DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Scheme of Instruction and

Syllabus of

M.Tech (Computer Science and Engineering)

Full-Time & CEEP

2023-24

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

INSTITUTE

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students‟ heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services for the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

Vision

To be a leading academic department in the area of Computer Science and Information Technology with Learning and research processes of global standards that contribute to innovations in various scientific disciplines and societal needs and also motivate young engineers to face future technological challenges.

Mission

- To achieve excellence in teaching in the field of Computer Science and Engineering
- To promote learning in free thinking and innovative environment with the state-of-art-technologies
- To cultivate skills to promote information and communication technology
- Advancement of knowledge in various specializations of Computer Science and Engineering
- To impart skills to develop technical solutions for societal needs and inculcate Entrepreneurial talents

Programme Educational Objectives (PEO)

The graduating students of the Computer Science and Engineering program will be able:

PEO 1	To understand the principles and advanced methods in computer science and engineering, and their applications in various fields.
PEO 2	To acquire systems thinking to evaluate alternate computing solutions with economics and environmental considerations.
PEO 3	To acquire research and technical communication skills.
PEO 4	To impart professional ethics and lifelong learning skills for professional advancement.

Programme Outcomes (PO)

PO 1	An ability to apply principles, methods in design and development of software and hardware systems.
PO 2	An ability to analyze problems, developing algorithmic solutions in multiple domains
PO 3	To demonstrate the usage of software tools and technologies, industry practices in the design of software system
PO 4	Able to apply system thinking in designing and evaluation of sustainable solutions with professional ethics.
PO 5	Able to do research and develop solutions to practical problems
PO 6	Able to do systematic literature survey, identify emerging trends and prepare technical reports.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING, U.C.E., O.U
M. Tech. (COMPUTER SCIENCE AND ENGINEERING)

Type of course	Course Code	Course Name	Contact hours Per week		Scheme of Evaluation		Credits
			L	P	CIE	SEE	
SEMESTER-I							
Core-I	CS101	Mathematical Foundations of Computer Science	3	-	40	60	3
Core-II	CS102	Advanced Data Structures	3	-	40	60	3
Core-III	CS103	High Performance Computing	3	-	40	60	3
Program Elective-I	CS 111	Sentiment Analysis	3	-	40	60	3
	CS112	Advanced Compiler Design					
	CS113	Human Computer Interaction					
	CS114	Distributed Computing					
	CS 301	Artificial Intelligence and Machine Learning					
Program Elective-II	CS 121	Data Mining	3	-	40	60	3
	CS122	Information Retrieval Systems					
	CS123	Reliability and Fault Tolerance					
	CS124	Software Reuse Techniques					
	CS 311	Enterprise Architecture					
Program Elective-III	CS131	Storage Management	3	-	40	60	3
	CS132	Performance Evaluation of Computing					
	CS133	Cloud Computing					
	CS134	Scripting Language for Design Automation					
	CS525	Block Chain Technologies					
Lab-I	CS161	AWS with Dev Ops Lab -I	-	2	50	-	1
Seminar	CS166	HPC Lab -I	-	2	50	-	1
TOTAL			**18**	**4**	**340**	**360**	**20**
SEMESTER-II							
Core-IV	CS104	Generative Artificial Intelligence	3	-	40	60	3
Core–V	CS105	Bio -Informatics	3	-	40	60	3
Core-VI	CS106	Parallel and Distributed databases	3	-	40	60	3
Program Elective-IV	CS 141	Cyber Systems Security	3	-	40	60	3
	CS142	Soft Computing					
	CS143	Data Analytics					
	CS303	Deep Learning					
	CS 502	Digital Forensics					
Program Elective-V	CS151	Simulation & Modeling	3	-	40	60	3
	CS152	Secure Coding Principles					
	CS153	Image Processing and Computer Vision					
	CS304	Programming for Big Data Systems					
	CS 544	Social Media Analytics					
Open Elective	OE941BM	Medical Assistive Devices	3	-	40	60	3
	OE942BM	Medical Imaging Techniques					
	OE941CE	Green Building Technology					

	OE942CE	Cost Management of Engineering Projects					
	OE941CS	Business Analytics					
	OE941EC	Elements of Embedded Systems					
	OE941EE	Waste To Energy					
	OE942EE	Power Plant Control and Instrumentation					
	OE941ME	Operation Research					
	OE942ME	Composite Materials					
	OE943ME	Industrial Safety					
	OE941LA	Intellectual Property Rights					
Lab-II	CS361	Artificial Intelligence Lab	-	2	50	-	1
Lab-III	CS 162	Advanced Databases Lab	-	2	50	-	1
MiniProject	CS171	Mini Project	-	4	50	-	2
TOTAL			**18**	**8**	**390**	**360**	**22**
SEMESTER-III							
Audit-I	AC040	Research Methodology	2	-	40	60	0
Audit-II	AC031	English for Research Paper Writing	2	-	40	60	0
	AC032	Disaster Mitigationand Management					
	AC033	Sanskrit for Technical Knowledge					
	AC034	Value Education					
	AC035	Stress Management by Yoga					
	AC036	Personality Development through Life Enlightenment Skills					
	AC037	Constitution of India					
	AC038	Pedagogy Studies					
	AC039	E-Waste Management					
Dissertation-I	CS181	Dissertation Phase-I	-	20	100	-	10
TOTAL			**4**	**20**	**180**	**120**	**10**
SEMESTER-IV							
Dissertation-II	CS182	Dissertation Phase-II		32	100	100	16
GRANDTOTAL			**40**	**64**	**1010**	**940**	**68**

CS 101	**MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE**					
CORE - I						
Pre-requisites	Discrete Mathematics Probability and Statistics		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
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.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the basic notions of discrete and continuous probability.
CO-2	Apply the methods of statistical inference, and learn application of sampling distributions in Data mining and Machine Learning.
CO-3	Apply statistical analysis to algorithmic problems of simple to moderate complexity in different domains.
CO-4	Model different applications of Computer science as graph theory problems

UNIT – I
Density, and cumulative distribution functions, Expected value, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains.

UNIT – II
Random samples, sampling distributions of estimators**,** and Maximum Likelihood**.**

UNIT – III
Statistical inference**,** Introduction to multivariate statistical models: 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, unique factorization, Euler's function, modular arithmetic, Fermat's little theorem, Chinese remainder theorem, modular exponentiation, RSA public key encryption.

Suggested Reading:

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**					
	CORE - II					
Pre-requisites	Data Structures Design and Analysis of Algorithms		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Understand the ADT/libraries and choose appropriate data structures to design algorithms for a specific problem.
2	Understand the necessary mathematical abstraction to solve problems.
3	To familiarize students with advanced problem-solving paradigms and data structure used to solve algorithmic problems.
4	Analysis of efficiency and proofs of correctness

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the implementation of symbol table using hashing techniques.
CO-2	Develop and analyse algorithms for red-black trees, B-trees and Splay trees.
CO-3	Develop algorithms for text processing applications.
CO-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: String 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.

Suggested Reading:

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.

CS 103	**HIGH PERFORMANCE COMPUTING**					
CORE- III						
Pre-requisites	Computer Organization		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
1	To understand the concepts of Instruction Level Parallelism
2	To learn the shared and distributed memory architectures
3	To understand the cache coherency issues and solutions
4	To learn the interconnection networks and latency tolerance techniques

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Analyse the performance of pipelined processors.
CO-2	Distinguish the various architectures and cache hierarchies and its performances.
CO-3	Solve memory inconsistency problem on shared and distributed memory architectures
CO-4	Analyze the performance of interconnection networks and its latency tolerance 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, VLIW and GPU 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, Snoopybased 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, MemoryBased 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 Reading:

1	John L. Hennessy, David A. Patterson, ***Computer Architecture: A Quantitative Approach***, Morgan Kaufmann Publishers Inc., 6th Edition, 2017.
2	Id. Culler, Jaswinder Pal Singh, and Anoop Gupta, ***Parallel Computer Architecture: AHardware/Software Approach***, Morgan Kaufmann, 1999.
3	Kai Hwang, ***Advanced Computer Architecture***, Tata McGraw-Hill Education, 3rd Edition, 2017.

CS 111	**SENTIMENT ANALYSIS**					
PROGRAM ELECTIVE - I						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Understand the introducing real time problems related to sentiment extraction with an aim to bridge the gap between unstructured and structured data
2	To facilitate qualitative and quantitative analysis of opinions
3	To discuss the existing techniques for solving real time sentiment extraction problems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the problem of sentiment analysis and opinion summarization as mini NLP.
CO-2	Use text classification and ML techniques for sentiment classification of documents.
CO-3	Use rules of sentiment composition in aspect-based sentiment analysis and aspect extraction.
CO-4	Generate sentiment lexicons and analyse comparative opinions.
CO-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, CrossLanguage Sentiment Classification, Emotion classification of Documents.
Sentence Subjectivity and Sentiment Classification: Subjectivity, Sentence Sentiment Classification, Dealing with Conditional Sentences, Dealing with Sarcastic Sentences, Crosslanguage 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, Coreference 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 Reading:

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 112	**ADVANCED COMPILER DESIGN**					
PROGRAM ELECTIVE - I						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To understand Superscalar and VLIW processors, processor parallelism
2	To understand Dependence Testing, Vectorization, Loop Normalization.
3	To understand Runtime Symbolic Resolution, Packaging of Parallelism
4	To analyze Control Dependence, Loop Fusion
5	To familiarize students with Cache Management in Complex Loop Nests, Software Prefetching

Course Outcomes :	
On completion of this course, the student will be able to implement :	
CO-1	Analyze the performance of Superscalar and VLIW processors parallelism
CO-2	Apply the dependence Testing, Vectorization, Loop Normalization.
CO-3	Demonstrate the Runtime Symbolic Resolution, Packaging of Parallelism
CO-4	Analyze Control Dependence and Loop Fusion

UNIT– I

Compiler Challenges for High-Performance Architectures:
Overview and Goals, Pipelining, Vector Instructions, Superscalar and VLIW Processors, Processor Parallelism, Memory Hierarchy, Case Study: Matrix multiplication, Advanced Compiler Technology.

Dependence: Theory and Practice
Introduction, Dependence and its Properties, Simple Dependence Testing, Parallelization and Vectorization, Case Studies

UNIT – II

Dependence Testing:
Introduction, Background and Terminolog, Dependence Testing Overview, Single-Subscript Dependence Tests, Testing in Coupled Groups, An empirical study, Putting It All Together, case studies

Preliminary Transformations:
Introduction, Information Requirements, Loop Normalization, Data Flow Analysis, Induction-Variable Exposure, case studies.

UNIT – III Enhancing Fine-Grained Parallelism:

Overview, Loop Interchange, Scalar Expansion, Scalar and Array Renaming, Node Splitting, Recognition of Reductions, Index-set Splitting, Run-time Symbolic Resolution, Loop Skewing, Putting It All Together, Complications of Real Machines, Case Studies. Creating Coarse-Grained Parallelism: Introduction , Single-Loop Methods, Perfect Loop Nests, Imperfectly Nested Loops, An Extended Example, Packaging of Parallelism, Case Studies

UNIT– IV

Control Dependence:
Introduction, If Conversion, Control Dependence, Case Studies **Compiler Improvement of Register Usage:**
Introduction, Scalar Register Allocation, Scalar Replacement, Unroll-and-Jam, Loop Interchange, Loop Fusion, Putting It All Together, Complex Loop Nests, Case Studies

UNIT –V

Cache Management:
Introduction, Loop Interchange, Blocking, Cache Management in Complex Loop Nests, Software Pre fetching .
Scheduling:
Overview, Instruction Scheduling , Vector Unit Scheduling, Case Studies **Inter procedural Analysis and Optimization:**
Introduction, Inter procedural Analysis, Inter procedural Optimization, Managing Whole-Program Compilation, Case Studies

Suggested Reading:

1	Randy Allen & Ken Kennedy **— Optimizing Compilers for Modern Architectures" Publishers -**Morgan Kaufmann, 4 October – 2001.
2	Ken Kennedy & John R. Allen Optimizing compilers for modern architectures: a dependence-based approach, Morgan Kaufmann, October – 2001.

CS 113	**HUMAN COMPUTER INTERACTION**					
PROGRAM ELECTIVE - I						
Pre-requisites	Computer Graphics GUI programming		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce the concepts of user goals , conceptual models and process of interaction design
2	To study cognitive , social and emotional aspects of interaction
3	To learn Data Analysis, Interpretation, and Presentation techniques
4	To learn the concepts of prototyping and discovering user requirements
5	To introduce the concepts of controlled evaluation and Walk-Throughs

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of user experience design , interaction types , and frameworks
CO-2	Use cognitive frameworks , principles of social interaction in the design of interfaces
CO-3	Gather data and use various quantitative and qualitative analytic techniques
CO-4	Design prototypes and develop personas
CO-5	Use predictive models and conduct usability testing

UNIT– I

Interaction Design: Introduction, Good and Poor Design, what is Interaction Design, The User Experience, Understanding UsersAccessibility and Inclusiveness, Usability and User Experience Goals

Process of Interaction Design: Introduction, What is Involved in Interaction Design, Practical Issues,

Conceptualizing Interaction: Introduction,ConceptualizingInteraction,Conceptual Models, Interface Metaphors, Interaction Types, Paradigms, Visions, Theories, Models, and Frameworks

UNIT– II
Cognitive Aspects: Introduction, What is Cognition, Cognitive Frameworks, **Social Interaction:**Introduction, Being Social ,Face-to-Face Conversations, Remote Conversations, Co-presence, Social Engagement **Emotional Interaction:** Introduction, Emotions and the User Experience,Expressive Interfaces and Emotional Design, Annoying Interfaces, Affective Computing and Emotional AI , Persuasive Technologies and Behavioural Anthropomorphism Change.

UNIT– III
Interfaces : Introduction , Interface Types , Natural User Interfaces and Beyond, Which Interface **Data Gathering:** Introduction, Five Key Issues ,Data Recording, Interviews, Questionnaires, Observation, Choosing and Combining Techniques **Data Analysis, Interpretation, and Presentation :**Introduction, Quantitative and Qualitative,Basic Quantitative Analysis, Basic Qualitative Analysis, Kind of Analytic Framework to Use, Tools to Support Data Analysis, Interpreting and Presenting the Findings

UNIT– IV
Discovering Requirements: Introduction, Data Gathering for Requirements, Bringing Requirements to Life: Personas and Scenarios, Capturing Interaction with Use Cases **Design, Prototyping, and Construction:** Introduction, Prototyping, Conceptual Design, Concrete Design, Generating Prototypes, Construction **Interaction Design in Practice:** Introduction,AgileUX, Design Patterns ,Open Source Resources, Tools for Interaction Design.

UNIT–V
Introducing Evaluation: Introduction ,Types of Evaluation, Evaluation Case Studies, Case Studies, Other Issues to Consider in Evaluation **Evaluation Studies: From Controlled to Natural Settings:** Introduction ,Usability Testing, Conducting Experiments, Field Studies **Evaluation: Inspections, Analytics, and Models:** Introduction ,Inspections: Heuristic Evaluation and Walk-Throughs,Analytics and A/B Testing, Predictive Models.

Suggested Reading:

1	Helen Sharp, Jennifer Preece, Yvonne RogersInteraction Design: Beyond HumanComputer Interactionwiley Publishing 5th Edition 2019
2	Jenifer Tidwell, Charles Brewer, AynneValencia,DesigningInterfaces,O'REllIEY 3rdEdition 2020
3	Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, About Face: The Essentials of Interaction Design Wiley, 4th Edition 2014
4	**Elizabeth Goodman, Mike Kuniavsky,**Observing the User Experience,Elsevier 2ndEdition 2012
5	Jesmond Allen, James Chudley,Smashing UX Design,Wiley ,1st Edition 2012

CS 114	**DISTRIBUTED COMPUTING**					
PROGRAM ELECTIVE - I						
Pre-requisites	Operating Systems		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To understand fundamental concepts of distributed computing and its design.
2	To know different protocols involved in communication.
3	To gain the knowledge on process model.
4	To develop the understanding of distributed object based & distributed multimodal Systems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-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.
CO-2	Explain the necessary structures and alternative approaches to design solutions.
CO-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, HigherLevel 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 Reading:

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

CS 301	**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**					
CORE-III						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To familiarize the principles of Artificial Intelligence
2	To study the techniques for knowledge representation and inference
3	To learn the techniques involved in the creation of intelligent systems
4	To study different applications like Game Playing Expert Systems, machine learning and natural language processing

Course Outcomes :	
On completion of this course, the student will be able to:	
CO-1	Use different logical systems for inference over formal domain representations.
CO-2	Formalize a given problem in the language/framework of different AI methods
CO-3	Design and perform an empirical evaluation of different algorithms on a problem formalisation

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 mini max 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 Reading:

1	Stephen Lucci, Danny Kopec. Artificial Intelligence iMercury 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 121	**DATA MINING**					
PROGRAM ELECTIVE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Explain different data mining tasks and the algorithms.
CO-2	Evaluate models/algorithms with respect to their accuracy.
CO-3	Conceptualize a data mining solution to a practical problem
CO-4	Develop hypotheses based on the analysis of the results obtained and test them.

UNIT – I
Introduction: 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 Reading:

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

CS 122	**INFORMATION RETRIEVAL SYSTEMS**					
PROGRAM ELECTIVE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the algorithms and techniques for information retrieval (document indexing and retrieval, query processing).
CO-2	Quantitatively evaluate information retrieval systems.
CO-3	Classify and cluster documents.
CO-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.

P**robabilistic 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 completelink clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering.

UNIT –V

Matrix decompositions and latent semantic indexing: Linear algebra review, Termdocument matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing.

Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.

Web crawling and Indexes: Overview, Crawling, Distributing indexes, Connectivity servers. Link analysis: The Web as a graph, Page Rank, Hubs and Authorities.

Suggested Reading:

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

CS 123	**RELI ABILITY AND FAULT TOLERANCE**					
PROGRAM ELECTIVE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Understand the risk of computer failures and their peculiarities compared with other system failures
2	Identify the software reliability in terms of fulfilling the user requirements.
3	Find out the fault tolerance computers

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Deal with repairable and non-repairable systems by following reliability Engineering principles.
CO-2	Design the systems with fault avoidance.
CO-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 Nonrepairable 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 Reading:

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 124	**SOFTWARE REUSE TECHNIQUES**					
PROGRAM ELECTIVE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce Software engineering and its reusability techniques to work with different design patterns.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand different design patterns and analyse them to enhance software reusability.
CO-2	Evaluate Structural patterns and behavioural patterns.
CO-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 Reading:

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, KevlinHenney, Douglas C. Schmidt, Pattern Oriented Software Architecture , Wiley 1996.
4	James W Cooper, Java Design Patterns, A Tutorial, Addison Wesley Publishers 2000

CS 311	**ENTERPRISE ARCHITECTURE**					
PROGRAM ELECTIVE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Learn the fundamentals of EA
2	Study the business architecture
3	Understand the organizational structure of EA
4	Comprehend enterprise engineering
5	Gain insights into cloud computing opportunities for EA

Course Outcomes *:*	
On completion of this course, the student will be able to :	
CO-1	Learn the fundamentals of EA.
CO-2	Study the business architecture
CO-3	Understand the organizational structure of EA
CO-4	Comprehend enterprise engineering
CO-5	Gain insights into cloud computing opportunities for EA

UNIT – I
Introduction to EA -System analysis, general system theory, definitions and objectives of considerations, Properties of EA, system approach to EA development, principle definitions

UNIT – II
Business architecture, definition and features, BSC – balanced score card basics and its reflection in EA, Strategic governance, Event Causality effects in EA under scope of BS

UNIT– III
Organizational structure of EA and basic models, Information and technology architecture basics, Introduction to EA structuring and modeling, Business architecture (inc. business process modeling, IBM Component business model), Information architecture, Technology architecture and integration between the layers model

UNIT – IV
Introduction to enterprise engineering (EE), Enterprise transformations (waterfall and agile), EAP, EA methodologies: PRISM, ARIS Framework, Zachmann Framework , FEAF, DODAF and TOGAF, Introduction to Service orientation in Enterprise Engineering (SOA, SoEA), Technological infrastructure for Big Data handling in EA

UNIT –V
Cloud Computing Opportunities for EA, Flexible (agile) business and information architectures (SoEA). Introduction to Spark, Spark Data Frames, SQL, Datasets through worked examples. Spark's low level APIs, RDDS, execution of SQL & Data Frames. How Spark Runs on a Cluster. Structured Streaming, Spark's Stream – Processing Engine.

Suggested Reading:

1	" Designing Enterprise Architecture Frameworks: Integrating Business Processes with IT Infrastructure by N Zarvić, R Wieringa. Apple Academic Press (19 April 2016), 360 p. URL: https://doi.org/10.1201/b16417
2	" Neubauer M., Stary CH., S-BPM in the Production Industry. Stakeholder approach, Springer Open, 2017. URL: https://www.springer.com/gp/book/9783319484655
3	A systematic literature review on Enterprise Architecture Implementation Methodologies by Babak D., Mohd N. Elsevier (June 2015), p. 1-20. URL: https://doi.org/10.1016/j.infsof.2015.01.012
4	Spark : The Definite Guide – Bill Chambers, MateiZaharia, 2018.

CS 131	**STORAGE MANAGEMENT**					
	PROGRAM ELECTIVE - V					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	The evolution of storage and implementation models
2	Storage devices principles including structure, host I/O processing, & core algorithms
3	Storage classes, interconnection protocols, and management principles
4	Storage network design principles, Networked storage capabilities (Snaps, mirroring, virtualization)
5	Backup, Business Continuity, and Disaster Recovery principles

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Search, retrieve and synthesize information from a variety of systems and sources.
CO-2	Evaluate systems and technologies in terms of quality, functionality, cost-effectiveness and adherence to professional standards.
CO-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 Reading:

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 132	**PERFORMANCE EVALUATION OF COMPUTING**					
PROGRAM ELECTIVE - III						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To learn principles of system modelling and general measurement principles.
2	To learn the concepts of stochastic processes and queuing models.
3	To understand the basics of simulation techniques, experimental design and Tools.
4	To understand the application of system modelling and simulation techniques to operating systems, database systems and computer communication systems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Describe performance evaluation models, metrics, factors and parameters.
CO-2	Select appropriate evaluation techniques and workloads for a system.
CO-3	Design measurement and simulation experiments.
CO-4	Use simple queuing models to analyze the performance of systems.
CO-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, ColoredPt 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 Reading:

1	Paul. J. Fortier and Howard E. Michel, Computer Systems Performance Evaluation and Prediction, First 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 133	**CLOUD COMPUTING**					
PROGRAM ELECTIVE - III						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the basic approaches and Core ideas of Cloud Computing.
CO-2	Understand the Challenges and approaches in the management of the Cloud environments.
CO-3	Familiarize with advanced paradigms and solutions necessary for building and managing modern Cloud environments.
CO-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 Reading:

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 134	**SCRIPTING LANGUAGES FOR DESIGN AUTOMATION**					
PROGRAM ELECTIVE - III						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Use Python Programming which is a compatible scripting language to design applications.
CO-2	Develop applications using the features of Object-oriented programming.
CO-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 Reading:

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.

CS 525	**BLOCK CHAIN TECHNOLOGIES**					
PROGRAM ELECTIVE - III						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To Introduce the Theoretical Foundations of blockchain through bitcoin.
2	To Introduce Hash functions and Transactions.
3	To Study Algorithms for Mining and Consensus implementation.
4	To Study Ethereum and Smart contracts concepts.
5	To Learn the concepts of Oracles and Decentralized Applications (DApps).

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the principles of blockchain technologies and bitcoin
CO-2	Be familiar with hash functions with wallets
CO-3	Understand mining and consensus strategies
CO-4	Understand Ethereum and tockens
CO-5	Understand smart contracts of ethereum
CO-6	Understand Oracles and Decentralized Applications.

UNIT – I
Introduction What is Bitcoin ,Bitcoin Uses, Users ,Getting Started ,Getting your first bitcoins ,Sending and receiving bitcoins, Transactions, Blocks, Mining, The Genesis Block,Merkle Trees,Block Header Hash and the Blockchain
Keys, Addresses, Wallets Introduction of Crptography, Public key cryptography and crypto-currency, Private and Public Keys, Elliptic Curve Cryptography Explained Generating a public key, Bitcoin Addresses, Base58 and Base58Check Encoding Key Formats, Implementing Keys and Addresses ,Wallets ,Non-Deterministic (Random) Wallets ,Deterministic (Seeded) Wallets ,Mnemonic Code Words, Hierarchical Deterministic Wallets (BIP0032/BIP0044), Advanced Keys and Addresses, Encrypted Private Keys (BIP0038), Pay To Script Hash (P2SH) and Multi-Sig Addresses ,Vanity Addresses ,Paper Wallets

UNIT – II

Transactions

Introduction of Transaction Lifecycle, Creating Transactions, Broadcasting Transactions to the Bitcoin Network, Propagating Transactions on the Bitcoin Network, Transaction Structure, Transaction Outputs and Inputs, Transaction Outputs, Transaction Inputs ,Transaction Fees ,Adding Fees to Transactions Transaction Chaining and Orphan Transactions, Transaction Scripts and Script Language ,Script Construction (Lock + Unlock) ,Scripting Language ,Turing Incompleteness ,Stateless Verification ,Standard Transactions ,Pay to Public Key Hash (P2PKH) ,Pay-toPublic-Key ,Multi-Signature ,Data Output (OP_RETURN) Pay to Script Hash (P2SH)

Mining and Consensus

De-centralized Consensus, Independent Verification of Transactions, Mining Nodes , Aggregating Transactions into Blocks, Transaction Age, Fees, and Priority, The Generation Transaction, Coinbase Reward and Fees, Structure of the Generation Transaction, Coinbase Data, Constructing the Block Header, Mining the Block, Proof-of-Work Algorithm ,Difficulty Representation ,Difficulty Target and Re-Targeting ,Successfully Mining the Block , Validating a New Block ,Assembling and Selecting Chains of Blocks ,Blockchain Forks, Mining and the Hashing Race, The Extra Nonce Solution ,Mining Pools ,Consensus Attacks

UNIT – III

What Is Ethereum

Compared to Bitcoin, Ether Currency Units, Choosing an Ethereum Wallet Control and Responsibility, Getting Started with MetaMask, Creating a Wallet Switching Networks, Getting Some Test Ether, Sending Ether from MetaMask Exploring the Transaction History of an Address, Introducing the World Computer Externally Owned Accounts (EOAs) and Contracts, A Simple Contract: A Test Ether Faucet.

Cryptography

Ethereum‘s Cryptographic Hash Function: Keccak-256, Ethereum Addresses, Ethereum Address Formats, Inter Exchange Client Address Protocol, Hex Encoding with Checksum in Capitalization (EIP-55)

The Ethereum Virtual Machine

What Is the EVM? Comparison with Existing Technology, The EVM Instruction Set (Bytecode Operations), Ethereum State ,Compiling Solidity to EVM Bytecode ,Contract Deployment Code ,Disassembling the Bytecode

UNIT – IV

Transactions

Transmitting Value to EOAs and Contracts,Transmitting a Data Payload to an EOA or Contract,Special Transaction: Contract Creation ,Digital Signatures ,The Elliptic Curve Digital Signature Algorithm ,How Digital Signatures Work ,Verifying the Signature ,ECDSA Math ,Transaction Signing in Practice ,Raw Transaction Creation and Signing ,Raw Transaction Creation with EIP-155 ,The Signature Prefix Value (v) and Public Key

Recovery, Separating Signing and Transmission (Offline Signing) ,Transaction Propagation ,Recording on the Blockchain ,Multiple-Signature (Multisig) Transactions
Tokens How Tokens Are Used ,Tokens and Fungibility ,Counterparty Risk ,Tokens and Intrinsicality ,Using Tokens: Utility or Equity ,ERC223: A Proposed Token Contract Interface Standard ,ERC777: A Proposed Token Contract Interface Standard ,ERC721: Nonfungible Token (Deed) Standard

UNIT –V
Oracles Why Oracles Are Needed, Oracle Use Cases and Examples, Oracle Design,Patterns Data Authentication,Computation Oracles, Decentralized Oracles, Oracle Client Interfaces in Solidity
Decentralized Applications (DApps) What Is a DApp, Backend (Smart Contract), Frontend (Web User Interface), Data Storage, Decentralized Message Communications Protocols, A Basic DApp Example: Auction DApp, Auction DApp: Backend Smart Contracts, Auction DApp: Frontend User Interface ,Further Decentralizing the Auction DApp ,Storing the Auction DApp on Swarm ,Preparing Swarm ,Uploading Files to Swarm ,The Ethereum Name Service (ENS) ,History of Ethereum Name Services ,The ENS Specification ,Bottom Layer: Name Owners and Resolvers ,Middle Layer: The .eth Nodes ,Top Layer: The Deeds,Registering a Name, Managing Your ENS Name, ENS Resolver, Resolving a Name to a Swarm Hash (Content), From App to DApp

Suggested Reading:

1	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, **Bitcoin and Cryptocurrency Technologies, P**rinceton university press Princeton and Oxford.
2	Andreas M. Antonopoulos**, Mastering Bitcoin: Programming the Open Blockchain,** O'Reilly.
3	Dr. Gavin Wood, Andreas M. Antonopoulos**, Mastering Ethereum: Building Smart Contracts and Dapps,** O'Reilly.

CS 161	**AWS with Dev Ops LAB-I**					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
1	To introduce fundamental concepts of cloud computing with focus on AWS architecture and services.
2	To enable students to design and manage secure VPCs, EC2 instances, and load balancers
3	To provide hands-on experience in cloud storage, networking, monitoring, and automation using AWS tools
4	To develop skills in database deployment, container orchestration, and serverless computing using AWS services
5	To equip students with knowledge of cloud security, DevOps tools, and infrastructure automation using IaC tools like CloudFormation and Terraform.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Explain the principles of cloud computing and compare on-premise vs cloud infrastructure
CO-2	Design and configure secure, scalable VPC environments and EC2 instances in AWS.
CO-3	Implement AWS services for load balancing, storage, monitoring, and database management.
CO-4	Deploy containerized applications using ECS, EKS, and manage serverless apps with Lambda
CO-5	Automate infrastructure deployment using CloudFormation and Terraform and integrate DevOps tools for CI/CD.

AWS Modules

Module 1:

- Introduction to Cloud Computing
- Introduction to AWS & Azure Cloud Computing
- Understanding differences between On-premises and Cloud architecture.
- Understanding AWS Regions & Availability Zones.
- Understanding IP Addressing & Sub-netting.
- Understanding Shared Infra Structure and Isolation in AWS Cloud.

Module 2:

- What is a VPC(Virtual Private Cloud)?
- VPC Architecture and Internal working of VPC.
- Design and Deploy Virtual Private Cloud.
- Create Subnets, Internet gateway, Routing, Security Groups and deploy EC2 machine with Key Pair.

Module 3:

- What is VPC Peering?
- Single & Multi-Region VPC Peering.
- Configure Intra VPC and Inter-VPC Peering.
- Real time use cases of AWS VPC Peering.
- Problems with VPC Peering and solutions.

Module 4:

- What is Network Address Translation?
- Configuring a NAT Gateway.
- Securing inbound connectivity with NAT Gateway.
- Understanding VPC Endpoints.
- Testing the use case with VPC End Points.

Module 5:

- How to monitor & secure VPC traffic?
- What is a Security Group(SG)?
- What is Network Access Control List (NACL)?
- Differentiate SG vs NACL?
- Testing Security Group & NACL
- Understanding AWS Network Firewall
- Creating Rule Groups, Firewall Policy and Deploy Firewall.
- Restricting Websites and Application traffic using AWS Network Firewall.
- Working with DNS Firewall

Module 6:

- Overview of VPN Connectivity between AWS and On-Prem DC?
- What is a Virtual Private Gateway(VPG)?
- Creating a Virtual Private Gateway and establish VPN Connection?
- Testing the VPN Connectivity between On-Premises and AWS on private networks.
- Integrating AWS VPC with Azure using Site-to-Site VPN.
- Deploying Transit Gateway for VPN Connectivity.
- VPC Peering Configuration & use cases.

Module 7:

- Introduction to EC2 Instances and deployment options.
- EC2 Metadata, Variable Creation and AMI Creation
- EC2 Launch Templates, Spot Instances & Reservations.
- Introduction to Elastic Block Storage(EBS) and Instance Store.
- Creating and configuration EBS Storage.
- Understanding AWS Snapshots.
- Performing EBS backup using Snapshots and Life Cycle Manager

Module 7:

- Introduction to Application & Network Load Balancer.
- Difference between Targets Groups and Load Balancer.
- Deploy and Configure Network Load Balancer and perform load balancing.
- Simulate Network Load Balancing Scenarios.
- Deploy and configure Application Load Balancing.
- Simulate Path-Based load balancing using multi-target groups.
- SSL Certificate configuration using AWS Certificate Manager and 3rd Party Certificate Authorities.
- Integrating NLB and ALB with Route53 Zones.

Module 9:

- Introduction to EC2 Auto Scaling
- Creating Custom AMI for Auto Scaling.
- AMI Automation with HashiCorp Packer.
- Creating Launch Configuration and Auto Scaling Groups
- Deploy the machines behind NLB and perform CPU stress testing
- Simulate Auto Scaling Scenarios

Module 10:

- Introduction to AWS Systems Manager
- Using SSM RUN command for EC2 configuration Management.
- Using SSM session manager for EC2 console access.
- Overview on SSM Patching and Automation
- AWS SMS Parameter Store
- Accessing Sessions Managed using VPC Endpoints.

Module 11:

- Introduction to AWS Simple Storage Service(S3)
- Creating S3 buckets, versioning, static hosting and log configuration
- Creating bucket policies for granular S3 items access
- Creating Bucket wide replication and Life Cycle Policies.
- Introduction to Elastic File System (EFS)
- Creating EFS between AZs and testing data consistency.
- Introduction to Storage Gateway and Deploying it.
- Introduction to AWS Glacier and creating vaults.
- Introduction to FSx and AWS Backup

Module 12:

- Introduction Databases and SQL vs NoSQL
- Deploy MySQL RDS Multi-AZ Database
- Create a new DB on RDS and alter the data.
- Perform Failover and Failback of RDS Database
- Introduction to DynamoDB
- Create a Serverless application using DynamoDB, API Gateway & AWS Lambda.
- Introduction to AWS RedShift
- Create RedShift Cluster and upload data , query the data.
- Introduction to ElastiCache

Module 13:

- Introduction Cloudwatch, Dashboards, Alarms,
- Cloud Watch Logs and Schedules with Lambda
- Infra as a Code(IaaC) with Cloudformation and version with GitHub
- AWS AP & Resource audit with Cloud Trial & AWS Config.
- Working with Trusted Advisor, Service Catalog, License Manager & Personal Health Dashboard.

Module 14:

- Introduction to AWS IAM (Identity & Access Management)
- Creating Users, Roles, Groups and Security Policies.
- Restricting User Access and Cross Account Roles.
- Deploy AWS AD Directory Service, Create AWS Organization.
- Integration AWS Active Directory Service with Single Sign On.
- Introduction to AWS Resource Access manager(RAM), Inspector and Guard Duty.
- Understanding Cognito, KMS, Macie, CloudHSM & WAF.

Module 15:

- Introduction AWS Certificate Manager
- Creating SSL Certificates in ACM and Importing 3rd Party certificates with ACM.
- Create Route 53 domain and Application Load Balancer.
- Import SSL certificates to Load Balancer and convert HTTP to HTTPS
- Configuring Route53 Failover Policies.
- Introduction to CloudFront.
- Configuring S3 Static Website with CloudFront.
- Introduction to AWS Direct Connect and Global Accelerator.

Module 16:

- Introduction to Container Services.
- Installing and configuring Docker.
- Understand Docker Hub and download images.
- Creating containers on Docker pushing images to Docker Hub.
- Introduction to ECR and ECS.
- Creating a repository in ECR and uploading the images
- Create ECS Cluster with EC2 Machines.
- Creating Task Definitions for deploying containers.
- Deploy Tasks and Services on ECS Cluster.
- Deploy applications using Fargate.
- Deploying AWS EKS Cluster.
- Deploying PODs, Deployments & Services on EKS.

Module 17:

- AWS migration overview
- Deploying AWS Service Migration Service.
- Integrate SMS with VMware vSphere environment.
- Create replication job for copying On-prem machine to AWS.
- Introduction to Database Migration Service (DMS).
- Overview of migration a MySQL to RDS using DMS.
- Migrate data using DataSync.
- Introduction of AWS Migration Hub.

Module 18:

- Introduction to AWS Developer Tools.
- Create code repository and version control with CodeCommit.
- Understanding AWS CodeBuild.
- Building the Code from CodeCommit to WAR file using Code Build.
- Deploying Code with AWS Code Deploy.
- Creating Code pipelines and integrating with GitHub..
- Introduction to SNS/SES/SQS & Step Functions.

Module 19:

- Introduction to Automation & Configuration Tools.
- Understanding Infra as a Code(IaaC)
- Deploy infrastructure using Cloudformation, Stacksets.
- Cloudformation macros and Nested stacks.
- Introduction to Terraform.
- Understanding Terraform Vs CloudFormation.
- Deploying & Destroying AWS environment with Terraform.

Module 20:

- Understanding AWS Lambda.
- Creating functions using Python in Lambda and understanding contexts and events.
- Introduction to Boto Library and integrating with Lambda.
- Integrating AWS Lambda with other AWS Services.

CS 166	**HPC Lab-I**					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
1	To learn and apply basic Linux commands for distributed computing environments.
2	To set up and configure a Beowulf Cluster using the MPI library.
3	To install, configure, and execute sample applications on Alchemi Grid and GridSim Toolkit.
4	To understand and simulate cloud computing environments using cloud simulation toolkits.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Execute essential Linux commands and create a functional Beowulf Cluster using MPI
CO-2	Configure and analyze distributed applications using Alchemi Grid.
CO-3	Simulate and run programs using GridSim for grid computing analysis.
CO-4	Demonstrate the setup and simulation of cloud computing environments using relevant toolkits.

LIST OF PRACTICALS:

1. To study the basic commands of linux.
2. To establish Beowulf Cluster using MPI(Message Passing Interface) Library.
3. Installation and configuration of Alchemi Grid.
4. Running a sample application on Alchemi Grid and analysing it.
5. To study a Grid Simulation Toolkit.
6. To run two sample programs using GridSim Toolkit.
7. To study a Cloud Simulation Toolkit.
8. To setup Cloud.

SEMESTER-II

CS 104	**GENERATIVE ARTIFICIAL INTELLIGENCE**					
CORE-IV						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Understand and implement modern generative models for text, images, and other modalities
2	Adapt foundation models using prompting and fine-tuning techniques
3	Analyze scaling laws, attention mechanisms, and diffusion processes
4	Develop applied generative AI solutions with real-world impacts
5	Explore ethical considerations, risks, and interpretability challenges of generative AI

Course Outcomes :	
On completion of this course, the student will be able to:	
CO-1	Build and evaluate generative models like RNNs, Transformers, GANs, and VAEs
CO-2	Apply in-context learning, parameter-efficient tuning, and reinforcement learning from human feedback (RLHF)
CO-3	Analyze the architecture and optimization of large foundation models for diverse modalities
CO-4	Explore cutting-edge applications such as text-to-image generation, code generation, and autonomous agents
CO-5	Evaluate ethical, safety, and interpretability issues in generative AI systems

UNIT– I

Text Generation & Language Models :
- Introduction to RNN, LSTM, and Transformer-based language models
- Decoding strategies (sampling, beam search)
- Pre-training & fine-tuning
- Foundation models (e.g., GPT, T5, BERT)
- Applications: Chatbots, text completion, summarization

UNIT – II

Generative Models for Images & Diffusion
- CNNs and Vision Transformers
- Generative Adversarial Networks (GANs)
- Diffusion models: Denoising Score Matching, DDPM
- Variational Autoencoders (VAEs)
- Applications: Text-to-image (DALL·E), image inpainting

UNIT – III
Adaptation & Control of Generative Models - In-context learning - Prompt engineering and Prompt-to-Prompt - Fine-tuning: LoRA, Adapter tuning - Reinforcement Learning from Human Feedback (RLHF) - Applications: Instruction tuning, controlled generation

UNIT– IV
Scaling Laws & Efficient Training - Scaling laws in deep learning - Mixture-of-Experts (MoE) - Efficient attention: FlashAttention, Longformer - Parallel and distributed training - Applications: Efficient deployment of large models

UNIT –V
Multimodal, Ethical & Emerging Applications - Multimodal models: CLIP, Flamingo, Video Generation - Generative models for code (Codex), agents (AutoGPT) - Interpretability and hallucinations - AI alignment, safety, and bias mitigation

Suggested Reading:

1	Vaswani et al. (2017), Radford et al. (2019) for Unit-I topics
2	Goodfellow et al. (2014), Ho et al. (2020), Kingma & Welling (2014) for Unit-II topics
3	Ouyang et al. (InstructGPT), DPO (2023) for Unit-III topics
4	Kaplan et al. (2020), Shazeer et al. (MoE), DAO models for Unit-IV topics
5	OpenAI Codex, DeepMind's Flamingo, Survey on Hallucination in LLMs for Unit-V topics

CS 105	BIO INFORMATICS					
CORE -V						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To understand the fundamentals, scope, and applications of bioinformatics in biotechnology
2	To introduce various biological databases and develop skills in information retrieval.
3	To explain sequence alignment techniques and scoring matrices for similarity searches.
4	To familiarize students with homology modeling and phylogenetic tree construction.
5	To expose students to advanced topics such as DNA mapping, sequencing methods, and comparative genomics.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify and explain the role of bioinformatics in biological research and biotechnology
CO-2	Utilize primary and secondary biological databases for data retrieval and analysis.
CO-3	Perform and interpret sequence alignments using algorithms and scoring matrices
CO-4	Construct phylogenetic trees and apply homology modeling tools for protein structure prediction
CO-5	Analyze sequencing data and perform comparative sequence analysis using bioinformatics tools

UNIT– I

Introduction to Bioinformatics

Need of Computers in Biotechnology; History, Scope & Applications of Bioinformatics, Elementary commands and protocols, ftp, telnet, http.

UNIT – II

Data Bases

Primary Data Base Information:

Introduction to Biological databases, Organization and management of databases. Searching and retrieval of information from the World Wide Web. Structure databases - PDB (Protein Data Bank), Molecular Modeling Databases (MMDB). Primary Databases NCBL, EMBL, DDBJ.

Secondary Data Base:Introduction to Secondary Databases Organization and management of databases Swissprot, PIR, KEGG.

Biochemical Data Bases: Introduction to BioChemical databasesorganization and Management of databases. KEGG, EXGESCY, BRENDA, ERGO.

UNIT – III
Sequencing Alignment and Scoring Matrices Aligment-Local, Global alignment, pair wise and multiple sequence alignments, Concept of gap penalty and e-value, Alignment algorithms, Dynamic programming in sequence alignment: Neddleman-Wunsch Aligorithm and Smith-Waterman Algorithm, Amino acid substitution Matrices (PAM, BLOSUM). Sequence similarity search with database: BLAST and FASTA.

UNIT – IV
Homology and Phylogenetic analysis Introduction to Homology, Levels of protein structures, Homology modeling of proteins (sequence to structure), Cn3D, RasMol and SPDbV in homology modeling-case studies. Introduction to phylogenetics, Methods of Phylogenetic analysis, Role of multiple sequence alignment algorithms in Phylogenetic analysis, Automated Tools for Phylogenetic Analysis, Construction of phylogenetic tree.

UNIT –V
Special Topics in Bioinformatics DNA mapping and sequencing, Map alignment, Large scale sequencing methods: Shotgun and Sanger method. cDNA sequencing; Genome Mapping, Map assembly, Comparative Sequence analysis.

Suggested Reading:

1	Bioinformatics. David Mount, 2000. CSH Publications
2	Essential Bioinformatics by Jin Xiong, Cambridge University Press, 2011

CS 106	**PARALLEL AND DISTRIBUTED DATABASES**					
PROGRAM ELECTIVE - VI						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Understand the abstractions and details of distributed database management system
2	To Introduce distributed database design issues and semantic integrity control
3	To learn concepts of distributed query processing and multidatabase query processing
4	To learn distributed DBMS reliability and replication
5	To learn distributed object management and peer-to-peer database management systems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concepts and issues related to distributed database systems architectures
CO-2	Design distributed databases using top-down and bottom-up approach
CO-3	Understand semantic integrity control and distributed query processing
CO-4	Understand reliability issues and implement replication protocols
CO-4	Understand concepts of distributed object management and implement P2P schema mapping

UNIT – I
Distributed Databases: Distributed DBMS, Architectural Models for DDBS, Distributed DBMS Architecture, Distributed Data Sources **Distributed Database Design Issues &Integration** : Framework of Distribution , Distributed Design Issues, Top-Down Design Process , Fragmentation, Allocation

UNIT – II
Data Integration: Bottom-Up Design Methodology, Schema Matching, Schema Integration, Schema Mapping, Data Cleaning **Data and Access Control :** Database Security, Discretionary Access Control, Multilevel Access Control, Distributed Access Control, View Management, Views in Centralized DBMSs, Views in Distributed DBMSs, Maintenance of Materialized Views

UNIT – III
Query Decomposition and Data Localization: Query Decomposition, Localization of Distributed data **Optimization of Distributed Queries:** Query Optimization, Centralized Query Optimization, Join Ordering in Distributed Queries, Distributed Query Optimization **Multidatabase Query Processing:** Issues in Multidatabase Query Processing, Multidatabase Query Processing Architecture, Query Rewriting Using Views, Query Optimization and Execution, Query Translation and Execution

UNIT – IV
Distributed DBMS Reliability: Reliability Concepts and Measures, Failures in Distributed DBMS, Local Reliability Protocols, Dealing with Site Failures, Network Partitioning, Architectural Considerations. **Data Replication:** Consistency of Replicated Databases, Update Management Strategies, Replication Protocols, Group Communication, Replication and Failures, Replication Mediator Service

UNIT –V
Distributed Object Database Management systems: Fundamental Object concepts and Object models, Object distribution design. Architectural issues, Object management, Distributed object storage, Object query processing, Transaction management. **Peer-to-Peer Data Management:** Infrastructure, Schema Mapping in P2P Systems, Querying Over P2P Systems, Replica Consistency.

Suggested Reading:

1	Principles of Distributed Database Systems, Second Edition, M. Tamer Ozsu Patrick Valduriez
2	Distributed Databases principles and systems, Stefano Ceri, Giuseppe Pelagatti, Tata McGrawHill

CS 141	**CYBER SYSTEMS SECURITY**					
	PROGRAM ELECTIVE - IV					
Pre-requisites	Network Security		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To learn basic cyber security concepts
2	To learn social engineering attacks and countermeasures.
3	To learn about Malware and Kernel Debugging
4	To learn basic concepts of digital forensic practices
5	To introduce legal and compliance issues

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand different layers of security, vulnerabilities and threats
CO-2	Analyse vulnerabilities and apply counter measures for social engineering attacks
CO-3	Use kernel debugging, log analysis and network monitoring tools
CO-4	Analyse the forensic tools for evidence collection and Analysis.
CO-5	Understand IT Act and conduct compliance auditing

UNIT– I

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT – II

Social Engineering attacks and countermeasures. Password attacks, Privilege Escalation and Executing Applications, Network Infrastructure Vulnerabilities, IP spoofing, DNS spoofing, Wireless Hacking: Wireless footprint, Wireless scanning and enumeration, Gaining access (hacking 802.11), WEP, WPA, WPA2. **DoS attacks**. Web server and application vulnerabilities, SQL injection attacks, Vulnerability Analysis and Reverse Engineering, Buffer overflow attacks. Client-side browser exploits, Exploiting Windows Access Control Model for Local Elevation Privilege. Exploiting vulnerabilities in Mobile Application.

UNIT – III

Malware and Kernel Debugging:
Opening and Attaching to Processes, Configuration of JIT Debugger for Shellcode Analysis, Controlling Program Execution, Setting and Catching Breakpoints, Debugging with Python Scripts and Py Commands**,** DLL Export Enumeration, Execution, and Debugging**,** Debugging a VMware Workstation Guest (on Windows)**,** Debugging a Parallels Guest (on Mac OS X). Introduction to WinDbg Commands and Controls, Detecting Rootkits with WinDbgScripts**,**

Kernel Debugging with IDA Pro.
Networking: Socket module, Port Scanning, Packet Sniffing, Traffic Analysis, TCP Packet Injection, Log analysis. HTTP Communications with Python built in Libraries, Web communications with the Requests module, Forensic Investigations with Python: geo-locating, recovering deleted items, examining metadata and windows registry

UNIT – IV

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 –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 Reading:

1	Baloch, R., Ethical Hacking and Penetration Testing Guide, CRC Press, 2015.
2	Michael Sikorski, Andrew Honig ―Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software‖ publisher Williampollock
3	Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes,Computer Forensics and Legal Perspectives,Wiley
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 142	**SOFT COMPUTING**					
PROGRAM ELECTIVE - IV						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify and describe soft computing techniques and their roles in building intelligent Machines.
CO-2	Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
CO-3	Apply genetic algorithms to combinatorial optimization problems.
CO-4	Evaluate and compare solutions by various soft computing approaches for a given problem.
CO-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 Reading:

1	Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, 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 143	DATA ANALYTICS					
PROGRAM ELECTIVE - IV						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
1	To provide a comprehensive understanding of the principles and techniques of Data Analytics.
2	To develop skills in data preprocessing, exploration, and visualization for actionable insights.
3	To introduce statistical, machine learning, and deep learning methods for data-driven decision-making
4	To familiarize students with big data frameworks and tools for large-scale analytics
5	To enable the application of advanced analytics techniques in solving real-world problems across domains

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand core concepts and workflow of data analytics, from data acquisition to decision-making
CO-2	Perform data cleaning, transformation, and visualization for effective analysis.
CO-3	Apply statistical, machine learning, and deep learning algorithms to analyze structured and unstructured data.
CO-4	Utilize big data technologies like Hadoop and Spark for large-scale analytics tasks.
CO-5	Design and implement end-to-end analytics solutions for complex real-world applications.

UNIT – I

Introduction to Data Analytics
- Overview of Data Analytics: Concepts, lifecycle, and importance.
- Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive.
- Data types, sources, and acquisition.

UNIT – II

Data Preprocessing and Visualization
- Data cleaning, normalization, and transformation.
- Exploratory Data Analysis (EDA) techniques.
- Visualization tools and techniques (Matplotlib, Seaborn, Tableau).

UNIT – III
Statistical and Machine Learning Methods • Statistical foundations for analytics. • Supervised learning: Regression, Decision Trees, Ensemble methods. • Unsupervised learning: Clustering and Dimensionality Reduction.

UNIT – IV
Big Data Analytics • Big Data concepts, challenges, and ecosystem. • Hadoop, HDFS, and MapReduce basics. • Apache Spark for distributed data processing and analytics.

UNIT –V
Advanced Analytics and Applications • Deep learning for analytics (CNN, RNN for data-driven insights). • Time-series forecasting and anomaly detection. • Case studies: Healthcare, Finance, IoT, and Business Intelligence.

Suggested Reading:

1	Anil Maheshwari, 'Data Analytics', McGraw Hill Education.
2	Foster Provost and Tom Fawcett, 'Data Science for Business', O'Reilly.
3	Jure Leskovec, Anand Rajaraman, and Jeffrey Ullman, 'Mining of Massive Datasets', Cambridge University Press.
4	Vignesh Prajapati, 'Big Data Analytics with R and Hadoop', Packt Publishing.

CS 303	**DEEP LEARNING**					
PROGRAM ELECTIVE - IV						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce basic concepts of artificial neural networks and multilayer perceptrons
2	To introduce basic concepts of CNN and VGG
3	To introduce recurrent neural networks and LSTM‘s
4	To introduce auto encoders and GAN‘s

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the problem of XOR seperability and activation functions in ANN‘s
CO-2	Understand the problem of over fitting, under fitting, Gradient Descent and Stochastic Gradient Descet
CO-3	Demonstrate understanding of CNN‘s and VGG‘s
CO-4	Demonstrate understanding of RNN‘s and LSTM‘s
CO-5	Use auto encoders and GAN‘s

UNIT – I
Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.
Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT – II
Multilayer Perceptrons: Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle
Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT – III

Introduction to Convolutional Neural Networks: Introduction to CNNs, Kernel filter,
Principles behind CNNs, Multiple Filters
Modern Convolutional Neural Networks: Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet)

UNIT – IV
Recurrent Neural Networks: Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through **Time Modern Recurrent Neural Networks:** Gated Recurrent Units (GRU),Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence, Beam Search

UNIT –V
Auto encoders: Types of Auto Encoders and its applications **Generative Adversarial Networks:** Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks

Suggested Reading:

1	Goodfellow, I., Bengio,Y., and Courville, A., "Deep Learning", MIT Press, 2016.
2	Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "Dive into Deep Learning", 2020.
3	Dive into Deep Learning — Dive into Deep Learning 0.16.6 documentation (d2l.ai)

CS 502	**DIGITAL FORENSICS**					
PROGRAM ELECTIVE-IV						
Pre-requisites	Information Security Operating Systems Computer Networks		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Know how to apply memory analysis tools and file system analysis techniques to detect anti forensics.
CO-2	Understand privacy issues and able to use live/Online forensic tools.
CO-3	Analyze windows registry, Linux server configurations and Apache server to identify incidents.
CO-4	Analyze SQL databases and reconstruct activities by using SQL server toolkits.
CO-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, Pre fetch and Super fetch,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 rootkits, 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 Reading:

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.

CS 151	SIMULATION AND MODELING					
	PROGRAM ELECTIVE - V					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Define the basics of simulation modelling and replicating the practical situations in organizations
2	Generate random numbers and random variates using different techniques.
3	Develop simulation model using heuristic methods.
4	Analysis of Simulation models using input analyzer, and output analyzer
5	Explain Verification and Validation of simulation mode

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Categorize the random data of a physical system into a particular type of probability distribution function.
CO-2	Apply Chi-square test on the curve-fitting method employed on the random data of a physical system
CO-3	Creation of a mathematical model to simulate for checking the correct functioning of the algorithms
CO-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 Reading:

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	Agamkumartyagi, MATLAB and Simulink for Engineers, Oxford Publishers, 2011

CE 152	**SECURE CODING PRINCIPLES**					
PROGRAM ELECTIVE - V						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To understand the various security attacks
2	To learn how to recognize to coding errors
3	To understand techniques for developing a secure application.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand various attacks like DoS, buffer over flow, web specific, database specific, web-spoofing attacks.
CO-2	Demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications.
CO-3	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, CIATriad, Viruses, Trojans, and Worms in aNutshell, Security Conceptsexploit, threat, vulnerability, risk, attack. Malware Terminology: Rootkits, Trapdoors, Botnets, Key loggers, Honey pots. Active and Passive Security Attacks. IP Spoofing, Teardrop, DoS, DDoS ,XSS, SQL injection, Man in middle Attack, Format String attack. Types of Security Vulnerabilities-buffer over flows, Invalidated input, race conditions, access-control problems, weakness esinauthentication, 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 Over flows 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 Inter process Communication, Securing Signal Handlers and File Operations. XSS scripting attack and its types – Persistent and Non persistent attack XSS Countermeasures and Bypassing the XSS Filters.

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 Reading:

1	Michael Howard and David LeBlanc,‖ Writing Secure Code‖, Microsoft Press, 2nd Edition, 2004.
2	Jason Deckard, ―Buffer Overflow Attacks: Detect, Exploit, Prevent―, Syngress,1st Edition, 2005.
3	Frank Swiderski and Window Snyder, ―Threat Modeling‖, Microsoft Professional, 1st Edition, 2004.

CS 153	**IMAGE PROCESSING AND COMPUTER VISION**					
PROGRAM ELECTIVE - V						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To study elements of visualperception, intensity transformations and spatial filtering and smoothing techniques
2	To introduce the concepts of filtering in frequency domain and image restoration
3	To learn the concepts of color image processing and multi-resolution processing
4	To introduce concepts Image formation from geometrical perspective, 3D reconstruction
5	To study statistical modeling techniques and inverse problems in vision

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	apply intensity transformations and Spatial filters on digital images
CO-2	use frequency domain filtering techniques Image Smoothing and restoration.
CO-3	compress and segment color images, and use wavelet transforms in multiresolution processing and understand Pin hole camera and Multi-view stereo with N-cameras.
CO-4	Use statistical modeling techniques and restore blurred images

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, Colorbased Image Segmentation, Noise in Color Images, Color Image Compression. **Wavelets and Multi resolution Processing:** Background, Multiresolution Expansions, Wavelet Transforms in One Dimension, The Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets.

UNIT – IV
Image formation from geometrical perspective: Pinhole Camera model, Epipolar Geometry, Camera parameters, Essential matrix, Fundamental Matrix, Camera Calibration (calibration from predefined pattern, calibration from scene structure) **Multiview 3D reconstruction:** Stereo (depth from binocular view, rectification, one (or two) disparity map estimation technique(s)), Multi-view stereo (depth from 3 cameras, N number of cameras).

UNIT –V
Statistical Modelling of images: Markov Random field, Conditional random field, Gibb‘s sampling, Loopy Belief propagation based approximation.**3D reconstruction from single image:** Shape from Shading, Depth from Defocus.**Structure from Motion:** Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, Constrained structure and motion.**Inverse problems in CV:** Image restoration for images blurred by non-uniform motion. Super resolution (image registration and interpolation techniques).**Lightfield Photography:** Definition, Capturing techniques, Fourier Slicing and Digital Re focusing**Computational Photography:** HDR imaging, Super slo-mo video capturing.

Suggested Reading:

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.
3	*Multiple View Geometry in Computer Vision*. Second Edition. Richard *Hartley*. Australian National University, Canberra, Australia. Andrew *Zisserman*, 2004.
4	Anand Rangarajan, Rama Chellappa, ― Markov random field models in image processing‖ , MIT Press, 1995
5	Andrew Blake , Pushmeet Kohli, Carsten Rother, ―Markove Random Fields for Vision and Image Processing‖ , The MIT Press,2011
6	Ali Mohammed DJafari ―Inverse Problems in Vision and 3D Tomography ―, Wiley ,2010

CS 304	**PROGRAMMING FOR BIG DATA SYSTEMS**					
	PROGRAM ELECTIVE - V					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Learn business case studies for big data analytics
2	Understand NoSQL big data management
3	Perform map-reduce analytics using Hadoop and related tools

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Describe big data and use cases from selected business domains
CO-2	Explain NoSQL big data management
CO-3	Install, configure, and run Hadoop and HDFS
CO-4	Perform map-reduce analytics using Hadoop
CO-5	Use Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data analytics

UNIT – I

What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloudand big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

UNIT – II

Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schemaless databases, materialized views, distribution models, sharding, master-slave replication, peer to peerreplication, sharding and replication, consistency, relaxing consistency, version stamps, map-reduce, partitioning and combining, composing mapreduce calculations.

UNIT – III

Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadoop pipes, design of Hadoop distributed file system (HDFS), HDFSconcepts, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro, file-based data structures

UNIT – IV
Map Reduce workflows, unit tests with MRUnit, test data and local tests, anatomy of Map Reduce job run, classic Map-reduce, YARN, failures in classicMap-reduce and YARN, job scheduling, shuffle and sort, task execution, Map Reduce types, input formats, output formats

UNIT –V
Hbase, data model and implementations, Hbase clients, Hbase examples,praxis.Cassandra, Cassandra data model, Cassandra examples, Cassandra clients,Hadoop integration. Pig, Grunt, pig data model, Pig Latin, developing and testing Pig Latin scripts.Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, HiveQL queries.

Suggested Reading:

1	Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley, 2013
2	Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", 2012
3	Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
4	Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilly, 2012.
5	Eric Sammer, "Hadoop Operations", O'Reilly, 2012.
6	E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly, 2012
7	Lars George, "HBase: The Definitive Guide", O'Reilly, 2011.
8	Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilly Media, 200

CS 544	**SOCIAL MEDIA ANALYTICS**					
PROGRAM ELECTIVE - V						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce Types of social networks and data collection techniques
2	To introduce graph analytic techniques
3	To introduce topic models and random walks
4	To introduce recommendation systems and community detection

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand types of social networks and use various sampling techniques to collect social networks data
CO-2	Represent social network in the form of graph and apply various analysis and inferential methods
CO-3	Use random walk theory to analyze social network data
CO-4	Detect community and predict links in social networks

UNIT – I
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. Characteristics of OSNs, Information Diffusion, Experimental studies over OSNs,Sampling

UNIT – II
Social network Analysis, Social network and its reprsentation, Graph-matrix representation of social network, Inferernetial methods in Scoail network analysis.

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
Case Study : Exploring Twitter‘s API and Cookbook , Google+, Facebook and LinkedIn

Suggested Reading:

1	Song Yang and Franziska B Keller, ― Social Network Analysis‖, Sage Publishers, 2017
2	Mathew A Russel, ―Minig the Social Web ―, Orielly Publishers, 2nd Edition 2013

OE 941 BM	**MEDICAL ASSISTIVE DEVICES**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
2	To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
3	To develop improved lower-extremity devices

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Apply fundamental knowledge of engineering in rehabilitation
CO-2	Apply analytical skills to assess and evaluate the need of the end-user
CO-3	Develop self-learning initiatives and integrate learned knowledge for problem solving
CO-4	Understand the basics of robotics and apply their principles in developing prosthetics
CO-5	Apply the knowledge of computers in solving rehabilitation problems

UNIT – I
Introduction to Rehabilitation Engineering, Measurement and analysis of human movement, Disability associated with aging in the workplace and their solutions, clinical practice of rehabilitation engineering.

UNIT – II
Assistive Technology, Seating Biomechanics and systems. Wheeled Mobility: Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of Wheel chair propulsion. Power Wheelchair Electrical Systems. Control. Personal Transportation. Auxiliary devices and systems.

UNIT – III
Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system:Tactual augmentation. Tactual substitution. Measurement tools and processes: fundamental principles, structure, function; performance and behavior. Subjective and objective measurement methods.

UNIT – IV
Rehabilitation Robotics, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

UNIT – V
Augmentative and Alternative communication technology, Computer applications in Rehabilitation Engineering, telecommunications, and Web Accessibility.

Suggested Reading:

1	Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2	Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3	Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4	Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rdEd., CRC Press, Taylor & Francis Group, London, 2006.

OE 942 BM	**MEDICAL IMAGING TECHNIQUES**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To familiarize the students with various medical imaging modalities.
2	To make learners understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.
3	To make the students learn the advantages, disadvantages and hazards of various medical imaging equipment.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Interpret the working principle and operating procedure and applications of X-ray equipment.
CO-2	Understand the image reconstruction techniques and applications of CT.
CO-3	Summarize the image acquisition and reconstruction techniques in MRI.
CO-4	Comprehend the working principle, modes and medical applications of ultrasound imaging.
CO-5	Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

UNIT – I

X ray Imaging: Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization-Films, Fluorescent screens, Image Intensifiers.

Dental X-Ray machines, Portable and mobile X-Ray units, Mammographic X-Ray equipment, Digital Radiography and flat panel detectors.

Radiation safety, ALARA principle, Dose units and dose limits, Radiation dosimeters and detectors.

UNIT – II

Computed Tomography: Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging, 2D image reconstruction techniques - Iteration and Fourier methods. Applications of CT - Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography.

UNIT – III
Magnetic Resonance Imaging: Principles of NMR imaging systems, Image reconstruction techniques-Relaxation processes, imaging/ pulse sequences. Sub systems of an NMR imaging system, NMR detection system, types of coils, biological effects and advantages of NMR imaging. Functional MRI - The BOLD effect, intra and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization sources and dependences of physiological noise in fMRI.

UNIT – IV
Ultrasound Imaging: - Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion. Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

UNIT – V
Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera. Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography(SPECT) and Positron Emission Tomography (PET). Comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested Reading:

1	Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
2	S Webb, "*The Physics of Medical Imaging*", Adam Highler, Bristol Published by CRC Press, 1988.
3	A C Kak, "*Principle of Computed Tomography*", IEEE Press New York, 1988.
4	Hykes, Heorick, Starchman, *Ultrasound physics and Instrumentation* MOSBY year book, 2nd Ed. 1992.
5	Stewart C. Bushong, *Magnetic Resonance Imaging- physical and biological principles*, MOSBY, 2nd Ed., 1995.

OE 941 CE	**GREEN BUILDING TECHNOLOGY**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Exposure to the green building technologies and their significance.
2	Understand the judicial use of energy and its management.
3	Educate about the Sun-earth relationship and its effect on climate.
4	Enhance awareness of end-use energy requirements in the society.
5	Develop suitable technologies for energy management

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of energy use and energy processes in building.
CO-2	Identify the energy requirement and its management.
CO-3	Know the Sun-earth relationship vis-a-vis its effect on climate.
CO-4	Be acquainted with the end-use energy requirements.
CO-5	Be familiar with the audit procedures of energy

UNIT – I
Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT – II
Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT – III
Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT – IV
End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

UNIT – V
Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation Energy management options - Energy audit and energy targeting - Technological options for energy management.

Suggested Reading:

1	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2	Carter, W. Nick, (1991): Disaster Management, Asian Development Bank, Manila.
3	Sahni, Pardeep et.al. (eds.) (2002), Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

OE 942 CE	**COST MANAGEMENT OF ENGINEERING PROJECTS**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the concepts of cost management
2	Fundamentals of cost overruns
3	Introduce the concepts of Quantitative techniques for cost management Linear Programming, PERT/CPM.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
CO-2	Ability to appreciative detailed engineering activities of the project and execution of projects
CO-3	Preparation of project report and network diagram
CO-4	Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
CO-5	Applications of various quantitative techniques for cost management

UNIT – I
Introduction and 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 non- technical activities- Detailed Engineering activities.

UNIT – III
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. Project commissioning: mechanical and process.

UNIT – IV
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. 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 Reading:

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.

OE 941 CS	**BUSINESS ANALYTICS**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understanding the basic concepts of business analytics and applications
2	Study various business analytics methods including predictive, prescriptive and prescriptive analytics
3	Prepare the students to model business data using various data mining, decision making methods

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the basic concepts of business analytics
CO-2	Identify the application of business analytics and use tools to analyze business data
CO-3	Become familiar with various metrics, measures used in business analytics
CO-4	Illustrate various descriptive, predictive and prescriptive methods and techniques
CO-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, HoltWinter 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 Reading:

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

OE 941 EC	**ELEMENTS OF EMBEDDED SYSTEMS**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understanding various Embedded Design strategies
2	Designing Micro controller based Embedded Systems
3	Designing FPGA Based Embedded Systems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand Embedded Design Strategies and architecture of Arduino Board
CO-2	Program using various onboard components of Arduino
CO-3	Design real time interfacing with Arduino
CO-4	Understand Design Flow of FPGA, programming FPGA using Verilog HDL
CO-5	Implement combinational and sequential circuits using verilog HDL

UNIT – I
Embedded Systems Design Strategies: Micro Controller, DSP, FPGA, Introduction to Arduino (Micro controller Board), Components of Arduino, Architecture and Pin Configuration of ATMega328, Ports of ATMega328.

UNIT – II
Interfacing: Interfacing Switches, LEDs, Analog to Digital Converter, Digital to Analog Converter, Interfacing and Programming I2C, SPI

UNIT – III
Real Time Programming: Interfacing Key Pad, 7-segment display, LCD, Interfacing Sensors, Interfacing Stepper Motor**,** USB programming

UNIT – IV
FPGA Based Embedded Design: FPGA Design flow, Introduction to Verilog HDL**,** Basic building blocks, Data types of Verolog HDL, Behavioral Modelling, Data Flow Modelling, Structural Modelling, Hierarchal Structural Modelling, Case Studies on Verilog HDL descriptions of Basic Circuits

UNIT – V
Modelling of Circuits: Verilog HDL Implementation of Combinational MSI Circuits, Verilog HDL Implementation of Sequential MSI Circuits, Finite Sate Machine Design, Tasks and Functions, Introduction to Test Benches

Suggested Reading:

1	Ming-Bo Lin, Digital System Designs and Practices Using Verilog HDL and FPGAs, Wiley India, 2008
2	Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson Education, 2005
3	Simon Monk, Programming Arduino: Getting Started with sketches, Mc.Hill, 2016

Web Resources:

1	www.arduino.cc
2	www.learn.sparkfun.com/tutorials/arduino

OE 941 EE	**WASTE TO ENERGY**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To know the various forms of waste
2	To understand the processes of Biomass Pyrolysis.
3	To learn the technique of Biomass Combustion.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of conservation of waste
CO-2	Identify the different forms of wastage.
CO-3	Chose the best way for conservation to produce energy from waste.
CO-4	Explore the ways and means of combustion of biomass.
CO-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 Reading:

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.

OE 942 EE	**POWER PLANT CONTROL AND INSTRUMENTATION**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Learn the operation of different types of power plants.
2	Learn the working principle of instruments for measurement of electrical and non-electrical quantities like Temperature Pressure flow level measurements.
3	Understand the instrumentation and protection systems applied in thermal power plant.
4	Learn the control techniques employed for the operation of modern power generation plant

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Explain the different methods of power generation. Along with Piping and Instrumentation diagram of boiler.
CO-2	Select various measurements involved in power generation for measuring electrical and non-electrical parameters.
CO-3	Identify the different types of analyzers used for scrutinizing boiler steam and water.
CO-4	Model different types of controls and control loops in boilers.
CO-5	Illustrate the methods of monitoring and control of different parameters like speed, vibration of turbines

UNIT – I
Brief survey of methods of power generation, hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power generation, thermal power plants, block diagram, details of boiler processes, Piping and Instrumentation diagram of boiler, cogeneration.

UNIT – II
Electrical measurements, current, voltage, power, frequency, power factor etc, non-electrical parameters, flow of feed water, fuel, air and steam with correction factor for temperature, steam pressure and steam temperature, drum level measurement, radiation detector, smoke density measurement, dust monitor.

UNIT – III
Flue gas oxygen analyzer: Analysis of impurities in feed water and steam, dissolved oxygen analyzer. Chromatography, pH meter, fuel analyzer, pollution monitoring instruments.

UNIT – IV
Combustion control, air / fuel ratio control, furnace draft control, drum level control, main steam and reheat steam temperature control, super heater control, air temperature, distributed control system in power plants, interlocks in boiler operation.

UNIT – V
Speed, vibration, shell temperature monitoring and control, steam pressure control, lubricant oil temperature control, cooling system.

Suggested Reading:

1	Sam G. Dukelow, The Control of Boilers, Instrument Society of America, 2nd Edition, 2010.
2	P.K. Nag, „Power Plant Engineering", Tata McGraw-Hill, 1st Edition, 2001.
3	S.M. Elonka and A.L. Kohal, ―Standard Boiler Operations‖, Tata McGraw-Hill, 1st Edition, 1994.
4	R K Jain, ―Mechanical and Industrial Measurements‖, Khanna Publishers, 1st Edition, 1995.
5	E Al Wakil, ―Power Plant Engineering‖, Tata McGraw-Hill, 1st Edition, 1984.

OE 941 ME	**OPERATIONS RESEARCH**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60Marks	**CIE**		40Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand the dynamic programming to solve problems of discrete and continuous variables
2	Apply the concept of non-linear programming and carry out sensitivity analysis
3	Understand deterministic and probabilistic inventory control models.

Course Outcomes:	
After the completion of this course, the students shall be able to:	
CO-1	Understand the basics of OR, including mathematical modeling, feasible solutions and optimization.
CO-2	Able to carry out sensitivity analysis.
CO-3	Apply PERT/CPM in project management.
CO-4	Select appropriate inventory control model.
CO-5	Able to apply dynamic programming and understand the concept of non-linear programming.

UNIT–I
Development, Different Phases, Characteristics, Operations Research models and applications. Linear Programming Problem: Introduction, Basic Assumptions, Formulation, graphical method, simplex method: Big M and Two Phase method.

UNIT–II
DUALITY: Duality theory, primal-dual relationships, Economic interpretation, Dual simplex method, Post optimal or sensitivity analysis.

UNIT–III
Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity. Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT–IV
Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing ‗n' jobs through m machines. Game Theory: Introduction, Characteristics of Game Theory, Dominance theory, Mixed strategies (2 x 2, m x 2), Algebraic and graphical methods. Nonlinear programming problem: - Kuhn-Tucker conditions.

UNIT–V
Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finite population – Infinite population. Dynamic Programming: Characteristics, principle of optimality, deterministic problems.

Suggested Reading:

1	H.A.Taha, Operations Research, An Introduction, PHI,2008
2	H.M.Wagner, Principles of Operations Research, PHI,Delhi,2010
3	J.C.Pant,IntroductiontoOptimization:OperationsResearch,JainBrothers,Delhi, 2008.
4	Frederick S. Hillier, Gerald J. Lieberman, Operations Research, 10thEdition, McGraw Hill Pub. 2017.
5	Pannerselvam, Operations Research: Prentice Hall of India, 2010.
6	Ronald L. Rardin, Optimization in Operations Research, First Indian Reprint, Pearson Education Asia. 2002,

OE 942 ME	**COMPOSITE MATERIALS**					
	OPEN ELECTIVE					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Study the concepts of composite construction.
2	Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
3	Apply the concepts for design of multi-storey composite buildings.
4	Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of composite construction, and analysis and designs of composite beams.
CO-2	Analyse and design the composite floors
CO-3	Select suitable materials for composite columns,
CO-4	Analyse composite trusses and understand connection details.
CO-5	Analyse and design the multi-storey composite buildings

UNIT – I
Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions. Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

UNIT– II
Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

UNIT – III
Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

UNIT – IV
Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

UNIT – V
Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1	R.P. Johnson, ―Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings‖, Blackwell Publishing, Malden, USA, 2004.
2	―INSDAG Teaching Resources for Structural Steel Design‖, Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3	―INSDAG Handbook on Composite Construction – Multi-Storey Buildings‖, Institute for Steel Development and Growth Publishers, Calcutta, India.
4	―INSDAG Design of Composite Truss for Building‖, Institute for Steel Development and Growth Publishers, Calcutta, India.
5	―INSDAG Handbook on Composite Construction – Bridges and Flyovers‖, Institute for Steel Development and Growth Publishers, Calcutta, India.
6	IS: 11384-1985, ―Code of Practice for Composite Construction in Structural Steel and Concrete‖, Bureau of Indian Standards, New Delhi, 1985.

OE 943 ME	**INDUSTRIAL SAFETY**					
OPEN ELECTIVE						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Causes for industrial accidents and preventive steps to be taken.
2	Fundamental concepts of Maintenance Engineering.
3	About wear and corrosion along with preventive steps to be taken
4	The basic concepts and importance of fault tracing.
5	The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify the causes for industrial accidents and suggest preventive measures.
CO-2	Identify the basic tools and requirements of different maintenance procedures.
CO-3	Apply different techniques to reduce and prevent Wear and corrosion in Industry.
CO-4	Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
CO-5	Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc

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 of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, 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, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, 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 Machine tools, Pumps, Air compressors, 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 Reading:

1	H. P. Garg, ―Maintenance Engineering‖, S. Chand and Company
2	Audels, ―Pump-hydraulic Compressors‖, Mcgraw Hill Publication
3	Higgins & Morrow, ―Maintenance Engineering Handbook‖, Da Information Services.
4	Winterkorn, Hans, ―Foundation Engineering Handbook‖, Chapman & Hall London

OE 941 LA	**INT ELLECTUAL PROPERTY RIGHTS**					
	OPEN ELECTIVE					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

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

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of intellectual property rights.
CO-2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO-3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO-4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO-5	Apply the patents and demonstration of case studies.

UNIT – I

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

UNIT – II

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

UNIT – III

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

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

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

Suggested Reading:

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

CS 361	**ARTIFICIAL INTELLIGENCE LAB**					
LAB III						
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
1	Students can impart practical knowledge on Artificial intelligence programs with Python Language and able to process NLP libraries.

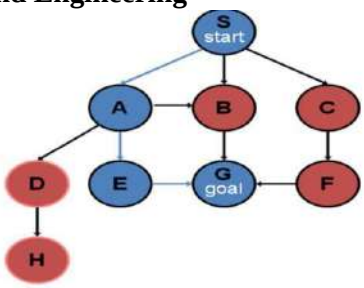
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to use various heuristic search strategies in Artificial Intelligence programs
CO-2	Able to use probabilistic reasoning in decision problems
CO-3	Able to use various open source ML libraries to evaluate different ML algorithms
CO-4	Able to use open source NLP libraries for processing text processing applications

List of Programs:

1. Implement the following graph search algorithms using Python
    a. Breadth First Search
    b. Depth First Search
    c. Depth First Iterative Deepening Search
    d. A* Search using 8 tiles game

The input parameters will be the graph G, start state and goal state. Represent the graph using dictionary, key-value pair. Example:

```
G = {
'S': ['A','B','C'],
'A': ['D','E','B'],
'B': ['G'],
'C': ['F'],
'D': ['H'],
'E': ['G'],
'F': ['G'],
'G': [],
'H': []
}
```



Open list should contain the states that are to be expanded and closed list should contain the states that are already expanded.

1. Implement the Minimax search algorithm in game playing using recursion in Python
2. Implement the Eight Queens problem using constraint satisfaction algorithm using Python
   3. Write a program that implements Naive Bayes Machine Learning Algorithm from scratch without using the libraries in Python. Your program should read the training and test data set files that are in the ARFFformat and classify each of the instances in the test data set file. This is a binary classification problem.
4. Students are expected to learn any one of the following:
   a. Scikit-learn (https://scikit-learn.org/) an open source machine learning Python library that supports supervised and unsupervised learning. The sklearn.datasets package embeds small toy datasets. It includes utilities to load these datasets. Students are expected to study and make use of these datasets

   b. Weka (http://www.cs.waikato.ac.nz/ml/weka/) a widely used ML toolkit that supports supervised and unsupervised learning. Weka provides various data sets in ARFF format.

Students are expected to study and make use of these datasets

5. Write Python program to use sklearn‟s DecisionTreeClassifier to build a decision tree for the sklearn‟s datasets or use Weka‟s J48 tree learner.
6. Write a Python program or use the Weka Toolkit for the K-means algorithm.
7. Design a perceptron classifier to classify handwritten numerical digits (0-9). Implement using scikit or Weka.
8. Write a Python program to segment a text into linguistically meaningful units, such as paragraphs, sentences, or words. For segmenting text into tokens (words and wordlike units) use regular expressions.
9. Write a program to label words (tokens) with parts of speech such as noun, adjective, and verb using a PoS tagger

Suggested Reading:

1. Introduction to Python Programming. Gowrishankar S., Veena A. CRC Press, Taylor & Francis Group, 2019
2. scikit-learn user guide.https://scikit-learn.org/stable//_downloads/scikit-learn-docs.pdf 3. Ian Witten, Eibe Frank, and Mark Hall, Chris Pal. DATA MINING: Practical Machine Learning Tools and Techniques, 4thEdition. Morgan Kaufmann.
4. Jacob Perkins. Python 3 Text Processing with NLTK 3 Cookbook. Packt Publishing. 2014

CS 162	**ADVANCED DATA BASES LAB**					
LAB III						
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		25 Marks	

Course Objectives :	
1	To develop database applications using object relational mappings and XML
2	To implement algorithms for query processing engine
3	To develop simple applications using Hadoop and map reduce framework

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Develop database applications in object relational database concepts
CO-2	Develop database application using hybernet frame work
CO-3	Implement query processing algorithms
CO-4	Implement data processing applications using Hadoop and map reducing framework

1. Design a database application using object relational database
2. Design a database application using persistent programming language
3. Design a database application using hibernate
4. Create XML database and write queries using XQuery and XPath
5. Implement relational algebra operations
   1. Selection operation 2. Hass Join 3. Merge Join
6. Implement parallel join and parallel sorting 7. Use visualization tools to draw query plans
8. Installation & Configuration of Hadoop.
9. Using Hadoop for counting word frequency with Map Reduce.
10. Write a Map Reduce Application which processes a log file of a system. List out the users who have logged for max period on the system. Use sample Log file from the internet and process it using a pseudo distribution mode on Hadoop platform.

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

CS 171	**MINI PROJECT**					
	Mini project					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	4	2
Evaluation	**SEE**	-	**CIE**	50 Marks		

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To review available literature and formulate structural engineering problems
2	To learn the technique of writing reports and prepare presentation

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify engineering problems reviewing available literature
CO-2	Understand of contemporary / emerging technology for various processes and systems.
CO-3	Share knowledge effectively in oral and written form and formulate documents
CO-4	Present solution by using his/her technique applying engineering principles.
CO-5	Prepare technical report and presentation

Guidelines:

The students are required to search / gather the material / information on a specific topic comprehend it and present / discuss in the class. Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Mini Project will have 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 highlighting individuals‘ contribution. Continuous assessment of Mini Project at Mid Semester and End Semester will be monitored by the departmental committee.

AUDIT COURSES

SEMESTER –III

AC 040	**RESEARCH METHODOLOGY**					
AUDIT COURSE- I						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To understand the research process
2	To solve unfamiliar problems using scientific procedures
3	To pursue ethical research
4	To use appropriate tools for documentation and analysis of data

Course Outcomes :	
On completion of this course, the student will be able to Implement:	
CO-1	Understand research problem formulation
CO-2	Design experiments
CO-3	Analyze research related information
CO-4	Write papers and thesis, Follow research ethics
CO-5	Use tools for analysis and thesis writing

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 Modeling: 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 Reading:

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	LaTEX for Beginners, Workbook, Edition 5, March 2014.

AC 031	**ENGLISH FOR RESEARCH PAPER WRITING**					
AUDIT COURSE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand that how to improve your writing skills and level of readability
2	Understand the nuances of language and vocabulary in writing a Research Paper.
3	Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Interpret the nuances of research paper writing.
CO-2	Differentiate the research paper format and citation of sources.
CO-3	To review the research papers and articles in a scientific manner.
CO-4	Avoid plagiarism and be able to develop their writing skills in presenting the research work.
CO-5	Create a research paper and acquire the knowledge of how and where to publish their original research papers

UNIT – I
Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

UNIT – II
Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT – III
Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

UNIT – IV
Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.

UNIT – V
Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits *Presentation Skills:* Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

Suggested Reading:

1	C. R Kothari, Gaurav, Garg, ―*Research Methodology Methods and Techniques*‖, 4/e, New Age International Publishers.
2	Day R, ―*How to Write and Publish a Scientific Paper*‖**,** Cambridge University Press, 2006
3	―*MLA Hand book for writers of Research Papers*‖, 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum‘s, ―*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

AC 032	DISASTER MITIGATION AND MANAGEMENT					
	AUDIT COURSE - II					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction of various types of disasters and its effect on structures.
2	Learning of quality assurance and damage assessment of structures
3	Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.
4	Awareness about flood characteristics and flood forecasting systems
5	Description of Flood mitigation, adjustment, and regulation

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of disaster and seismic performance of buildings
CO-2	Able to assess various damages in structures and give assurance of quality of concrete
CO-3	Decide the appropriate repair, strengthening, rehabilitation and technique required for a case study of building.
CO-4	Applications of flood routing, flood forecasting and space time characteristics of rainfall.
CO-5	Advanced understanding of flood plain adjustments and employment of appropriate technologies for flood mitigation.

UNIT – I
Disaster: Classifications - Causes - Impacts including social, economical, political, environmental, health, psychosocial, etc.
Seismic performance of buildings: case studies of major earthquakes in the country, damage to buildings, damage patterns, performance of non-engineered buildings- Introduction to repair and rehabilitation of structures.

UNIT – II
Quality assurance for concrete – Strength, Durability and Thermal properties of concrete. Damage Assessment**:** - Condition assessment and distress, Purpose of assessment, Rapid assessment - diagnostic techniques, Investigation of damage, , Evaluation of surface and structural cracks, Damage assessment procedure, destructive, non-destructive and semi destructive testing systems, Procedure for evaluating damaged of structure.

UNIT – III
Repair, Rehabilitation And Retrofitting Techniques : Repair materials, Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create –Underpinning, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques

UNIT – IV
Introduction to Disasters: Hazard, Vulnerability, Resilience, Risks.-Disaster- Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.
Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.
Space-time characteristics of rainfall: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

UNIT – V
Flood Routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.
Flood mitigation: flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.
Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards.

Suggested Reading:

1	Barry A. Richardson, ―Defects and Deterioration in Buildings‖, E &FN Spon Press, London, 1991.
2	J. H. Bungey, ―Testing of Concrete in Structures‖, Chapman and Hall,New York, 1989.
3	―A.R. Santakumar, ―Concrete Technology‖, Oxford University Press,New Delhi, 2006.
4	―Pankaj Agarwal and Manish Shrihkande (2006). ―Earthquake Resistance Design of Structures.‖ Prentice Hall of India.
5	―Ravishankar.K., Krishnamoorthy.T.S, "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004. New Technological Age‖,2016.
6	CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008.

AC 033	SANSKRIT FOR TECHNICAL KNOWLEDGE					
	AUDIT COURSE - II					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2	To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3	To explore the huge knowledge from ancient Indian literature

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Develop passion towards Sanskrit language
CO-2	Decipher the latent engineering principles from Sanskrit literature
CO-3	Correlates the technological concepts with the ancient Sanskrit history.
CO-4	Develop knowledge for the technological progress
CO-5	Explore the avenue for research in engineering with aid of Sanskrit

UNIT – I
Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonymssandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)

UNIT – II
Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava‘s sine and cosine theory (origination of Taylor's series). The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

UNIT – III

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering): Building construction-soil testing-mortar-town planning-Machine definition-cruciblefurnace-air blower- Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

UNIT – IV
*Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology):*Computer languages and the Sanskrit languages-computer command words and the vediccommand words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

UNIT – V
*Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering):*Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vesselkosthiyanthram

Suggested Reading:

1	M Krishnamachariar, ―*History of Classical Sanskrit Literature",* TTD Press, 1937.
2	M.R. Kale, ―*A Higher Sanskrit Grammar: For the Use of School and College Students*‖, Motilal Banarsidass Publishers, 2015.
3	Kapail Kapoor, ―*Language, Linguistics and Literature: The Indian Perspective",* ISBN- 10: 8171880649, 1994.
4	―*Pride of India*‖, Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5	Shri Rama Verma, ―*Vedas the source of ultimate science",* Nag publishers, 2005.

AC 034	**VALUE EDUCATION**					
	AUDIT COURSE - II					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand the need and importance of Values for self-development and for National development.
2	Imbibe good human values and Morals
3	Cultivate individual and National character.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Gain necessary Knowledge for self-development
CO-2	Learn the importance of Human values and their application in day to day professional life.
CO-3	Appreciate the need and importance of interpersonal skills for successful career and social life
CO-4	Emphasize the role of personal and social responsibility of an individual for allround growth.
CO-5	Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.

UNIT – I
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.

UNIT – II
Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT – III
Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

UNIT – IV
Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

UNIT – V
Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

Suggested Reading:

1	Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*‖, Oxford University Press, New Delhi, 1998.
2	Jaya DayalGoyandaka, ―*Srimad Bhagavad Gita with Sanskrit Text*‖, Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

AC 035	STRESS MANAGEMENT BY YOGA					
	AUDIT COURSE - II					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Creating awareness about different types of stress and the role of yoga in the management of stress.
2	Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3	Prevention of stress related health problems by yoga practice.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand yoga and its benefits.
CO-2	Enhance Physical strength and flexibility.
CO-3	Learn to relax and focus.
CO-4	Relieve physical and mental tension through Asanas
CO-5	Improve work performance and efficiency.

UNIT – I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT – II
Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT – III
Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT – IV
Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

Unit – V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1	―Yogic Asanas for Group Training - Part-I‖: Janardhan Swami Yogabhyasi Mandal, Nagpur
2	―Rajayoga or Conquering the Internal Nature‖ by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3	Nagendra H.R nad Nagaratna R, ―Yoga Perspective in Stress Management‖, Bangalore, Swami Vivekananda Yoga Prakashan

Web resource:

1	https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2	https://freevideolectures.com/course/3539/indian-philosophy/11

AC 036	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**					
AUDIT COURSE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To learn to achieve the highest goal happily
2	To become a person with stable mind, pleasing personality and determination
3	To awaken wisdom in students

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Develop their personality and achieve their highest goal of life.
CO-2	Lead the nation and mankind to peace and prosperity.
CO-3	To practice emotional self regulation.
CO-4	Develop a positive approach to work and duties.
CO-5	Develop a versatile personality.

UNIT – I
Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT – II
Neetisatakam – Holistic development of personality (cont‘d) - Verses 52, 53, 59 (dont‘s) - Verses 71,73,75 & 78 (do‘s) - Approach to day to day works and duties.

UNIT – III
Introduction to Bhagavad Geetha for Personality Development - Shrimad Bhagawad Geeta: Unit 2 – Verses 41, 47, 48 - Unit 3 – Verses 13,21,27,35 - Unit 6 – Verses 5,13,17,23,35 - Unit 18 – Verses 45, 46, 48 Unit – 6: Verses 5, 13, 17, 23, 35; Unit – 18: Verses 45, 46, 48.

UNIT – IV
Statements of basic knowledge - Shrimad Bhagawad Geeta: Unit 2- Verses 56, 62,68 - Unit 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT – V
Role of Bahgavadgeeta in the present scenario - Unit 2 – Verses 17 – Unit 3 – Verses 36, 37, 42 - Unit 4 – Verses 18, 38, 39 - Unit 18 – Verses 37, 38, 63.

Suggested Reading:

1	―Srimad Bhagavad Gita‖ by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2	Bhartrihari‘s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit, Sansthanam, New Delhi.

Web resource:

1	NTPEL:http://nptel.ac.in/downloads/109104115

AC 037	CONSTITUTION OF INDIA					
	AUDIT COURSE - II					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	The history of Indian Constitution and its role in the Indian democracy.
2	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.
3	Have knowledge of the various Organs of Governance and Local Administration.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the making of the Indian Constitution and its features.
CO-2	Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
CO-3	Have an insight into various Organs of Governance - composition and functions
CO-4	Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
CO-5	Understand Electoral Process, special provisions.

UNIT – I
History of making of the Indian constitutions: History, Drafting Committee (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features.

UNIT – II
Contours of Constitutional Rights and 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 – III
Organs of Governance": Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT – IV
Local Administration - District‘s Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT – V
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 Reading:

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.

Web resource:

1	http://www.nptel.ac.in/courses/103107084/Script.pdf

AC 038	PEDAGOGY STUDIES					
	AUDIT COURSE - II					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To present the basic concepts of design and policies of pedagogy studies.
2	To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.
3	To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
CO-2	Examine the effectiveness of pedagogical practices.
CO-3	Understand the concept, characteristics and types of educational research and perspectives of research.
CO-4	Describe the role of classroom practices, curriculum and barriers to learning.
CO-5	Understand Research gaps and learn the future directions.

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 followed 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 material 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 - 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 Reading:

1	Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*‖, 31 (2): 245 – 261, 2001.
2	Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*‖, Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3	Akyeampong K, ―*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"*International Journal Educational Development, 33 (3): 272- 282, 2013.
5	Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.
6	Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

AC 039	**E-WASTE MANAGEMENT**					
AUDIT COURSE - II						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to E-Waste management
2	Understanding on resource efficiency and circular economy
3	E-waste Management rules 2016
4	RoHS compliances/directives to EEE

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Complete understanding on E-Waste management
CO-2	Understanding on effective recycling methodologies for e-waste management
CO-3	Overall understanding about E-waste Management rules 2016 and strategies for ewaste management
CO-4	Understanding on RoHS compliances for EEE products

UNIT – I
Waste Electrical and Electronic Equipment (WEEE): Flows, Quantities and Management, a Global Scenario; The Importance of Waste Management; Types of Waste- Solid and Liquid; Criteria for EEE/E-Waste Classification; Multivariate Model for E-Waste Estimation; Environmental and Health Effects of Waste Management, Inventorisation of E-Waste and Emerging trends in E-waste disposal with bench marks for depollution - global scenario; Dumping, Burning and Landfill: Impact on the Environment

UNIT – II
Effective Waste Management and Disposal Strategies; Legislative Influence on Electronics Recycling; Waste Management Rules and Their Amendments; Extended Producer Responsibility (EPR) in E-Waste Management; The Role of Collective versus Individual Producer Responsibility in E-Waste Management

UNIT – III
Electronic Waste: Public Health Implications; Restriction of Hazardous Substances (RoHS) Directives in Electrical and Electronic Equipment; Materials Used in Manufacturing Electrical and Electronic Products

UNIT – IV
Recycling and Resource Management: Ecological and Economical Valuation; Life Cycle Assessment (LCA) Approach to Waste Management System; Environmental Incentives for Recycling and Life Cycle Analysis of Materials Recycling Electronic Waste: Challenges and Opportunities for Sustainable Management; Resource Recovery from E-waste: Efficiency and Circular Economy; Integrated Approach to E-Waste Recycling: Recycling and Recovery Technologies, Recycling and Recovery Technologies.

UNIT – V
Cases studies: E-waste Generation, collection and recycling

Suggested Reading:

1	Electronic Waste Management and Treatment Technology, Editors: MajetiNarasimhaVara Prasad MeththikaVithanage
2	Electronic Waste Management, Edited by R. E. Hester, R. M. Harrison, RSC Publishing 2009
3	Solid Waste Technology & Management, Christensen, T., Ed., Wiley and Sons., 2011
4	Electronics Waste Management: An India Perspective. Front Cover. Sandip Chatterjee. Lap Lambert Academic Publishing GmbH KG, 2010 - Electronic
5	Handbook of Electronic Waste Management, International Best Practices and Case studies, Elsevier, 2019
6	E-waste: Implications, regulations, and management in India and current global best practices. Author(s): RakeshJohri, TERI Press

CS 181	MAJOR PROJECT PHASE-I					
DISSERTATION -I						
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	20	10
Evaluation	**SEE**	-	**CIE**	100 Mark		

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

Guidelines:

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. 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

CS 182	**MAJOR PROJECT PHASE -II**					
DISSERTATION -II						
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	32	16
Evaluation	**SEE**	100	**CIE**	100 Mark		

Course Outcomes :	
At the end of the course, the student will be able to:	
CO-1	Use different experimental techniques.
CO-2	Use different software/ computational/analytical tools.
CO-3	Design and develop an experimental set up/ equipment/test
CO-4	Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
CO-5	Either work in a research environment or in an industrial environment.
CO-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.

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