perform an empirical evaluation of different algorithms on a problem formalisation, and state the conclusions that the evaluation supports.
5. Make use of methods from artificial intelligence in the analysis, design and implementation of computer programs in academic as well as industrial application.

UNIT-I

Overview of Artificial Intelligence: Introduction. The Turing Test, Strong AI versus Weak AI, Heuristics, Identifying Problems Suitable for AI, Applications and Methods, Early History of AI, Recent History of AI to the Present, AI in the New Millennium.

Uninformed Search: Introduction: Search in Intelligent Systems, State-Space Graphs, Generate-and-Test Paradigm, Blind Search Algorithms, Implementing and Comparing Blind Search Algorithms.

Informed Search: Introduction, Heuristics, Informed Search Algorithms – Finding Any Solution, The Best-First Search, The Beam Search, Additional Metrics for Search Algorithms, Informed Search – Finding An Optimal Solution, Informed Search – Advanced Search Algorithms.

UNIT-II

Search Using Games: Introduction, Game Trees and Minimax Evaluation, Minimax with Alpha-Beta Pruning, Variations and Improvements to Minimax, Games of Chance and the Expect minimax Algorithm, Game Theory.

Logic in Artificial Intelligence: Introduction, Logic and Representation, Propositional Logic, Predicate Logic – Introduction, Several Other Logics.

Knowledge Representation: Introduction, Graphical Sketches and the Human Window, Graphs and the Bridges of Königsberg Problem, Search Trees, Representational Choices, Production Systems, Object Orientation, Frames, Scripts and the Conceptual Dependency

System, Semantic Networks, Associations, More Recent Approaches, Agents: Intelligent or Otherwise.

UNIT-III

Production Systems: Introduction, Background, Basic Examples, Production Systems and Inference Methods, Production Systems and Cellular Automata, Stochastic Processes and Markov Chains.

Uncertainty in AI: Introduction, Fuzzy Sets, Fuzzy Logic, Fuzzy Inferences, Probability Theory and Uncertainty.

Expert Systems: Introduction, Background, Characteristics of Expert Systems, Knowledge Engineering, Knowledge Acquisition, Case-Based Reasoning, More Recent Expert Systems.

UNIT-IV

Machine Learning : Introduction, Machine Learning: A Brief Overview, The Role of Feedback in Machine Learning Systems, Inductive Learning, Learning With Decision Trees, Problems Suitable for Decision Trees, Entropy, Constructing A Decision Tree With ID3, Issues Remaining.

Machine Learning : Neural Networks Introduction, Rudiments of Artificial Neural Networks, McCulloch-Pitts Network, The Perceptron Learning Rule, The Delta Rule, Backpropagation, Implementation Concerns, Discrete Hopfield Networks, Application Areas.

UNIT-V

Natural Language Understanding: Introduction, History of Natural Language Processing, Syntax and Formal Grammars, Semantic Analysis and Extended Grammars, Statistical Methods in NLP, Probabilistic Models for Statistical NLP, Linguistic Data Collections for Statistical NLP.

Suggested Readings

1. Stephen Lucci, Danny Kopec. Artificial Intelligence in the 21st Century. A Living Introduction. Mercury Learning and Information. 2nd Edition. 2016.
2. Russell, Norvig: Artificial Intelligence, A Modern Approach, Pearson Education, Second Edition. 2004.
3. Rich, Knight, Nair: Artificial Intelligence, Tata McGraw Hill, Third Edition 2009.
4. Saroj Kaushik. Artificial Intelligence. Cengage Learning. 2011.

CS 144

ARTIFICIAL NEURAL NETWORKS

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To provide an introduction to the field of artificial neural networks and machine learning.
- To teach students how to solve practical problems via implementation of these techniques via simulation.
- To promote further independent learning on the topics of artificial neural networks and machine learning.

Course Outcomes:

After Completion of the course Students will be able to:

1. Model Neuron and Neural Network, and to analyze ANN learning, and its applications.
2. Perform Pattern Recognition, Linear classification.
3. Develop different single layer/multiple layer Perception learning algorithms
4. Design of another class of layered networks using deep learning principles.

UNIT-I

Background to ANN: Introduction to artificial neural networks (ANN), intelligence, learning and knowledge. Historical development of Artificial Intelligence (AI) leading to ANN. PDP models -- Interactive and competition (IAC) and Constraint Satisfaction (CS) models.

UNIT-II

Basics of ANN: Basics of ANN, terminology, models of neurons, topology, basic learning laws, activation and synaptic dynamics models.

UNIT-III

Analysis of Feed forward Neural Networks (FFNN): Overview, linear associative networks, perceptron network, multilayer perceptron, gradient descent methods, back propagation learning.

UNIT-IV

Analysis of Feedback Neural Networks (FBNN): Overview, Hopfield model, capacity, energy analysis, state transition diagrams, stochastic networks, Boltzmann-Gibbs Law, simulated annealing, Boltzmann machine.

UNIT-V

Applications of ANN: Travelling salesman problem, image smoothing, speech recognition and texture classification.

Suggested Readings

1. B Yegnanarayana, Artificial Neural Networks, Prentice-Hall of India, New Delhi, 1999

2. Simon Haykin, Neural networks and learning machines, Pearson Education, 2011

3. Jacek M Zurada, Introduction to artificial neural systems, PWS publishing Company, 1992

4. David E Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 1, Cambridge MA: MIT Press, 1986a

5. James McClelland, David E Rumelhart, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 2, Cambridge MA: MIT Press, 1986b

6. David Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: A handbook of models, Cambridge MA: MIT Press, 1989.

CS 215

REAL TIME SYSTEMS

Instruction : 3L hrs per week
Duration of SEE : 3 hours
CIE : 30 Marks
SEE : 70 Marks
Credits: 3

Course Objectives:

- Develop an understanding of various Real Time systems Application.
- Obtain a broad understanding of the technologies and applications for the emerging and exciting domain of real-time systems.
- Get in-depth hands-on experience in designing and developing a real operational system.

Course Outcomes:

After Completion of the course Students will be able to:

1. Explain concepts of Real-Time systems and modeling.
2. Recognize the characteristics of a real-time system.
3. Understand and develop document on an architectural design of a real-time system.
4. Develop and document Task scheduling, resource management, real-time operating systems and fault tolerant applications of Real-Time Systems.

UNIT-I

Introduction: Definition, Applications and Types of Real Time Systems, Typical Case Studies of Real Time Systems, Time Constraints.

A Reference Model for Real Time Systems: Processors and Resources, Periodic Task Model, Precedence and Data Dependency, Temporal, Foundational and Resource Parameters, Scheduling Hierarchy.

UNIT-II

Real Time Scheduling: Different Approaches- Clock Driven, Priority Driven, Scheduling of Periodic and Sporadic Jobs in Priority- Driven Systems.

UNIT-III

Resource Management Resources and Resource Access Control, Critical Section, Priority-Ceiling Protocols, concurrent Access to Data Objects.

UNIT-IV

Implementation Aspects: Timing Services and Scheduling Mechanisms, Other Basic Operating System Functions, Processor Reserves and Resource Kernel, Open System Architecture, Capabilities of Commercial Real Time Operating Systems, Predictability of General Purpose Operating Systems.

UNIT-V

Case Studies: Vx – Works, and RT Linux.

Suggested Readings

1. Jane W.S. Liu, *Real Time Systems*, Pearson Education, 2001.
2. C.M. Krishna and Kang G. Shin, *Real Time Systems*, Mc-Graw Hill Companies Inc., 1997.
3. Raymond J.A. Buhr, Donald L. Bailey, *An Introduction to Real Time Systems*, Prentice Hall International, 1999.
4. K.V.K.K. Prasad, *Embedded Real Time Systems, Concepts, Design and Programming*, Dreamtech Press, 2003.

CS 216

SOFT COMPUTING

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
- To implement soft computing based solutions for real-world problems.
- To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.

Course Outcomes:

After Completion of the course Students will be able to:

1. Identify and describe soft computing techniques and their roles in building intelligent Machines.
2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
3. Apply genetic algorithms to combinatorial optimization problems.
4. Evaluate and compare solutions by various soft computing approaches for a given problem.
5. Recognize the underlying mathematics and logic behind various soft computing algorithms.

UNIT-I

Introduction to Soft Computing and Neural Networks: Evolution of Computing Soft Computing Constituents from Conventional AI to Computational Intelligence-Machine Learning Basics.

UNIT II

Genetic Algorithms: Introduction to Genetic Algorithms (GA) –Applications of GA in Machine Learning-Machine Learning Approach to Knowledge Acquisition.

UNIT III

Neural networks: Machine Learning Using Neural Network, Adaptive Networks –Feed forward Networks –Supervised Learning Neural Networks–Radial Basis Function Networks-Reinforcement Learning–Unsupervised Learning Neural Networks–Adaptive Resonance architectures – Advances in Neural networks.

UNIT IV

Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.

UNIT V

Neuro-Fuzzy Modelling: Adaptive Neuro, Fuzzy Inference Systems, Coactive Neuro, Fuzzy Modelling, Classification and Regression Trees, Data Clustering Algorithms, Rule base Structure Identification, Neuro-Fuzzy Control, Case studies.

Suggested Readings

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, *Neuro-Fuzzy and Soft Computing*, Prentice- Hall of India, 2003.
2. George J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic-Theory and Applications*, Prentice Hall, 1995.
3. James A. Freeman and David M. Skapura, *Neural Networks Algorithms, Applications, and Programming Techniques*, Pearson Edn., 2003.
4. Mitchell Melanie, *An Introduction to Genetic Algorithm*, Prentice Hall, 1998.
5. David E. Goldberg, *Genetic Algorithms in Search, Optimization and Machine Learning*, Addison Wesley, 1997.

CS 343

WEB MINING

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives:

- To know the basic concepts of data mining and machine learning for extracting information from web.
- To learn the concepts of information retrieval, structured information extraction and integration techniques.
- To understand web structure mining and usage mining.
- To gain the knowledge on the concepts of opinion mining and sentiment analysis.

Course Outcomes:

After Completion of the course Students will be able to:

1. Apply association rule mining and text classification techniques for web documents.
2. Use similarity metrics and clustering algorithms for web documents.
3. Use link analysis for social network analysis and to rank web search results.
4. Design and implement a crawler application to collect and index documents from the web.
5. Use web usage mining techniques to discover web usage patterns and sentiment/ opinion finding.

UNIT-I

Introduction: The World Wide Web, History of the Web and the Internet, Web Data Mining

Association Rules and Sequential Patterns: Basic Concepts, Apriori Algorithm, Data Formats for Association Rule Mining, Mining with Multiple Minimum Supports, Mining Class Association Rules.

Supervised Learning: Basic Concepts, Decision Tree Induction, Classifier Evaluation, Naïve Bayesian Classification, Naïve Bayesian Text Classification, K-Nearest Neighbor Learning, Ensemble of Classifiers.

UNIT-II

Unsupervised Learning: Basic Concepts. K-means Clustering, Representation of Clusters, Hierarchical Clustering, Distance Functions, Data Standardization, Handling of Mixed Attributes, Which Clustering Algorithm to Use? Cluster Evaluation.

Information Retrieval and Web Search: Basic Concepts, Relevance Feedback, Evaluation Measures, Text and Web Page Pre-Processing, Inverted Index and Its Compression.

UNIT-III

Information Retrieval and Web Search: Web Search, Meta-Search: Combining Multiple Rankings, Web Spamming.

Link Analysis: Social Network Analysis, Co-Citation and Bibliographic Coupling, PageRank , HITS, Community Discovery.

UNIT-IV

Web Crawling: A Basic Crawler Algorithm, Implementation Issues, Universal Crawlers, Focused Crawlers, Topical Crawlers, Evaluation, Crawler Ethics and Conflicts.

Structured Data Extraction: Wrapper Generation**,** Preliminaries, Wrapper Induction, Instance-Based Wrapper Learning, Automatic Wrapper Generation, String Matching and Tree Matching, Multiple Alignment, Building DOM Trees, Extraction based on a single list page, extraction based on a single list page : Nested doda records, Extraction based on multiple pages, Some other issues.

Information Integration: Introduction to Schema Matching, Pre-Processing for Schema Matching, Schema-Level Match, Domain and Instance-Level Matching, Combining Similarities, 1: Match, Some other issues, Integration of Web Query Interfaces, Constructing a Unified Global Query Interface.

UNIT-V

Opinion Mining and Sentiment Analysis: Sentiment Classification, Feature-Based Opinion Mining and Summarization, Comparative Sentence and Relation Mining, Opinion Search, Opinion Spam.

Web Usage Mining: Data Collection and Pre-Processing, Data Modeling for Web Usage Mining, Discovery & analysis of web usage patterns.

Suggested Readings

1. Bing Liu , *Web Data Mining*, Springer India, 2010
2. Soumen Chakrabarti, *Mining the Web*, Morgan-Kaufmann Publishers, Elseiver, 2002
3. Manu Konchady, *Text Mining Application Programming*, Cengage Learning, 2006

CS 148

SOFTWARE ENGINEERING FOR RTS

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- Demonstrates agility in solving software and system challenges with a comprehensive set of skills appropriate to the needs of the dynamic global computing-based society.
- Capable of diverse team and organizational leadership in computing project settings.
- Demonstrates ethical principles in the application of computing-based solutions to societal and organizational problems.
- Continually acquires skills and knowledge to support a professional pathway, including (but not limited to) communication, analytic, and technical skills.

Course Outcomes:

After Completion of the course Students will be able to:

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
3. Use the techniques, skills, and modern engineering tools and processes necessary for software engineering practice.
4. Apply software engineering perspective through software design and construction, requirements analysis, verification, and validation, to develop solutions to modern problems such as security, data science, and systems engineering.

UNIT-I

I**ntroduction:** Review of Software Engineering Concepts, Characteristics of Real Time Systems, Importance of including Time Factor, The Real Time System Life Cycle: Requirement Specifications, State Charts.

UNIT-II

Structured Design Approaches: Event Based Model, Process-Based Structured Design, Graph-Based Theoretical Model, Petri Net Models: Stochastic Petri Net (SPN) Model Analysis, Annotated Petri Nets, Time-Augmented Petri Nets, Assessment of Petri Net Methods.

UNIT-III

Axiomatic Approaches: Weakest Precondition Analysis, Real Time Logic, Time Related History variables, State Machines and Real-Time Temporal Logic.

UNIT-IV

Language Support Restrictions: Real-Time Programming Descipline, Real-Time Programming Languages, Schedulability Analysis.

UNIT-V

Verification and Validation of Real-Time Software: Testing Real Time Properties, Simulation as Verification Tool, Testing Control and Data Flow, Proof Systems, Operational Approach.

Suggested Readings

1. Shem – Tow Levi and Ashok K. Agarwal, *Real Time System Design*, McGraw Hill International Editions, 1999.
2. Cooling J.E. Jim Cooling, *Software Engineering for Real Time Systems*, Addison Wesly,2002.

AC 035

CONSTITUTION OF INDIA

Instruction: 2 periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 0

Course Objectives:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes:

After Completion of the course Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I

• **History of Making of the Indian Constitution:**
History
Drafting Committee, (Composition & Working)

UNIT-II

• Philosophy of the Indian Constitution:
Preamble
Salient Features

UNIT-III

• Contours of Constitutional Rights & Duties:
• Fundamental Rights
• Right to Equality
• Right to Freedom
• Right against Exploitation
• Right to Freedom of Religion
• Cultural and Educational Rights
• Right to Constitutional Remedies
• Directive Principles of State Policy
• Fundamental Duties.

UNIT-IV

- Organs of Governance:
- Parliament
- Composition
- Qualifications and Disqualifications
- Powers and Functions
- Executive
- President
- Governor
- Council of Ministers
- Judiciary, Appointment and Transfer of Judges, Qualifications
- Powers and Functions

UNIT-V

- Local Administration:
- District's Administration head: Role and Importance,
- Municipalities: Introduction, Mayor and role of Elected Representative, CE of Municipal Corporation.
- Pachayati raj: Introduction, PRI: Zila Pachayat.
- Elected officials and their roles, CEO Zila Pachayat: Position and role.
- Block level: Organizational Hierarchy (Different departments),
- Village level: Role of Elected and Appointed officials,
- Importance of grass root democracy

UNIT-VI

- **Election Commission:**
- Election Commission: Role and Functioning.
- Chief Election Commissioner and Election Commissioners.
- State Election Commission: Role and Functioning.
- Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Readings:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AC 036

PEDAGOGY STUDIES

Instruction: 2 periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 00

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes:

After Completion of the course Students will be able to:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I

- Introduction and Methodology:
- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

UNIT-II

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

UNIT-III

- Evidence on the effectiveness of pedagogical practices
- Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV

- Professional development: alignment with classroom practices and follow-up support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment

- Barriers to learning: limited resources and large class sizes

UNIT-V

Research gaps and future directions

- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

Suggested Readings

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

AC 037

STRESS MANAGEMENT BY YOGA
(Audit course)

Instruction: 3periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 00

Course Objectives:

- Creating awareness about different types of stress and the role of yoga in the management of stress.
- Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
- Prevention of stress related health problems by yoga practice.

Course Outcomes:

After the completion of this course, the students shall be able to:

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas.
5. Improve work performance and efficiency.

UNIT I

Introduction: Definition of **Stress** – Types of stress: Acute and chronic - Stressors – Definition of **Yoga** from various sources – Types of yoga – Karma yoga, Gnana yoga, Bhakti yoga and Raja yoga – Concept of Bhagavad Geeta - Yoga versus exercise –Basics of Physiology and Psycholoy – Brain and its parts – CNS and PNS – HPA axis – Sympethetic and Para sympethetic nervous systems – Fight and Flight mechanism - Relationship between stress and yoga.

UNIT II

Ashtanga Yoga: Do`s and Don'ts in life: (i) **Yam** - Ahinsa, satya, astheya, bramhacharya and aparigraha (ii) **Niyam**-Shaucha, santosh, tapa, swadhyay, ishwarpranidhan – (iii) **Asana** (iv) **Pranayama (**v) **Prathyahara (**vi) **Dharana** (vii) **Dhyana (**viii) **Samadhi** – Illustrations of eight steps of Ashtanga yoga.

UNIT III

Asana and Stress: Definition of Asana from Pathanjali – Origin of various names of asanas - Various yoga poses and their benefits for mind & body – Sequence of performing asanas: Standing, sitting, lying down on stomach, lying down on back and inverted postures – Activation of Annamaya kosha – Effect on various chakras, systems and glands thereby controlling the stress levels through the practice of asanas.

UNIT IV

Pranayama and Stress*:* Definition of pranayama from Shankaracharya - Regularization of breathing techniques and its effects - Types of pranayama – Heat generating and cold generating techniques – Pranayama versus chakras and systems – Breathing techniques versus seasons - Anger and breathing rate – Activation of pranamayakosha – Pranayama as the bridge between mind and body – Stress control through pranayama.

UNIT V

Dhyana and Stress*:* Distinction between Dhyana and Dharana– Preparation for Dhyana through prathyahara and dharana – Activation of Vignanamayakosha – Types of mind: conscious, superconscious and subconscious – Activation of manomayakosha through Dhyana – Silencing the mind thereby controlling the stress levels

Suggested Readings:

1 '*Yogic Asanas for Group Tarining-Part-I*" : Janardan Swami Yogabhyasi Mandal, Nagpur

2 "*Rajayoga or Conquering the Internal Nature*" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

3 *"Light onYoga"* by BKS Iyengar.

4 "*The search for happiness and bliss*" by Swami Sarvapriyananda on you tube – https://youtu.be/xfywJTPkw7Y.

5 "*Mastering the mind*" by Swamini Vimalananda on you tube - https://youtu.be/EXniWH9DMF8.

AC 038

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

(Audit course)

Instruction: 3periods per week Duration of SEE: 3 hours

CIE: 30 marks SEE: 70 marks

Credits: 00

Course Objectives

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes

After the completion of this course, the students shall be able to:

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

UNIT I

- Neetisatakam-Holistic development of personality
- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

UNIT II

- Approach to day-to-day work and duties.
- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

UNIT III

- Statements of basic knowledge.
- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16, 17, 18
- Personality of Role model. Shrimad Bhagwad Geeta:
- Chapter2-Verses 17, Chapter 3-Verses 36, 37, 42,
- Chapter 4-Verses 18, 38, 39
- Chapter18 – Verses 37, 38, 63

Suggested Reading:

1 Swami SwarupanandaAdvaita Ashram "*Srimad Bhagavad Gita",* (Publication Department), Kolkata.

2 P.Gopinath, *"Bhartrihari's Three Satakam (Niti-sringar-vairagya*)", Rashtriya Sanskrit Sansthanam, New Delhi.

CS070

MINI PROJECT WITH SEMINAR

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for systematic independent study of state of the art topics in broad area of his/her specialization.

Seminar topics can be choosen by the students with the advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.
Literature survey
Organization of material
Preparation of Power point Presentation slides
Technical writing

Each student is required to

1. Submit one page of synopsis of the seminar talk two days before for display on notice board.
2. Give 20 minutes presentation through MS-PowerPoint Presentation Slides followed by 10 minutes discussion.
3. Submit a report on the seminar topic with a list of references and slides used within a week.

Seminars are to be scheduled from the 3rd week of the last week of the semester and any change in schedule should be discouraged.
The CIE marks will be awarded to the students by atleast 2 faculty members on the basis of oral presentation and report as well as their involvement in the discussion.

CSXXX

Parallel Programming Lab Exercises

Instruction**:** 3 hrs per week CIE: 50 marks
Credits: 1.5

Course Objectives:

- Able to learn Real Time applications.

Course Outcomes:

After Completion of the course Students will be able to:

1. Develop Remote Method Invocation.
2. Establish Client Server applications.
3. Work with Hadoop Technology.

1. Write a program that has a total of 4 processes. Process with rank 1, 2 and 3 should send the messages respectively to the process with rank 0: OU, HELLO, TEST
2. Write a program to send a message from rank 0 process to rank 1 process. The message needs to be sent in a variable called "Message". The message to be sent is "OU".
3. Write a program that has a total number of 4 processes. The process with rank 0 should send ACTS letter to all the processes using Scatter call
4. Write a program to find maximum value in array of six integers with 6 processes and print the result in root process using Reduce call
5. Computation of PI using Numerical Integration method using parallel programming
6. Implement a parallel merge sort algorithm
7. Implement a parallel search algorithm
8. Implement parallel graph traversal algorithms
9. Hello world OpenCL program
10. Write an OpenCL program to add two matrices
11. Write a program to multiply two matrices using OpenCL
12. Write a program for vector addition using OpenCL
13. Hello world CUDA program
14. Usage of CUDA events for GPU timing, overlapping CPU and GPU execution
15. Demonstrates simple quick sort implemented using CUDA Dynamic Parallelism.
16. Write a program for the dot product using CUDA
17. Write a program for Matrix-vector multiplication using CUDA
18. Write a program for sparse matrix multiplication using CUDA
19. Write a program for Global reduction using CUDA

SEMESTER-III									
1	Professional Elective-V	CS151	Simulation & Modelling	3	0	0	30	70	3
		CS152	Software Project Management						
		CS153	Secure Coding Principles						
		CS154	Storage Management						
		CS217	Parallel and Distributed Databases						
		CS155	Social Media Analytics						
		CS218	Scripting Languages For Design Automation						
2	Open Elective	OE941	Business Analytics	3	0	0	30	70	3
		OE942	Industrial Safety						
		OE943	Operations Research						
		OE944	Cost Management of Engineering Projects						
		OE945	Composite Materials						
		OE946	Waste to Energy						
		OE947	Cyber Security						
		OE948	Internet of Things (IoT)						
3	Dissertation	CS181	Major Project Phase-I	0	0	20	100**		10
TOTAL				**6**	**0**	**20**	**160**	**140**	**16**

CS 151

SIMULATION AND MODELLING

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- Define the basics of simulation modelling and replicating the practical situations in organizations.
- Generate random numbers and random variates using different techniques.
- Develop simulation model using heuristic methods.
- Analysis of Simulation models using input analyzer, and output analyzer.
- Explain Verification and Validation of simulation mode.

Course Outcomes:

After Completion of the course Students will be able to:

1. Categorize the random data of a physical system into a particular type of probability distribution function.
2. Apply Chi-square test on the curve-fitting method employed on the random data of a physical system.
3. Create mathematical model to simulate for checking the correct functioning of the algorithms.
4. Evaluate on most suitable algorithm for a problem solving, after testing the different designs with modeling/simulation.

UNIT-I

Introduction to simulation: Advantages & Dis-advantages of simulation – Areas of applications, Systems and Systems Environment, Concept of a system, Discrete & Continuous system – Models, types of models, Steps in a simulation study – Examples, Discrete – Event System simulation.

UNIT-II

Overview of Statistical Models and Queuing Systems, Programming languages for Simulation: Continuous and Discrete Simulation Languages – GPSS, SIMAN, SIMSCRIPT, MATLAB and SIMULINK.

UNIT-III

Random Numbers: Generation, Properties of Random Numbers, Generation of Pseudo Random Numbers, Tests for Random Numbers.

Random Variate: Generation, Inverse Transformation Technique, Uniform Distribution, Exponential Distribution, Weibul's Distribution, Triangular Distribution, Empirical Continuous Distribution, Discrete Distributions, Direct Transformation for the Normal Distribution, Convolution Method of Erlang Distribution, Acceptance Rejection Techniques: Poisson Distribution, Gamma Distribution.

UNIT-IV

Input Data Analysis: Data Collection: Identify the Distribution, Parameter and Estimation.

Goodness of fit tests: Chi-Square Test – KS Test; Multivariate and time series input models, Verification and Validations of Simulation Models, Model Building, Verification and Validation: Verification of Simulation Models, Calibration and Validation of Models, face validity, Validation of Model Assumptions. Validation Input/output Transformations, Input/output Validation using Historical Input Data, Input/output Validation Sing Turning Test.

UNIT-V

Output Data Analysis, Stochastic, Nature of output data, Types of Simulation with respect to output Analysis, Measures of Performance and their Estimation; output Analysis for Terminating Simulations, Output Analysis for steady – State Simulations.

Comparison and Evaluation of Alternative System Designs: Comparison of several system Designs, Statistical Models for Estimating the Effect of Design Alternatives

Suggested Readings

1. Jabey Banks, John S. Cansen and Barry L. Nelson, *Discrete – Event System Simulation*, Prentice Hall of India, 2001.
2. Nursing Deo, *System Simulation with Digital computer*, Prentice Hall of India, 1979.
3. Anerill M. Law and W. David Kelton, *Simulation Modelling and Analysis*, McGraw Hill. 2001.
4. Agam kumar tyagi, MATLAB and Simulink for Engineers, Oxford Publishers, 2011

CS 152

SOFTWARE PROJECT MANAGEMENT

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives

- To introduce the conventional and evolution of software.
- Resolve the process of managing software from conventional to modern.
- Analyze the architecture of model-based software and the process flow.
- Describe the process automation, process management and its discriminants.
- Review the economics for the next generation software.

Course Outcomes

After Completion of the course Students will be able to:

1. Analyze and design the software architecture. Have an exposure for organizing and managing a software project.
2. Apply, analyze, design and develop the software project. Design various estimation levels of cost and effort.
3. Acquire the knowledge of managing, economics for conventional, modern and future software projects.

UNIT-I

Conventional Software Management, Evolution of Software Economics, Improving Software Economics, Old Way & New.

UNIT-II

Life – Cycle phases, Artifacts of the process, Model Based Software Architectures, Workflows of the Process, Checkpoints of the process.

UNIT-III

Iterative Process Planning, Project Organizations & Responsibilities, Process Automation, Project Control of Process Instrumentation, Tailoring the Process.

UNIT-IV

Modern Project profiles, Next Generation Software Economics, Modern process Transitions, Managing Contacts, Managing People & Organizing Terms.

UNIT-V

Process improvement & mapping to the CMM, ISO 12207 – an overview, programme management.

Suggested Readings

1. Walker Royce, *Software Project Management – A Unified frame work*, Pearson Education, Addision, 1998,
2. Bob Hughes and Mike Cotterell , *Software Project Management*, Tata Mc Graw Hill, 3rd Edition, 2010.
3. Watt.S. Humphery, *Managing Software Process* , Addison - Wesley, 2008.

CS 153

SECURE CODING PRINCIPLES

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives:

- To understand the various security attacks
- To learn how to recognize to coding errors
- To understand techniques for developing a secure application.

Course Outcomes:

After Completion of the course Students will be able to:

1. To understand various attacks like DoS, buffer overflow, web specific, database specific, web-spoofing attacks.
2. To demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications.
3. To identify the nature of the threats to software and incorporate secure coding practices throughout the planning and development of the product.

UNIT- I

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. IPSpoofing, Teardrop, DoS, DDoS, XSS, SQL injection, Man in middle Attack, 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.

UNIT-II

Need for secure systems: 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.

UNIT- III

Threat modeling process and its benefits: Identifying the Threats by Using Attack Trees, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization.

Secure Coding Techniques: Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks. Security Issues in C Language: String Handling, Avoiding Integer Overflows and Underflows and Type Conversion Issues- Memory Management Issues, Code Injection Attacks.

UNIT-IV

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

UNIT- V

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

Suggested Readings

1. Michael Howard and David Le Blanc," *Writing Secure Code*" ,MicrosoftPress,2nd Edition, 2004.
2. Jason Deckard, "*Buffer Overflow Attacks: Detect, Exploit, Prevent*", Syngress,1st Edition,2005.
3. Frank Swiderski and Window Snyder, "*Threat Modeling*",MicrosoftProfessional,1st Edition, 2004.

CS 154

STORAGE MANAGEMENT

Instruction : 3L hrs per week | Duration of SEE : 3 hours
CIE : 30 Marks | SEE : 70 Marks
Credits: 3

Course Objectives:

- The evolution of storage and implementation models.
- Storage devices principles including structure, host I/O processing, & core algorithms
- Storage classes (SAN, NAS. CAS), interconnection protocols, and management principles.
- Storage network design principles, Networked storage capabilities (Snaps, mirroring, virtualization).
- Backup, Business Continuity, and Disaster Recovery principles.

Course Outcomes:

After Completion of the course Students will be able to:

1. Search, retrieve and synthesize information from a variety of systems and sources.
2. Evaluate systems and technologies in terms of quality, functionality, cost-effectiveness and adherence to professional standards.
3. Integrate emerging technologies into professional practice. Apply theory and principles to diverse information contexts.

UNIT -I

Introduction to Information Storage and Management, Storage System Environment, Intelligent Storage System.

UNIT-II

Direct-Attached Storage and Introduction to SCSI, Storage Area Networks, Network-Attached Storage.

UNIT-III

IP SAN, Content-Addressed Storage, Storage Virtualization.

UNIT-IV

Introduction to Business Continuity, Backup and Recovery, Local Replication.

UNIT -V

Remote Replication, Securing the Storage Infrastructure, Managing the Storage Infrastructure.

Suggested Readings

1. G. Somasundaram, Alok Shrivastava, *Information Storage and Management*, Wiley Publishing Inc., 2009.
2. Raplh H. Thornburgh, Burry J Schoenborn, *Storage Area Networks*, Prentice-Hall, 2000.

CS 217

PARALLEL AND DISTRIBUTED DATABASES

Instruction : 3L hrs per week Duration of SEE : 3 hours
CIE : 30 Marks SEE : 70 Marks
Credits: 3

Course Objectives:

- To introduce general idea about what parallel and Distributed databases are.
- To explain the overview of what can be parallelized in DMBS (Query, Operations, Updating).
- To impart the existing architectures for parallel databases

Course Outcomes:

After Completion of the course Students will be able to:

- Describe in detail query processing and techniques involved in query optimization.
- Understand Design of Distributed DBMS Implementations.
- Master transaction processing, concurrency control and crash recovery in distributed DBMS.

UNIT- I

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

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

UNIT-II

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

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

UNIT-III

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

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

UNIT-IV

Distributed Databases: Reference architecture for DDB, Types of Data Fragmentation, Distribution Transparency for Read-only applications, Distribution Transparency for Update applications, Distributed Database Access Primitives, Integrity Constraints in DDB.

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

UNIT-V

Translation of Global Queries to Fragment Queries: Equivalence transformations for queries, transforming global queries into fragment queries, distributed grouping and aggregate function evaluation, parametric queries.

Optimization of Access Strategies: Access Control Models, Database Security, A framework for query optimization, Join queries, General queries.

Suggested Readings

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

CS155

SOCIAL MEDIA ANALYTICS

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To understand the basic of in the usage of the Internet, there has been an exponential increase in the use of online social media and networks on the Internet.
- To understand usage of internet in Social Medial Websites like Facebook, YouTube, LinkedIn, Twitter, Flickr, Instagram, Google+, Four Square, Pinterest, Tinder
- To understanding of privacy and security issues on online social media. Privacy and security of online social media need to be investigated, studied and characterized from various perspectives (computational, cultural, psychological, etc.).

Course Outcomes:

After completion of course Student will be able to:

1. Appreciate various privacy and security concerns (spam, phishing,fraud nodes, identity theft) on Online Social Media.
2. To Collect Data from OSM, analyze and visualize the Data within the context of PSOSM.
3. Clearly articulate one or two concerns comprehensively on one Online Social Media, this will be achieved by homework.

UNIT-I
Online Social Networks (OSNs): Introduction - Types of social networks (e.g., Twitter, Facebook), Measurement and Collection of Social Network Data, Social Networks - Basic Structure and Measures, Basics of Text Processing over Social Data, Entity linking and entity resolution for Social data.

UNIT II
Studying Characteristics of OSNs, Information Diffusion, Experimental studies over OSNs,Sampling

UNIT-III
Fundamentals of Social Data Analytics, Topic Models, Random Walks, Heterogeneous Information Networks

UNIT-IV
Applied Social Data Analytics, Recommendation Systems, Community identification and link prediction.

UNIT V
Online experiments for Computational Social Science, Big Data Sampling

CS 218

SCRIPTING LANGUAGES FOR DESIGN AUTOMATION

Instruction : 3L hrs per week
CIE : 30 Marks
Credits: 3

Duration of SEE : 3 hours
SEE : 70 Marks

Course Objectives:

- To introduce Decision and Repetition Structures of Scripting languages.
- To learn basics concepts and different operations on Files, strings, Dictionaries and sets.
- To introduce Object oriented features to develop real time applications.
- To understand GUI programming for design automation.

Course Outcomes:

After Completion of the course Students will be able to:

1. Use Python Programming which is a compatible scripting language to design applications.
2. Develop applications using the features of Object-oriented programming.
3. Create Graphical Interfaces for design automation.

UNIT I

Introduction to Python Programming: Program Development Cycle, Input, Processing, and Output, Variables, Performing Calculations (Operators, Type conversions, Expressions),

Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables.

Repetition Structures: Introduction, while loop, for loop, Input Validation Loops, Nested Loops.

UNIT II

Functions: Introduction, Defining and Calling a Void Function, Designing a Program to Use Functions, Local Variables, Passing Arguments to Functions, Global Variables and Global Constants, Value-Returning Functions.

Lists and Tuples: Sequences, Introduction to Lists, List slicing, Finding Items in Lists with the in Operator, List Methods and Useful Built-in Functions, Copying Lists, Processing Lists, Two-Dimensional Lists, Tuples.

UNIT III

File and Exceptions: Introduction to File Input and Output, Using Loops to Process Files, Processing Records, Exceptions.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT IV

Recursion: Introduction, Problem Solving with Recursion, Examples of Recursive Algorithms.

Object-Oriented Programming: Procedural and Object-Oriented Programming, Classes, Working with Instances, Techniques for Designing Classes, Inheritance, Polymorphism.

UNIT V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Tony Gaddis, *Starting out with Python*, Pearson College Division, 3rd Edition, 2014.
2. John V Guttag, *Introduction to Computation and Programming using Python*, MIT Press, 3rd Edition, 2016.

OE941

BUSINESS ANALYTICS
(Open Elective)

Instruction: 3periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 3

Course Objectives

- To understand the role of business analytics within an organization.
- To analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data.
- To use decision-making tools/Operations research techniques and manage business process using analytical and management tools.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the basic concepts of business analytics.
2. Identify the application of business analytics and use tools to analyze business data.
3. Become familiar with various metrics, measures used in business analytics.
4. Illustrate various descriptive, predictive and prescriptive methods and techniques.
5. Model the business data using various business analytical methods and techniques.

UNIT I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics** - Linear Programming (LP) and LP model building.

UNIT V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Suggested Readings:

1. U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017.

2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015.
+
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015.

Web Resources

1.https://online courses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

OE942

INDUSTRIAL SAFETY
(Open Elective)

Instruction: 3periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 3

Course Objectives

- To understand industrial safety and remember features of factory act 1948.
- Analyze maintenance tools, corrosion preventive measures and fault causes.
- Assess the importance of periodic inspections and maintenance.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the necessity of industrial safety and remember features of factory act 1948 for health and safety.
2. Analyze the tools used for maintenance.
3. Become thorough of the corrosion preventive measures.
4. Analyze the causes of faults and draw decision trees.
5. Understand importance of periodic maintenance and inspection procedures.

UNIT I

Industrial Safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Suggested Readings:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgraw Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OE943

OPERATIONS RESEARCH
(Open Elective)

Instruction: 3periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 3

Course Objectives

- To understand the dynamic programming to solve problems of discrete and continuous variables
- To apply the concept of non-linear programming and carry out sensitivity analysis
- To understand deterministic and probabilistic inventory control models.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Apply the dynamic programming to solve problems of discrete and continuous variables
2. Apply the concept of non-linear programming
3. Carry out sensitivity analysis
4. Understand deterministic and probabilistic inventory control models.
5. Model the real-world problem and simulate it.

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

UNIT IV

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

Suggested Readings:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

OE944

COST MANAGEMENT OF ENGINEERING PROJECTS
(Open Elective)

Instruction: 3periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 3

Course Objectives

- Introduce the concepts of cost management, inventory valuation, decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand strategic cost management process, control of cost and decision making based on the cost of the project.
2. Appreciate detailed engineering activities of the project and execution of projects
3. Prepare project report and network diagram
4. Plan Cost Behavior, Profit Planning, Enterprise Resource Planning, Total Quality Management.
5. Apply various quantitative techniques for cost management

UNIT I

Introduction: Overview of the Strategic Cost Management Process Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram.

UNIT III

Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

UNIT IV

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench

Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Readings:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi

2. Charles T. Horngren and George Foster, Advanced Management Accounting

3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher

5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OE945

COMPOSITE MATERIALS
(Open Elective)

Instruction: 3periods per week
Duration of SEE: 3 hours
CIE: 30 marks
SEE: 70 marks
Credits: 3

Course Objectives

- To understand the fundamentals of composite materials and the role of matrix and reinforcement.
- To know the principles of manufacturing composite
- To understand the strength and failure criteria of lamina and laminate.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Define a composite, identify the matrix and reinforcement and highlighting the features and application of different composite materials.
2. Classify composites, illustrate the mechanical behaviour of composites and predict properties using micromechanics principles.
3. Illustrate the manufacturing of metal matrix composites and outline the properties and applications.
4. Illustrate the manufacturing of Polymer matrix composites and outline the properties and applications.
5. Apply various failure criteria to assess the strength of lamina and laminates.

UNIT I

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT III

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Suggested Readings:

1. Material Science and Technology- Vol 13- Composites by R.W. Cahn-VCH, West Germany.
2. Materials Science and Engineering, An Introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley &Sons, NY, Indian edition, 2007.
3. Composite Materials- K. K. Chwala.
4. Composite Materials Science and Applications-Deborah D.L. Chung.
5. Composite Materials Design and Applications-Danial Gay, Suong V. Hoa and Stwphen W. Tsai.

OE946

WASTE TO ENERGY
(Open Elective)

Instruction: 3periods per week Duration of SEE: 3 hours
CIE: 30 marks SEE: 70 marks
Credits: 3

Course Objectives

- To know the various forms of waste
- To understand the processes of Biomass Pyrolysis.
- To learn the technique of Biomass Combustion.

Course Outcomes

After the completion of this course, the students shall be able to:

1. Understand the concept of conservation of waste
2. Identify the different forms of wastage
3. Chose the best way for conservation to produce energy from waste
4. Explore the ways and means of combustion of biomass
5. Develop a healthy environment for the mankind

UNIT I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Readings:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE947

CYBER SECURITY
(Open Elective)

Instruction: 3periods per week
Duration of SEE: 3 hours
CIE: 30 marks
SEE: 70 marks
Credits: 3

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies

Course Outcomes:

After Completion of the course Student will be able to:

1. Understand the various network threats.
2. Analyse the forensic tools for evidence collection.
3. Apply the firewalls for threat analysis.

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

OE948

INTERNET OF THINGS
(Open Elective)

Instruction: 3periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 3

Course Objectives:

- To understand the concepts of Internet of Things and able to build IoT applications
- To learn the programming and use of Arduino and Raspberry Pi boards.
- To know about data handling and analytics in SDN.

Course Outcomes:

After Completion of the course Student will be able to:

1. Known basic protocols in sensor networks.
2. Program and configure Arduino boards for various designs.
3. Python programming and interfacing for Raspberry Pi.
4. Design IoT applications in different domains.

UNIT – I

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.

UNIT – II

Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino,

UNIT – III

Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi

UNIT - IV

Implementation of IoT with Raspberry Pi, Introduction to Software defined Network (SDN), SDN for IoT, Data Handling and Analytics,

UNIT - V

Cloud Computing, Sensor-Cloud, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Suggested Readings:

1. "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. “Make sensors”: Terokarvinen, kemo, karvinen and villey valtokari, 1st edition, maker media, 2014. 3. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti
3. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”
4. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
5. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013

CS181

MAJOR PROJECT PHASE I

Instruction	20 Periods per week
End Semester Evaluation	70 Marks
Mid Semester Evaluation	30 Marks
Credits	10

Course Outcomes: At the end of the course, the student will be able to:

1. Synthesize knowledge and skills previously gained and apply them to new technical problem.
2. Select from different methodologies, methods and analyses to produce a suitable research design, and justify their design.
3. Present the findings of their technical solution in a written report.
4. Presenting the work in International/ National conference or reputed journals.
5. Develop oral and written communication skills to present and defend their work in front of technically qualified audience

GUIDELINES:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study.

The student shall identify the domain and define dissertation objectives. The referred literature should preferably include IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Computer Science, cyber security, parallel Algorithms and Artifical Intelligence and Machine Learning, Computing and Processing (Hardware and Software), NLP and Image Processing and Analysis and any other related domain. In case of industry sponsored projects, the relevant application notes, product catalogues should be referred and reported. The student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution, and submit the proposal within a month from the date of registration.

Evaluation for stage-I is based on mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions and must bring out individuals contribution. Continuous assessment of Project stage – I at Mid Semester and End Semester will be monitored by the departmental committee.

A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, record of continuous progress. In case of unsatisfactory performance, committee may recommend repeating the Phase-I work.

SEMESTER-IV									
1	Dissertation	CS182	Major Project Phase-II	0	0	32	0	200	16
TOTAL				**0**	**0**	**32**	**0**	**200**	**16**

CS 182

MAJOR PROJECT PHASE-II

Instruction	32 Periods per week
End Semester Evaluation	200 Marks
Credits	16

Course Outcomes: At the end of the course, the student will be able to:

1. Use different experimental techniques.
2. Use different software/ computational/analytical tools.
3. Design and develop an experimental set up/ equipment/test
4. Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
5. Either work in a research environment or in an industrial environment.
6. Present and convince their topic of study to the engineering community.

GUIDELINES:

Project stage – II will be extension of the work on the topic identified in Project stage – I. Student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study.

A dissertation should be presented in standard format as provided by the department. The candidate has to be in regular contact with his guide. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc. There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.