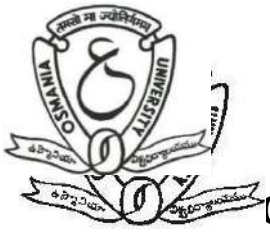


DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Scheme of Instruction and

Syllabus of

M.Tech

(Artificial Intelligence & Machine Learning)

Full-Time & CEEP

2025-26

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-ofart-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 Artificial Intelligence and Machine Learning program will be able:

PEO 1	To understand the principles and methods of Artificial Intelligence and their applications in various domains.
PEO 2	To acquire systems thinking to evaluate data intensive Machine learning based solutions with economic and environmental considerations.
PEO 3	To acquire research and technical communication skills.
PEO 4	To impart professional ethics and life long learning skills for professional advancement.

Programme Outcomes (PO)

PO 1	Able to apply principles, methods in design and development of data intensive software and hardware systems.
PO 2	Able to analyze problems, formulate AI & ML based solutions in various domains.
PO 3	Able to utilize different open source AI & Machine Learning tools, data sets to develop end to end systems.
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. (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

Type of course	Course Code	Course Name	Contact hours per week		Scheme of Evaluation		Credits
			L	P	CIE	SEE	
SEMESTER-I							
Core-I	CS 101	Mathematical Foundations of Computer Science	3	-	40	60	3
Core-II	CS 102	Advanced Data Structures	3	-	40	60	3
Core-III	CS 301	Artificial Intelligence and Machine Learning	3	-	40	60	3
Program Elective-I	CS 311	Natural Language Processing	3	-	40	60	3
	CS 312	Number Theory and Cryptography					
	CS 112	Advanced Compiler Design					
	CS 121	Data Mining					
	CS 131	Bio-Informatics					
Program Elective-II	CS 321	Enterprise Architecture	3	-	40	60	3
	CS 322	Exploratory Data Analysis Using Python					
	CS 323	Web Engineering					
	CS 122	Information Retrieval System					
	CS 525	Block Chain Technologies					
Program Elective-III	CS 331	Statistical Machine Translation	3	-	40	60	3
	CS 332	Cryptography- I(Applied Cryptography)					
	CS 113	Human Computer Interaction					
	CS 133	Cloud Computing					
	CS 531	Knowledge Representation and Reasoning					
Lab-I	CS 161	AL Lab	-	2	50	-	1
Lab-II	CS 366	ML Lab	-	2	50	-	1
		TOTAL	**18**	**4**	**340**	**360**	**20**
SEMESTER-II							
Core-IV	CS 302	Generative Artificial Intelligence	3	-	40	60	3
Core – V	CS 303	Deep Learning	3	-	40	60	3
Core – VI	CS 304	Programming for Big Data Systems	3	-	40	60	3
Program Elective-IV	CS 341	Reinforcement Learning	3	-	40	60	3
	CS 342	Parallel and Distributed Data bases					
	CS 343	Automatic Speech Recognition					
	CS 344	Large Scale Multimedia Search					
	CS 345	Web Mining					
Program Elective-V	CS 351	Interpretable Machine Learning	3	-	40	60	3
	CS 352	Machine Learning for Algorithmic Trading					

	CS 353	Secure Cloud Computing					
	CS 142	Data Analytics					
	CS 151	Simulation and Modeling					
Open Elective	OE 941 BM	Medical Assistive Devices	3	-	40	60	3
	OE 942 BM	Medical Imaging Techniques					
	OE 941 CE	Green Building Technology					
	OE 942 CE	Cost Management of Engineering Projects					
	OE 941 CS	Business Analytics					
	OE 941 EC	Elements of Embedded Systems					
	OE 941 EE	Waste To Energy					
	OE 942 EE	Power Plant Control and Instrumentation					
	OE 941 ME	Operations Research					
	OE 942 ME	Composite Materials					
	OE 943 ME	Industrial Safety					
	OE 941 LA	Intellectual Property Rights					
Lab-II	CS 361	Artificial Intelligence Lab	-	2	50	-	1
Lab-III	CS 362	Programming for Big Data Systems Lab	-	2	50	-	1
Mini Project	CS 371	Mini Project	-	4	50	-	2
TOTAL			**18**	**8**	**390**	**360**	**22**
SEMESTER-III							
Audit – I	AC 040	Research Methodology	2	-	40	60	0
Audit-II	AC 031	English for Research Paper Writing	2	-	40	60	0
	AC 032	Disaster Mitigation and Management					
	AC 033	Sanskrit for Technical Knowledge					
	AC 034	Value Education					
	AC 035	Stress Management by Yoga					
	AC 036	Personality Development through Life Enlightenment Skills					
	AC 037	Constitution of India					
	AC 038	Pedagogy Studies					
	AC 039	E-Waste Management					
Dissertation-I	CS 381	Dissertation Phase-I	-	20	100	-	10
TOTAL			**4**	**20**	**180**	**120**	**10**
SEMESTER-IV							
Dissertation-II	CS 382	Dissertation Phase-II	-	**32**	**100**	**100**	**16**
GRAND TOTAL			**40**	**64**	**1010**	**940**	**68**

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

Course Objectives :	
1	To understand the mathematical fundamentals in probabilistic and statistical concepts
2	To develop the understanding of the mathematical and logical basis of various techniques like machine learning, programming language design, and concurrency.
3	To study various Graph Theory problems.

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 and Design and Analysis of Algorithms		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To learn the various data structures and to design algorithms for a specific problem.
2	To understand the necessary mathematical abstraction to solve problems.
3	To familiarize with advanced problem-solving paradigms and data structures used to solve algorithmic problems.
4	To understand the basics of computational geometry and its efficiency

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

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

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 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 311	NATURAL LANGUAGE PROCESSING					
	PROGRAM ELECTIVE-I					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To gain knowledge on NLP.
2	To deal with morphological processing, syntactic parsing, information extraction.
3	To understand probabilistic NLP and classification of text using Python‟s NLTK Library.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Write Python programs to manipulate and analyze language data.
CO-2	Demonstrate key concepts from NLP and linguistics to describe and analyze language.
CO-3	Understand the data structures and algorithms that are used in NLP.
CO-4	Classify texts using machine learning and deep learning.

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

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

UNIT– III
Learning to Classify Text: Supervised Classification, Evaluation, Naive Bayes Classifiers

Deep Learning for NLP: Introduction to Deep Learning, Convolution Neural Networks, Recurrent Neural Networks, Classifying Text with Deep Learning

UNIT – IV

Extracting Information from Text

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

Analyzing Sentence Structure

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

UNIT –V

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

Suggested Reading:

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

CS 312	NUMBER THEORY AND CRYPTOGRAPHY					
PROGRAM ELECTIVE-I						
Prerequisites	Discrete Mathematics		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**CIE**	**40 Marks**	**SEE**		**60 Marks**	

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

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Suggested Reading :

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

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:	
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 Terminology, 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, 2001.
2	Ken Kennedy & John R. Allen Optimizing compilers for modern architectures: a dependence-based approach, Morgan Kaufmann, 2001.

CS 121	DATA MINING					
	PROGRAM ELECTIVE- I					
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, Vipin Kumar, Introduction to Data Mining, Pearson Education, 2008.

CS 131	BIO INFORMATICS					
PROGRAM ELECTIVE - I						
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 321	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 322	EXPLORATORY DATA ANALYSIS USING PYTHON					
	PROGRAM ELECTIVE – II					
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
1	To gain the fundamentals of Exploratory data analysis and understand different stages of EDA process
2	To familiarize with NumPy and Pandas tool and also to change the dataset inorder to analyze them better.
3	To gain overview on essential linear algebra and statistical measures for gaining insights about data and their correlation.
4	To understand time series data and how to perform EDA on it.
5	To use EDA techniques on real datasets, prepare different types of models and evaluate them

Course Outcomes :	
On completion of this course, the student will be able to implement :	
CO-1	Understand the fundamentals of Exploratory data analysis and its visual aids
CO-2	Preprocess raw data, cleaning the data and learn different methods of grouping dataset.
CO-3	Solve linear system of equations, descriptive statistics measures like measure of central tendency and measure of dispersion
CO-4	Perform data reduction and different methods of time series analysis
CO-5	Learn different methods for model development and three types of machine learning algorithm (supervised, unsupervised and reinforcement learning)

UNIT– I
Exploratory Data Analysis Fundamentals: Understanding data science,The significance of EDA,Steps in EDA,Making sense of data,Numerical data: discrete data,Continuous data.Categorical data.
Measurement scales: Nominal, Ordinal, Interval,Ratio.Comparing EDA with classical and Bayesian analysis, Software tools available for EDA: NumPy,Pandas , Matplotlib, IPython and Jupyter, SciPy ,Scikit

UNIT – II

Data loading: Loading the dataset, Data transformation Data cleansing ,Loading the CSV file, Reading and writing: CSV file with numpy, pandas, excel, json. Data analysis

Data Cleaning: Exploring data **,**Filtering data to weed out the noise, Column-wise filtration, row-wise filtration. Handling outliers, Feature encoding techniques: one-hot encoding, Label encoding, ordinal encoder. Features scaling: Methods for feature scaling.Feature transformation, Feature splitting.

Missing values, detecting missing values, example of detecting missing values, causes of missing values, types of missing values, diagnosis of missing values, dealing with missing values, dropping by rows, dropping by columns, mathematical operations with nan, errors, types of errors, dealing with errors.

Grouping Datasets: Understanding groupby (), groupby mechanics, selecting a subset of columns, max and min, mean, Data aggregation, group-wise operations, Renaming grouped aggregation columns Group-wise transformations, pivot tables, cross-tabulations.

UNIT – III

linear algebra: Fitting to polynomials with numpy, determinant, finding the rank of a matrix, matrix inverse using numpy, solving linear equations using numpy, decomposing a matrix using svd, eigen vectors and eigen values using numpy, generating random numbers

Descriptive Statistics: Understanding statistics, distribution functions uniform distribution, normal distribution, exponential distribution, binomial distribution. Cumulative distribution function, descriptive statistics. Measures of central tendency, mean/average, median , mode ,Measures of dispersion, standard deviation, variance, skewness, kurtosis, types of kurtosis. Calculating percentiles, Quartiles, visualizing quartiles.

Correlation: Introducing correlation, Types of analysis, Understanding univariate analysis, Understanding bivariate analysis, Understanding multivariate analysis. Discussing multivariate analysis using the Titanic dataset, Outlining Simpson's paradox ,Correlation does not imply causation.

UNIT– IV

Data reduction : distinction between data reduction and data redundancy, the objectives of data reduction, types of data reduction, performing numerosity data reduction, random sampling, stratified sampling, random over/undersampling, performing dimensionality data reduction, PCA **Time Series Analysis:** Understanding the time series dataset, fundamentals of TSA, univariate time series, characteristics of time series data, tsa with open power system data, data cleaning, time-based indexing, visualizing time series, grouping time series data, resampling time series data.

UNIT –V
Hypothesis Testing and Regression: Hypothesis testing, Hypothesis testing principle, statsmodels library, Average reading time, Types of hypothesis testing, T-test.p-hacking. Understanding regression, Types of regression, Simple linear regression, Multiple linear regression, Nonlinear regression, Constructing a linear regression model, Model evaluation, Computing accuracy, Understanding accuracy, implementing a multiple linear regression model. **Machine learning**: Types of machine learning, Understanding supervised learning, Regression, Classification Understanding unsupervised learning, Applications of unsupervised learning, Clustering using MiniBatch, K-means clustering, Extracting keywords, Plotting clusters, Word cloud. Understanding reinforcement learning, Difference between supervised and reinforcement learning, Applications of reinforcement learning.

Suggested Reading:

1	Hands-On Exploratory Data Analysis with Python, Suresh Kumar Mukhiya, Usman Ahmed, Packt Publishing, 2020
2	Python Data Analysis: Perform data collection, data processing, wrangling, visualization, and model building using Python, 3rd Edition, AvinashNavlani , Armando Fandango , Ivan Idris, Packt Publishing, 2021
3	Hands-On Data Preprocessing in Python Roy , Jafari Packt Publishing, 2022
4	Wes McKinney ―python for data analysis‖, 2nd Edition, publisher o'reilly , 2017

CS 323	WEB ENGINEERING					
	PROGRAM ELECTIVE – II					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To provide students with conceptual and practical knowledge, and skills required to develop web applications and web services.
2	To gain knowledge on web metrics and quality.
3	To focus on web resource management.
4	To know web evolution and its maintenance and web intelligence

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

UNIT – I

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

UNIT – II

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

UNIT– III

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

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

UNIT –V
Web Maintenance and Evolution: Techniques and Methodologies, Program Transformations for Web Application Restructuring, the Requirements of Methodologies for Developing Web Applications. A Customer Analysis-Based Methodology for Improving Web Business Systems
Web Intelligence: Techniques and Applications, Analysis and Customization of Web-Based Electronic Catalogs, Data Mining using Qualitative Information on the Web.

Suggested Reading :

1	Woojong Suh, Web Engineering Principles and Techniques, Idea Group Publications 2005.
2	Emilia Mendes, Nile Mosley, Web Engineering, Springer Berlin Heidelberg, 2006.

CS 122	INFORMATION RETRIEVAL SYSTEM					
	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 525	BLOCKCHAIN TECHNOLOGY					
PROGRAM ELECTIVE - II						
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

Introductio: 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 , Transactio 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-to-Public-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: Non-fungible 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): Introduction,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,** Princeton University Press and Oxford, 2016
2	Andreas M. Antonopoulos**, Mastering Bitcoin: Programming the Open Blockchain,** O'Reilly, 2017.
3	Dr. Gavin Wood, Andreas M. Antonopoulos**, Mastering Ethereum: Building Smart Contracts and Dapps,** O'Reilly, 2018.

CS 331	**STATISTICAL MACHINE TRANSLATION**					
PROGRAM ELECTIVE - III						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Introduce the field of machine translation (systems that translate speech or text from one human language to another), with a focus on statistical approaches.
2	Three major paradigms will be covered: word-based translation, phrase-based translation, and syntax-based translation.
3	Students will gain hands-on experience with building translation systems and working with real-world data, and they will learn how to formulate and investigate research questions in machine translation.

Course Outcomes :	
On completion of the course, to earn the grade Pass the student should at least be able to:	
CO-1	Describe and critically discuss the architecture of machine translation systems;
CO-2	Handle basic tools for training and applying machine translation systems;
CO-3	Compare different types of machine translation strategies, such as rule-based, statistical and neural machine translation;
CO-4	Evaluate machine translation output using automatic and manual methods and explain possible causes of translation errors;
CO-5	Critically read and summarise a scientific works in the field of machine translation

UNIT – I
Overview of machine translation,the statistical approach to MT Word-based alignment and translation: IBM word alignment models, n-gram language models. Absolute discounting and KneserNey smoothing., n-gram language models continued, Very large language models.

UNIT – II
Phrase based translation and discriminative training: Phrase-based MT, Why do we need phrases, Relationship to EBMT, Phrase extraction, Estimating phrase translation probabilities and the problem of over fitting, From the noisy channel to linear models, Phrase features, Phrase reordering models, Phrase based decoding, K- best lists.

UNIT– III
Maximum entropy, Minimum error-rate training, Perceptron, max-margin methods, System combination. Interlude: Subword translation, Transliteration. Integrating traditional translation rules, Integrating morphology into translation, Decoding with lattices for morphology and word segmentation.

UNIT – IV
Syntax based translation, Hierarchical and syntax based MT , Why do we need syntax, Synchronous context-free grammars and TSGs, Extracting synchronous CFGs and TSGs from parallel data, Estimating rule probabilities and the problem of overfitting, Extracting synchronous TSGs from treetree data and the problem of non-isomorphism.

UNIT –V
CKY decoding, CKY with an n-gram language model, More CKY decoding: Binarization. k-best lists. Decoding with lattices, Source-side tree decoding. Target-side left-to-right decoding, Syntax-based language models, Beyond synchronous CFGs and TSG, Towards semantics based translation.

Suggested Reading:

1	Statistical Machine Translation, P. Koehn, Cambridge Unv. Press, 2010
2	Hybrid Approaches to Machine Translation, M.R.Costa-Jussa, et al. , Springer, 2016
3	Machine Translation, Pushpak Bhattacharyya, CRC Press, 2015
4	Handbook of Natural Language Processing and Machine Translation, J.Olive, C.Christianson, J.McCary , Springer, 2011

CS 332	CRYPTOGRAPHY-I					
	PROGRAM ELECTIVE-III					
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	Understand basics of Cryptography and Network Security.
2	Secure a message over insecure channel by various encryption and decryption algorithms
3	Learn about how to maintain the Confidentiality, Integrityand Availability of a data.
4	Understand various protocols for networksecurityto protectagainst the threats in the networks.

Course Outcomes:	
On completion of this course,the student will be able to:	
CO-1	Provide security of the data over the network.
CO-2	Apply the Encryption anddecryption algorithms
CO-3	Analyze the public key cryptography techniques
CO-4	Apply the various advanced protocols to protect against attacks

UNIT– I

Cryptographic Techniques and Algorithms
Course Introduction: History of Cryptography, Security Overview.
Classical Encryption Techniques: Symmetric Cipher Model, Some Basic Terminology, Cryptography Classification, Cryptanalysis, Substitution, One-Time Pad, Transposition, (Permutation) Ciphers, Product Ciphers, Rotor Machines, Rotor Machine Principle, Steganography.
Block Ciphers and DES: Block vs. Stream Ciphers, Shannon‟s S-P Networks, FeistelCipher Structure, Feistel Cipher Design Elements, Data Encryption Standard (DES), Avalanche Effect,Avalanche in DES,Strength of DES,DifferentialCryptanalysis,Linear Cryptanalysis, Block Cipher Design Principles.

UNIT– II

BasicConceptsinNumberTheoryandFiniteFields: Euclid's Algorithm, Modular Arithmetic, Algebraic Structures, Galois Fields, Polynomial Arithmetic.
AdvancedEncryptionStandard(AES): BasicStructure ofAES,SubstituteBytes,Shift Rows,MixColumns,AESArithmetic,AddRoundKey,AES Key Expansion,AESExample KeyExpansion, AES Example Encryption, AESExample,Avalanche AES Decryption.

BlockCipherOperations: Double-DES,Triple-DES,DES-X,ElectronicCodeBook(ECB), CipherBlockChaining(CBC),MessagePadding,CipherTextStealing(CTS),Cipher Feedback(CFB),Output Feedback(OFB),Counter(CTR).

UNIT–III

Pseudo Random Number Generation and Stream Ciphers: Pseudo Random Numbers, A Sample Generator, Terminology, Linear-Congruential Generators, Blum Blum Shub Generator, Random & Pseudorandom Number Generators, Using Block Ciphers aes PRNGs, RC4 Stream Ciphers.

Public Key Cryptography: Mathematical Background (Fermat's Little Theorem, Euler Totient Function , Euler's Theorem Chinese Remainder Theorem etc.) Public KeyEncryption,Symmetric vs. Public-Key, RSA Public KeyEncryption, RSA KeyConstruction, Exponentiation, RSA Issues, Factoring.

Cryptographic Hash Functions: Hash Function, Cryptographic Hash Functions, Applicationsof CryptoHashFunctions,BirthdayProblem,Block CiphersasHashFunctions, SecureHashAlgorithm(SHA)

UNIT– IV

Message Authentication Codes: Message Security Requirements, MAC, HMAC, Using Symmetric Ciphers for MACs. Cipher-based Message Authentication Code (CMAC), Authenticated Encryption, CCM.

Digital Signatures: Digital Signature Model, Attacks, Forgeries, Digital Signature, Requirements, Digital Signature Standard (DSS), DSS vs. RSA Signatures, Digital Signature Algorithm (DSA), DSA Key Generation, DSA Signature Creation, DSA Signature Verification.

Key Management and Distribution: Key Distribution Using KDC, Key Distribution Using PublicKeys,SecretKeyDistributionwithConfidentialityandAuthentication,Distributionof Public Keys, Public-Key Certificates PKI, PKIX, and X.509, CA Hierarchy.

User Authentication Protocols: User Authentication, Replay Attacks, Needham Schroeder Protocol Denning‟s Modification, One-Way Authentication for Email, Kerberos, Remote User Authentication Using Public Keys

UNIT–V

Advanced Protocols: Zero knowledge Proofs, Identity based public key, Secure elections, Secure multi-party computation, Digital cash.

Secure Socket Layer: Web Traffic Security Approaches SSL Architecture, SSL Handshake Protocol, SSL Handshake Protocol Actions, Handshake Messages, Security Capability Negotiation, Cryptographic Computations, SSL Change Cipher Spec Protocol, SSL Alert Protocol, SSL Record Protocol Services, SSL Record Protocol Operation.

Transport Level Security (TLS): HTTPS, HTTPS Use, Secure Shell (SSH), SSH Protocol Stack, SSH Transport Layer Protocol, SSH User Authentication Protocol, SSH Connection Protocol, Port Forwarding.

Wireless Network Security: Wireless Network Threats, Countermeasures Mobile Device Security Wi-Fi Operation IEEE 802.11 Architecture IEEE 802.11 Services WiredEquivalent Privacy (WEP), 802.11i Wireless LAN Security.

ElectronicMailSecurity, IPSecurity, Intrusion Detection, Malicious Software.

SuggestedReading:

1	WilliamStallings,"CryptographyandNetworkSecurity:PrinciplesandPractice,"6th Edition,Pearson,2014
2	BehrouzA. ForouzanandDebdeepMukhopadhyay,CryptographyandNetwork Security,TataMcGrawHill.
3	D.R.Stinson:Cryptography:TheoryandPractice(DiscreteMathematicsandIts Applications),3rd Edition,CRC Press,2005.
4	B.Schneier:Applied cryptography:protocols,algorithms, andsourcecodeinC, 2nd Edition,JohnWiley&Sons.
5	BernardMenezes:NetworkSecurity&Cryptography,FirstEdition, Cengage Learning,Delhi, 2011.

CS 113	HUMAN COMPUTER INTERACTION					
	PROGRAM ELECTIVE -III					
Pre-requisites			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 Use predictive models and conduct usability testing

UNIT – I

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

Process of Interaction Design: Introduction, What is Involved in Interaction Design, Practical Issues. **Conceptualizing Interaction:** Introduction, Conceptualizing Interaction, 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 Rogers Interaction Design: Beyond HumanComputer Interaction wiley Publishing 5th Edition 2019
2	Jenifer Tidwell, Charles Brewer, Aynne Valencia, Designing Interfaces, O'REllIEY 3rd Edition 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 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 531	BAYESIAN METHODS FOR HACKERS					
	PROGRAM ELECTIVE-III					
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 Bayesian methods including Bayesian model specification, Bayesian posterior inference, and model assessment
2	Develop and estimate linear and nonlinear Bayesian models
3	Understand the knowledge of distribution methods

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Acquire a good understanding of Bayesian methods including Bayesian model specification, Bayesian posterior inference, and model assessment.
CO-2	Use the acquired knowledge of Bayesian statistics to develop and estimate linear and nonlinear Bayesian models as well as have enough exposure to MCMC (Markov Chain Monte Carlo) computation.
CO-3	Deploy this knowledge in analyzing the various distribution methods

UNIT – I

The Philosophy of Bayesian Inference: Introduction, Our Bayesian Framework, Probability Distributions, Using Computers to Perform Bayesian Inference. Inferring Behavior from TextMessage Data. PyMC: Introduction, Parent and Child Relationships, PyMC Variables, Observations in the Model, Modeling Approaches, Model Appropriate, Separation Plots

UNIT – II

Opening the Black Box of MCMC, The Bayesian Landscape, Exploring the Landscape Using MCMC, Algorithms to Perform MCMC, Other Approximation Solutions to the Posterior, Unsupervised Clustering Using a Mixture Model, Posterior Samples, Using MAP to Improve Convergence, Diagnosing Convergence, Autocorrelation , Thinning, pymc.Matplot.plot(), MCMC, Intelligent Starting Values, Priors, The Folk Theorem of Statistical Computing.

UNIT– III

The Greatest Theorem Never Told : Introduction, The Law of Large Numbers, Intuition, Example: Convergence of Poisson Random Variables, Compute Var (Z), Expected Values and Probabilities , Bayesian Statistics, The Disorder of Small Numbers, Sorting, Derivation of Sorting Comments Formula.

UNIT – IV
Introduction, Loss Functions, Loss Functions in the Real World, Optimizing for the Showcase on The Price Is Right, Machine Learning via Bayesian Methods, Financial Prediction, Kaggle Contest on Observing Dark Worlds, The Data, Priors, Training and PyMC Implementation, Showcase on The Price Is Right, Machine Learning via Bayesian Methods, Financial Prediction, Kaggle Contest on Observing Dark Worlds, The Data, Priors, Training and PyMC Implementation

UNIT –V
Getting Our Priorities Straight: Introduction, Subjective versus Objective Priors, Decisions, Empirical Bayes, The Gamma Distribution, The Wishart Distribution, The Beta Distribution, Bayesian Multi-Armed Bandits, Applications, Trial Roulette Method, Conjugate Priors, Jeffreys Priors, Effect of the Prior as N Increases. Bayesian Perspective of Penalized Linear Regressions.

Suggested Reading:

1	Bayesian Methods for hackers Willey publications, Cameron Davidson-Pilon, 2015.
2	Bayesian Methods for Statistical Analysis , Australian Nat University Press, Borek Puza · 2015.
3	Bayesian Reasoning and Machine Learning, Cambridge University Press, David Barber · 2012.

CS 161	**AI LAB**					
LAB I						
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		50 Marks	

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

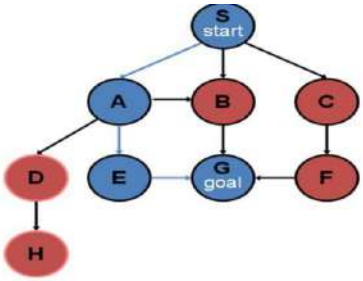
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to use various heuristic search strategies in Artificial Intelligence programs
CO-2	Able to use probabilistic reasoning in decision problems
CO-3	Able to use various open source ML libraries to evaluate different 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 366	ML LAB					
LAB2						
Pre-requisites			L	T	P	C
			-	-	2	1
Evaluation	SEE	-	CIE		50 Marks	

Course Objectives :	
1	Learn usage of Libraries for Machine Learning in Python and Demonstrate Dimensionality reduction methods.
2	Describe appropriate supervised learning algorithms for a given problem. Explore back propagation algorithm and ensemble methods
3	Discuss different unsupervised learning algorithms.
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Illustrate the applications of Python Machine Learning Libraries. Apply Dimensionality reduction methods for Machine Learning Tasks.
CO-2	Design and analyze various supervised learning mechanisms. Develop back propagation algorithm and Random Forest Ensemble method.
CO-3	Design and analyze various unsupervised learning algorithms

List of Programs:

1. Write a python program to import and export data using Pandas library functions
2. Demonstrate various data pre-processing techniques for a given dataset
3. Implement Dimensionality reduction using Principle Component 14 3 Analysis (PCA) method.
4. Write a Python program to demonstrate various Data 20 4 Visualization Techniques.
5. Implement Simple and Multiple Linear Regression Models.
6. Develop Logistic Regression Model for a given dataset.
7. Develop Decision Tree Classification model for a given dataset and use it to classify a new sample.
8. Implement Naïve Bayes Classification in Python
9. Build KNN Classification model for a given dataset.
10. Build Artificial Neural Network model with back propagation on a given dataset.
11. a) Implement Random Forest ensemble method on a given dataset.
    b) Implement Boosting ensemble method on a given dataset.
12. Write a python program to implement K-Means clustering Algorithm.

SEMESTER -II

CS302	**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

CS303	DEEP LEARNING					
	CORE - V					
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.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descet, Minibatch Stochastic Gradient Descent, Momentum, Adagrad, RMSProp, Adadelta, 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 304	PROGRAMMING FOR BIG DATA SYSTEMS					
CORE VI						
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, 2000

CS 341	**REINFORCEMENT LEARNING**					
PROGRAM ELECTIVE - IV						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Understand the Collection of machine learning techniques which solve sequential decision making problems using a process of trial-and-error.
2	Understand the Foundational models and algorithms used in RL
3	To familiarize students with advanced topics such as scalable function approximation using neural network representations
4	To understand concurrent interactive learning of multiple RL agents.

Course Outcomes *:*	
On completion of this course, the student will be able to :	
CO-1	Demonstrate knowledge of basic and advanced reinforcement learning techniques.
CO-2	Identification of suitable learning tasks to which these learning techniques can be applied.
CO-3	Appreciation of some of the current limitations of reinforcement learning techniques.
CO-4	Formulation of decision problems set up and run computational experiments, evaluation of results from experiments.

UNIT – I

Introduction: Course logistics and overview. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.

Probability Primer: Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence

UNIT – II

Markov Decision Process: Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations

Prediction and Control by Dynamic Programming: Overview of dynamic programming for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration, Banach fixed point theorem, proof of contraction mapping property of Bellman expectation and optimality operators, proof of convergence of policy evaluation and value iteration algorithms, DP extensions.

UNIT– III

Monte Carlo Methods for Model Free Prediction and Control: Overview of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling

TD Methods: Incremental Monte Carlo Methods for Model Free Prediction, Overview TD(0), TD(1) and TD(λ), k-step estimators, unified view of DP, MC and TD evaluation methods, TD Control methods - SARSA, Q-Learning and their variants.

UNIT – IV

Function Approximation Methods: Getting started with the function approximation methods, Revisiting risk minimization, gradient descent from Machine Learning, Gradient MC and Semi- gradient TD(0) algorithms, Eligibility trace for function approximation, After states, Control with function approximation, Least squares, Experience replay in deep QNetworks.

UNIT –V

Policy Gradients: Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods

Suggested Reading:

1	"Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition, 2018.
2	"Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy, 2021.

CS 342	Parallel and Distributed Data bases					
	PROGRAM ELECTIVE - IV					
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

CS343	AUTOMATIC SPEECH RECOGNITION					
	PROGRAM ELECTIVE - IV					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives : Students will be able to	
1	Know the theory and practice of automatic speech recognition (ASR),
2	Learn on the statistical approaches that comprise the state of the art ASR
3	Analyze the framework for speech recognition, including speech signal analysis, acoustic modeling using hidden Markov models, language modeling and recognition .

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Describe the statistical framework used for automatic speech recognition.
CO-2	Understand the weakness of the simplified speech recognition systems and demonstrate knowledge of more advanced methods to overcome these problems.
CO-3	Describe speech recognition as an optimization problem in probabilistic terms.
CO-4	Relate individual terms in the mathematical framework for speech recognition to particular modules of the system.
CO-5	Build a large vocabulary continuous speech recognition system, using a standard software toolkit.

UNIT – I
Introduction to Statistical Speech Recognition, HMMs for Acoustic Modeling, Hiddden Markov Models and Weighted finite state transducers.

UNIT – II
Weighted finite state transducers for Automatic Speech Recognition, Tied State Hidden Markov Models and Neural Networks based acoustic modeling(Hybrid/ Tandem/ Time Delay NN models)

UNIT– III
Introduction to RNN based models, Language models, Acoustic feature analysis for ASR

UNIT – IV
End- to end Neural architectures for ASR, Search and Decoding multilingual and low-resource ASR

UNIT –V
Speech Synthesis, CNN in Speech, Speaker Adaptation, Discriminative Training, Generative Adversarial Networks

Suggested Reading :

1	Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd Edition, 2019
2	Mark Gales and Steve Young, The application of hidden Markov models in speech recognition, Foundations and Trends in Signal Processing, 1(3):195-304, 2008.
3	Geoffrey Hinton, Li Deng, Dong Yu, George E. Dahl, Abdel-rahman Mohamed, Navdeep Jaitly, Andrew Senior, Vincent Vanhoucke, Patrick Nguyen, Tara N. Sainath, and Brian Kingsbury, Deep Neural Networks for Acoustic Modeling in Speech Recognition, IEEE Signal Processing Magazine, 29(6):82-97, 2012

CS 344	LARGE SCALE MULTIMEDIA SEARCH					
PROGRAM ELECTIVE - IV						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
1	To introduce the concepts of feature extraction , Concept-Based and Event-Based Video Search in Large Video Collections
2	To learn scalable Feature Extraction methods for Big Data Multimedia Mining and Video Understanding with Limited Training Labels
3	To familiarize the concepts of Multimodal Fusion and Large-Scale Social Multimedia
4	To introduce the concepts of privacy , data storage , management and searching of Big Multimedia
5	To introduce different Applications of Large-Scale Multimedia Search

Course Outcomes :	
CO-1	Extract features from large video collections and use multi-task learning for Concept-Based Video Search
CO-2	apply parallelization and deep learning techniques for feature extraction and use graph based models for video understanding
CO-3	use Multimodal Fusion in Multimedia Classification , analyze Social Multimedia Streams and develop Social Media Data Crawler.
CO-4	Understand challenges of Multimedia Privacy and storage , Construct Perceptual Hash Algorithms for searching
CO-5	apply deep learning for image tagging , Explore Millions of Images using Image Maps and Graphs

UNIT – I

Feature Extraction from Big Multimedia Data

Representation Learning on Large and Small Data: Introduction, Representative Deep CNNs, AlexN ReLU Nonlinearity, Data Augmentation, Dropout, Network in Network, MLP Convolutional Lay Global Average Pooling, VGG, Very Small Convolutional , Filters, Multi-scale Training, GoogLeN Inception Modules , Dimension Reduction, ResNet , Residual Learning, IdentityMapping by Shortcu Transfer Representation Learning, Method Specifications , Experimental Results and Discussion

Concept-Based and Event-Based Video Search in Large Video Collections: Introduction, Video preprocessing and Machine Learning Essentials, Video Representation, Dimensionality Reduction, Methodology for Concept Detection and Concept-Based Video Search, Cascades for Combining Different Video Representations

Multi-Task Learning for Concept Detection and Concept-Based Video Search, Exploiting Label Relations, Methods for Event Detection and Event-Based Video Search.

UNIT – II
Big Data Multimedia Mining: Feature Extraction Facing Volume, Velocity, and Variety: Introduction, Scalability through Parallelization, Scalability through Feature Engineering, Deep Learning-Based Feature Learning, Benchmark Studies
Large-Scale Video Understanding with Limited Training Labels: Introduction, Video Retrieval with Hashing, Graph-Based Model for Video Understanding , Experiments

UNIT– III
Multimodal Fusion of Big Multimedia Data: Multimodal Fusion in Multimedia Retrieval, Unsupervised Fusion in Multimedia Retrieval, Partial Least Squares Regression, Experimental Comparison, Late Fusion of Multiple Multimedia Rankings, Multimodal Fusion in Multimedia Classification.
Large-Scale Social Multimedia Analysis: Social Multimedia in Social Media Streams, Social Multimedia, Social Multimedia Streams, Analysis of the Twitter Firehose, Dataset: Overview, Linked Resource Analysis, Image Content Analysis, Geographic Analysis, Textual Analysis, LargeScale Analysis of Social Multimedia, Analysis of Visual Content, Analysis of Textual Content Analysis of Geographical Content, Analysis of User Content, Large-Scale Multimedia Opinion Mining System, Social Media Data Crawler.

UNIT – IV
Privacy and Audiovisual Content: Protecting Users as Big Multimedia Data Grows Bigger: Introduction, Protecting User Privacy, Multimedia Privacy, Privacy-Related Multimedia Analysis Research, The Larger Research Picture, Outlook on Multimedia Privacy Challenges.
Scalability in Multimedia Access, Data Storage and Management for Big Multimedia: Introduction, Media Storage, Processing Media, Multimedia Delivery, Case Studies: Face book
Perceptual Hashing for Large-Scale Multimedia Search: Introduction, Unsupervised Perceptual Hash Algorithms, K-Means Hashing, Kernelized Locality Sensitive Hashing, Supervised Perceptual Hash Algorithms, Constructing Perceptual Hash Algorithms

UNIT –V
Applications of Large-Scale Multimedia Search: Image Tagging with Deep Learning: Fine-Grained Visual Analysis: Introduction, Basic Deep Learning Models, Deep Image Tagging for Fine-Grained Image Recognition, Deep Image Tagging for Fine-Grained Sentiment Analysis.
Visually Exploring Millions of Images using Image Maps and Graphs : Introduction Algorithms for Image Sorting, Self-Organizing Maps, Self-Sorting Maps, Evolutionary Algorithms, Improving SOMs for Image Sorting, Quality Evaluation of Image Sorting Algorithms, 2D Sorting Results, Demo System for Navigating 2D Image Maps, Graph-Based Image Browsing.
Medical Decision Support Using Increasingly Large Multimodal Data Sets : Introduction, Data, Ground Truth, and Scientific Challenges, Techniques used for Multimodal Medical Decision Support, Application Types of Image-Based Decision Support, Discussion on Multimodal Medical Decision Support, Outlook or the Next Steps of Multimodal Medical Decision Support.

Suggested Reading:

1	Big data analytics for Large-Scale Multimedia Search, Benoit Huet, Edward Y. Chang, Ioannis Kompatsiaris, Wiley, 2019.

CS 345	WEB MINING					
	PROGRAM ELECTIVE - IV					
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives :	
1	To learn the basic concepts of data mining and machine learning for extracting information from web.
2	To learn the concepts of information retrieval, structured information extraction and integration techniques.
3	To understand the concepts of web structure mining and usage mining.
4	To learn the concepts of opinion mining and sentiment analysis.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Apply association rule mining and text classification techniques for web documents.
CO-2	Use similarity metrics and clustering algorithms for web documents.
CO-3	Use link analysis for social network analysis and to rank web search results.
CO-4	Design and implement a crawler application to collect and index documents from the web.
CO-5	Use web usage mining techniques to discover web usage patterns and sentiment/ opinion finding.

UNIT – I

Introduction: The World Wide Web, History of the Web and the Internet, Web Data Mining
Association Rules and Sequential Patterns: Basic Concepts, Apriori Algorithm, Data Formats for Association Rule Mining, Mining with Multiple Minimum Supports, Mining Class Association Rules
Supervised Learning: Basic Concepts, Decision Tree Induction, Classifier Evaluation, Naïve Bayesian Classification, Naïve Bayesian Text Classification, K-Nearest Neighbor Learning, Ensemble of Classifiers

UNIT II

Unsupervised Learning: Basic Concepts. K-means Clustering, Representation of Clusters, Hierarchical Clustering, Distance Functions, Data Standardization, Handling of Mixed Attributes, Which Clustering Algorithm to Use, Cluster Evaluation
Information Retrieval and Web Search: Basic Concepts, Relevance Feedback, Evaluation Measures, Text and Web Page Pre-Processing, Inverted Index and Its Compression

UNIT – III

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

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

UNIT – IV

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

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

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

UNIT –V

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

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

Suggested Reading:

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

CS 351	INTERPRETABLE MACHINE LEARNING					
	PROGRAM ELECTIVE - V					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce the concepts of Interpretation, Interpretability, and Explainability
2	To learn the importance of features and Global Model-Agnostic Interpretation Methods
3	To explore counterfactual explanations and Visualiz Convolutional Neural Networks
4	To study Interpretation Methods for Multivariate Forecasting , Feature Selection and Engineering for Interpretability
5	To introduce the concepts of Bias Mitigation , Causal Inference , Model Tuning for Interpretability

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the methods of traditional model interpretation and challenges of machine learning interpretability
CO-2	Measuring the impact of a feature on the outcome and use Local Model-Agnostic Interpretation Methods
CO-3	Understand Anchor and Counterfactual Explanations, visualize CNN and evaluate misclassifications
CO-4	Understand the effect of irrelevant features and Asses time series models and LSTM with interpretation methods
CO-5	Detect and mitigate Bias, create casual models, tune models for fairness

UNIT – I

Interpretation, Interpretability, and Explainability: Technical requirements, machine learning interpretation, Interpretability, Explainability, A business case for interpretability

Key Concepts of Interpretability: Preparations, Learning about interpretation method types and scopes, Appreciating what hinders machine learning interpretability

Interpretation Challenges: Reviewing traditional model interpretation methods, Predicting minutes delayed with various regression methods, Generalized Linear Models (GLMs).

UNIT – II

Fundamentals of Feature Importance and Impact: Technical requirements, The mission, The preparations, Measuring the impact of a feature on the outcome, Practicing PFI, Interpreting PDPs, Explaining ICE plots.

Global Model-Agnostic Interpretation Methods: The preparations, Learning about Shapley values, Interpreting SHAP summary and dependence plots, Accumulated Local Effects (ALE) plots, Global surrogates. Local Model-Agnostic Interpretation Methods: Leveraging SHAP's KernelExplainer for local interpretations with SHAP values, Employing LIME, Using LIME for NLP, Trying SHAP for NLP

UNIT– III

Anchor and Counterfactual Explanations: Unfair bias in recidivism risk assessments, Understanding anchor explanations, Exploring counterfactual explanations, Comparing with CEM

Visualizing Convolutional Neural Networks: Preparations, Loading the CNN model, Visualizing the learning process with activation-based methods, Evaluating misclassifications with gradient-based attribution methods, Saliency maps, Grad-CAM, Creating GradCam++ maps, Understanding classifications with perturbation-based attribution methods, LIME's Image Explainer, CEM, Bonus method: SHAP's Deep Explainer.

UNIT – IV

Interpretation Methods for Multivariate Forecasting and Sensitivity Analysis: Loading the LSTM models, Assessing time series models with traditional interpretation methods,
Generating LSTM attributions with integrated gradients, Computing global and local attributions with SHAP's KernelExplainer, Identifying influential features with factor prioritization, Computing Morris sensitivity indices, Quantifying uncertainty and cost sensitivity with factor fixing, Generating and predicting on Salteli samples.

Feature Selection and Engineering for Interpretability: The preparations, Understanding the effect of irrelevant features,Creating a base model, Reviewing filter-based feature selection methods, Basic filter-based methods, Correlation filter-based methods, Ranking filter-based methods, Comparing filterbased methods, Exploring embedded feature selection methods, Discovering wrapper, hybrid, and advanced feature selection methods, Wrapper methods, Hybrid methods, Advanced methods, Evaluating all feature-selected models, Considering feature engineering.

UNIT –V

Bias Mitigation and Causal Inference Methods: Detecting bias, Mitigating bias, Pre-processing bias mitigation methods, In-processing bias mitigation methods, Creating a causal model, Understanding heterogeneous treatment effects, Testing estimate robustness.

Monotonic Constraints and Model Tuning for Interpretability: Placing guardrails with feature engineering, Tuning models for interpretability, Tuning a Keras neural network, Tuning other popular model classes, Optimizing for fairness with Bayesian hyper parameter tuning and custom metrics, Constraints for XGBoost, Constraints for Tensor Flow Lattice.

Suggested Reading:

1	Interpretable Machine Learning with Python by Serg Masis, Released March 2021

CS352	**MACHINE LEARNING FOR ALGORITHMIC TRADING**					
	PROGRAM ELECTIVE - V					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce the concepts of ML driven trading strategies , data sources and use cases
2	To learn the alpha factors, financial feature engineering and Portfolio Optimization
3	To introduce Time-Series Models and Bayesian ML for trading
4	To introduce data driven techniques for asset allocation and using Tex data for trading
5	To introduce deep learning techniques for Financial Time Series and Satellite Image analysis

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Use API s to access market data and understand the process of designing and executing an ML-driven trading strategies
CO-2	develop alpha factors that predict returns , optimize portfolio and measure portfolio performance
CO-3	Use Time-Series Models for Volatility Forecasts and Statistical Arbitrage , Identify Longshort signals using Bayesian and Decision tree approaches
CO-4	apply unsupervised learning techniques to generate optimal portfolios and analyze financial news and sentiment using NLP techniques
CO-5	Use CNN, RNN for time series and grid data , implement Auto encoders for nonlinear feature extraction

UNIT – I

Machine Learning for Trading – From Idea to Execution: The rise of ML in the investment industry, Designing and executing an ML-driven strategy, ML for trading – strategies and use cases: Data mining for feature extraction and insights, Supervised learning for alpha factor creation, Asset allocation, Testing trade ideas, Reinforcement learning.

Market and Fundamental Data – Sources and Techniques: Market data reflects its environment, Working with high-frequency data, API access to market data, How to work with fundamental data, Financial statement data.

Alternative Data for Finance – Categories and Use Cases: The alternative data revolution, Sources of alternative data: Individuals, Business processes, Sensors; Criteria for evaluating alternative data: Quality of the signal content, Quality of the data, Technical aspects; The market for alternative data: Data providers and use cases; Working with alternative data: Scraping OpenTable data, Scraping and parsing earnings call transcripts

UNIT– II

Financial Feature Engineering – How to Research Alpha Factors: Alpha factors in practice – from data to signals, Building on decades of factor research, Engineering alpha factors that predict returns : From signals to trades – Zipline for backtests, Separating signal from noise with Alphalens, Alpha factor resources.

Portfolio Optimization and Performance Evaluation: How to measure portfolio performance, Risk and return: The evolution of modern portfolio management, Mean-variance optimization, Alternatives to mean-variance optimization, Risk parity, Risk factor investment, Hierarchical risk parity; Trading and managing portfolios with Zipline, Scheduling signal generation and trade execution, Implementing mean-variance portfolio optimization, Measuring back test performance with pyfolio, Creating the returns and benchmark inputs, Walk-forward testing – out-of-sample returns

UNIT– III

The Machine Learning Process: Machine learning from data works: challenges, Supervised learning, Unsupervised learning, Reinforcement learning, The machine learning workflow, Linear Models – From Risk Factors to Return Forecasts, Time-Series Models for Volatility Forecasts and Statistical Arbitrage: Tools for diagnostics and feature extraction, How to diagnose and achieve stationarity, Univariate time-series models, Multivariate time-series models, Cointegration – time series with a shared trend, Statistical arbitrage with cointegration.

Bayesian ML – Dynamic Sharpe Ratios and Pairs Trading: How Bayesian machine learning works, Probabilistic programming with PyMC3, Bayesian ML for trading, Random Forests – A Long-Short Strategy for Japanese Stocks, Decision trees – learning rules from data, Random forests – making trees more reliable, Long-short signals for Japanese stocks.

Unit – IV

Data-Driven Risk Factors and Asset Allocation with Unsupervised Learning: Dimensionality reduction, PCA for trading, Clustering: k-means clustering, Hierarchical clustering, Density-based clustering, Gaussian mixture models; Hierarchical clustering for optimal portfolios.

Text Data for Trading – Sentiment Analysis: ML with text data – from language to features, Key challenges of working with text data, The NLP workflow, Applications, From text to tokens – the NLP pipeline, NLP pipeline with spaCy and textacy, NLP with TextBlob, Counting tokens – the documentterm matrix, The bag-of-words model, Document-term matrix with scikit-learn

NLP for trading: The naive Bayes classifier, Bayes' theorem refresher, The conditional independence assumption, Classifying news articles, Sentiment analysis with Twitter and Yelp data. Topic Modeling – Summarizing Financial News: Learning latent topics – Goals and approaches, Probabilistic latent semantic analysis, Latent Dirichlet allocation, Modeling topics discussed in earnings calls, Topic modeling for with financial news, Word Embeddings for Earnings Calls and SEC Filings, word embeddings encode semantics, word2vec – scalable word and phrase embeddings. Sentiment analysis using doc2vec embeddings, architecture in TensorFlow.

UNIT –V
Deep Learning for Trading: Deep learning – what's new and why it matters, Designing an NN, A neural network from scratch in Python, Popular deep learning libraries, Optimizing an NN for a longshort strategy.**CNNs for Financial Time Series and Satellite Images:** How CNNs learn to model grid-like data, CNNs for satellite images and object detection, CNNs for time-series data – predicting returns. **RNNs for Multivariate Time Series and Sentiment Analysis:** How recurrent neural nets work, RNNs for time series with TensorFlow 2, RNNs for text data. **Autoencoders for Conditional Risk Factors and Asset Pricing:** Autoencoders for nonlinear feature extraction, Implementing autoencoders with TensorFlow 2,A conditional autoencoder for trading. Generative Adversarial Networks for Synthetic Time-Series Data,Creating synthetic data with GANs, How to build a GAN using TensorFlow 2, TimeGAN for synthetic financial data, Deep Reinforcement Learning – Building a Trading Agent, Elements of a reinforcement learning system.

Suggested Reading:

1	Machine Learning for Algorithmic Trading. Predictive Models to Extract Signals From Market and Alternative Data for Systematic Trading Strategies With Python, Stefan Jansen, Packt Publishers, 2020.

CS 353	SECURE CLOUD COMPUTING					
	PROGRAM ELECTIVE V					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce security principles and their importance in Cloud computing platforms
2	To familiarize Virtualization System Vulnerabilities and attacks
3	To introduce the technologies for virtualization based security enhancement
4	To introduce legal and compliance issues in cloud security

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand how the security concepts are applied in cloud computing environments
CO-2	Identify and manage vulnerabilities in VMs
CO-3	Demonstrate usage of technologies for protection of virtual servers, storage systems and logs
CO-4	Apply security standards, regulatory mandates, audit policies and compliance requirements for cloud vendors

UNIT - I

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defence in depth, least privilege, how these concepts apply in the cloud, what these concepts mean and their importance in PaaS, IaaS and SaaS. e.g. User authentication in the cloud; Cryptographic Systems- Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL.

UNIT – II

Vulnerability Issues: Isolation of users/VMs from each other. How the cloud provider can provide this; **Virtualization System Security Issues**- ESXi Security, ESX file system, security, storage considerations, backup and recovery; **Virtualization System Vulnerabilities**- Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware.

UNIT – III

Virtualization System-Specific Attacks:

Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking.

UNIT – IV
Technologies For Virtualization-Based Security Enhancement: IBM security virtual server protection, virtualization-based sandboxing; Storage Security- HIDPS, log management, Data Loss Prevention. Location of the Perimeter.

UNIT –V
Legal And Compliance Issues: Responsibility, ownership of data, right to penetration test, local law where data is held, examination of modern Security Standards (eg PCIDSS), how standards deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

Suggested Reading:

1	Tim Mather, Subra Kumara swamy, ShahedLatif, ―Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance‖ OReilly Media; 2009.
2	Ronald L. Krutz, Russell Dean Vines, ―Cloud Security‖ , 2010.
3	John Rittinghouse, James Ransome, ―Cloud Computing‖ CRC Press; 2009.
4	Sushil Jajodia, Krishna Kant, Pierangela marati, Anoop Singhal, Vipin Swarup, Cliff Wang , ―Secure Cloud Computing‖, Springer Book 2014

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 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 model

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to categorize the random data of a physical system into a particular type of probability distribution function.
CO-2	Ability to 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	Decide 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

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	To 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, Holt-Winter model, Croston‘s forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil‘s coefficient

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

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

Suggested 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

OE 941 EC	**ELE MENTS 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

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	The operation of different types of power plants.
2	The basic working principle of instruments for measurement of electrical and nonelectrical quantities like Temperature Pressure flow level measurements.
3	The instrumentation and protection systems applied in thermal power plant.
4	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 modelling, 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	1. 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 II					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		50 Marks	

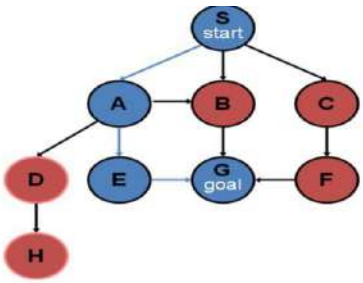
Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Able to use various heuristic search strategies in Artificial Intelligence programs
CO-2	Able to use probabilistic reasoning in decision problems
CO-3	Able to use various open source ML libraries to evaluate different 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 word-like 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, 4th Edition. Morgan Kaufmann.
4. Jacob Perkins. Python 3 Text Processing with NLTK 3 Cookbook. Packt Publishing. 2014

CS 362	**PROGRAMMING FOR BIG DATA SYSTEMS LAB**					
LAB III						
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**		50 Marks	

Course Objectives :

1	To implement Map Reduce programs for processing big data
2	To realize storage of big data using H base, Mongo DB
3	To analyze big data using linear models
4	To analyze big data using machine learning techniques such as SVM / Decision tree classification and clustering

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Process big data using Hadoop framework
CO-2	Build and apply linear and logistic regression models
CO-3	Perform data analysis with machine learning methods
CO-4	Perform graphical data analysis

LIST OF EXPERIMENTS

Hadoop

1. Install, configure and run Hadoop and HDFS
2. Implement word count / frequency programs using MapReduce
3. Implement an MR program that processes a weather dataset R
4. Implement Linear and logistic Regression
5. Implement SVM / Decision tree classification techniques
6. Implement clustering techniques
7. Visualize data using any plotting framework
8. Implement an application that stores big data in Hbase / MongoDB / Pig using Hadoop / R.

CS 371	**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	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	**DISAST R 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	**SANSK ЯIT 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	Get a working knowledge in illustrious Sanskrit, the scientific language in the world
2	Make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
3	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-crucible-furnaceair 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 vessel-kosthiyanthram

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	ST RESS 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-II‖: 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	**PERSO ALITY 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 SwarupanandaAdvaita 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 EWaste 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 381	**DISSERTATION PHASE-I**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	20	10
Evaluation	**SEE**	-	**CIE**	100 Marks		

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 and must bring out individuals contribution. Continuous assessment of Project stage – I at Mid Semester and End Semester will be monitored by the departmental committee. A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, record of continuous progress. In case of unsatisfactory performance, committee may recommend repeating the Phase-I work.

SEMESTER - IV

CS 382	**DISSERTATION PHASE -II**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	32	16
Evaluation	**SEE**	100	**CIE**	100 Marks		

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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