NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI

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Estd : 1984

DEPARTMENT OF

COMPUTER SCIENCE AND ENGINEERING

REGULATIONS – 2023

CURRICULUM & SYLLABUS OF

M. E. COMPUTER SCIENCE AND ENGINEERING

REGULATIONS 2023

CURRICULUM AND SYLLABUS

SEMESTER - I

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	23CT11C	Computational Mathematics	SFC	3	1	0	0	4	4
2.	23CT12C	Research Methodology and IPR	PCC	2	0	0	0	2	2
3.	23CT13C	Advanced Network Security	PCC	3	1	0	0	4	4
4.	23CT14C	Advanced Data Structures	PCC	3	1	0	0	4	4
5.	-	Program Elective Course – I	PEC	3	0	0	0	3	3
6.	-	Audit Course – I	AC	2	0	0	0	2	0
Practical Courses									
7.	23CT15C	Advanced Data Structures Laboratory	PCC	0	0	2	2	4	2
8.	-	Program Elective Course – I Laboratory	PEC	0	0	2	2	4	2
							TOTAL	**27**	**21**

SEMESTER – II

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	23CT21C	Advanced Algorithms	PCC	3	1	0	0	4	4
2.	23CT22C	Machine Learning Algorithms	PCC	3	1	0	0	4	4
3.	-	Program Elective Course – II	PEC	3	0	0	0	3	3
4.	-	Program Elective Course – III	PEC	3	0	0	0	3	3
5.	-	Audit Course – II	AC	2	0	0	0	2	0
Integrated Courses									
6.	23CT23C	Advanced Database Technology	PCC	3	0	2	0	5	4
Practical Courses									
7.	23CT24C	Machine Learning Algorithms Laboratory	PCC	0	0	2	2	4	2
8.	-	Program Elective Course – II Laboratory	PEC	0	0	2	2	4	2
9.	23CT25C	Mini Project with Seminar	PCC	0	0	0	4	4	2
							TOTAL	**33**	**24**

SEMESTER – III

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	-	Program Elective Course – IV	PEC	3	0	0	0	3	3
2.	-	Program Elective Course – V	PEC	3	0	0	0	3	3
3.	-	Program Elective Course – VI	PEC	3	0	0	0	3	3
4.	-	Open Elective Course -I	OEC	3	0	0	0	3	3
Practical Courses									
5.	23CT31C	Project Work – I	PCC	0	0	0	12	12	6
							TOTAL	**24**	**18**

SEMESTER – IV

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Practical Courses									
1.	23CT41C	Project Work – II	PCC	0	0	0	24	24	12
							TOTAL	**24**	**12**

PROGRAMME ELECTIVE COURSES (PEC)

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	E	C
Elective Courses for PEC III, IV, V and VI								
1.	PEC	23CT01E	Information Retrieval Techniques	3	0	0	0	3
2.	PEC	23CT02E	Cloud Management and Security	3	0	0	0	3
3.	PEC	23CT03E	Block Chain Technology	3	0	0	0	3
4.	PEC	23CT04E	Web Analytics	3	0	0	0	3
5.	PEC	23CT05E	Advanced Digital Image Processing	3	0	0	0	3
6.	PEC	23CT06E	Introduction to Intelligent Systems	3	0	0	0	3
7.	PEC	23CT07E	Predictive Data Analytics	3	0	0	0	3
8.	PEC	23CT08E	GPU Computing	3	0	0	0	3
9.	PEC	23CT09E	Quantum Computing	3	0	0	0	3
10.	PEC	23CT10E	Software Defined Network	3	0	0	0	3
11.	PEC	23CT11E	Game Theory	3	0	0	0	3
12.	PEC	23CT12E	Malicious Node Detection Methodologies	3	0	0	0	3
13.	PEC	23CT13E	Wireless Body Area Networks	3	0	0	0	3

14.	PEC	23CT14E	Cellular Automata Paradigm	3	0	0	0	3
15.	PEC	23CT15E	Vehicular Adhoc Networks	3	0	0	0	3
16.	PEC	23CT16E	Pattern Recognition	3	0	0	0	3
17.	PEC	23CT25E	Optimization Techniques	3	0	0	0	3
Elective Courses for PEC I and II								
18.	PEC	23CT17E	Data Science	3	0	0	0	3
19.	PEC	23CT18E	Data Science Laboratory	0	0	2	2	2
20.	PEC	23CT19E	Big Data Analytics and Management	3	0	0	0	3
21.	PEC	23CT20E	Big Data Analytics and Management Laboratory	0	0	2	2	2
22.	PEC	23CT21E	Cyber Security	3	0	0	0	3
23.	PEC	23CT22E	Cyber Security Laboratory	0	0	2	2	2
24.	PEC	23CT23E	Deep Learning	3	0	0	0	3
25.	PEC	23CT24E	Deep Learning Laboratory	0	0	2	2	2
26.	PEC	23CT26E	Dynamic Web Programming	2	0	2	0	3
Open Elective Courses								
27.	OEC	23GD01E	Energy Audit	3	0	0	0	3
28.	OEC	23GD02E	Industrial Safety	3	0	0	0	3
29.	OEC	23GD03E	Operations Research	3	0	0	0	3
30.	OEC	23GD04E	Cost Management of Engineering Projects	3	0	0	0	3
31.	OEC	23GD05E	Waste to Energy	3	0	0	0	3

Audit Courses 1 & 2

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	E	C
1.	AC	23AC01E	Technical Report Writing	2	0	0	0	0
2.	AC	23AC02E	Disaster Management	2	0	0	0	0
3.	AC	23AC03E	Sanskrit for Technical Knowledge	2	0	0	0	0
4.	AC	23AC04E	Value Education	2	0	0	0	0
5.	AC	23AC05E	Constitution of India	2	0	0	0	0
6.	AC	23AC06E	Pedagogy Studies	2	0	0	0	0
7.	AC	23AC07E	Stress Management by Yoga	2	0	0	0	0
8.	AC	23AC08E	Personality Development through Life Enlightenment Skills.	2	0	0	0	0

23CT11C COMPUTATIONAL MATHEMATICS

L	T	P	E	C
3	1	0	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply the knowledge of linear algebra concepts in data processing
CO2: apply the knowledge of matrix theory concepts in image processing
CO3: apply vector calculus to identify good parameters for solving problems
CO4: solve research problems by using optimization techniques
CO5: apply the number theory concepts in network security
CO6: analyze appropriate mathematical transform techniques in signal processing and wavelet

VECTOR SPACES **10**

Vector Space - Basis – Dimensions –Inner product –Norm - Systems of Linear Equations- Solving Systems of Linear Equations-Linear Independence-Linear Mappings-Affine Spaces- case study: Least square approximation.

ADVANCED MATRIX THEORY **10**

Matrix Decompositions - Determinant and Trace - Eigen values and Eigenvectors Cholesky Decomposition - Eigen decomposition and Diagonalization - Singular Value Decomposition-Matrix Approximation - case study on image preprocessing

VECTOR CALCULUS **10**

Gradients of Vector-Valued Functions-Gradients of Matrices-Identities for Computing Gradients - Back propagation and Automatic Differentiation - Automatic Differentiation-Higher-Order Derivatives - Linearization and Multivariate Taylor Series

NONLINEAR CONSTRAINED OPTIMIZATION **10**

Optimization Using Gradient Descent-Constrained Optimization and Lagrange Multipliers-Convex Optimization-Nonlinear constrained optimization- Heuristic non-linear optimization.

NUMBER THEORY **10**

Divisibility – Greatest Common Divisor – Prime Numbers – Fundamental Theorem of Arithmetic – Congruences – Fermat's Theorem – Euler's Function – Primality Testing – Solution of Congruences – Chinese Remainder Theorem – Wilson's Theorem- case study on cryptography problems.

MATHEMATICAL TRANSFORMS **10**

Affine Transform: Definition - Results – Properties - Laplace Transform: Definition – Results – Properties. Fourier Transform: Definition - Results – Properties -Radon transform – Relation between Fourier Transform and Radon Transform- Z -Transform: Results and Properties.

L: 45; P: 15; TOTAL: 60 PERIODS

REFERENCES

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.
2. S.B.Malik, "Basic Number Theory", 2nd Edition, Vikas Publishers, Paperback – 1, 2018.
3. Seymour Lipschutz, Marc Lipson, "Schaum's Outline of Linear Algebra", 3rd Edition, Paperback 2017.

4. David M. Burton, Elementary Number Theory, 7th Edition, Tata McGraw-Hill, 2017.
5. T.Veerarajan, “Transforms and Partial Differential Equations”, McGraw-Hill Publishers, Paperback Illustrated, 2016
6. Richard Bronson, Schaum's Outline of Matrix Operations, 2nd Edition, Paperback McGraw-Hill Education, 2011

23CT12C RESEARCH METHODOLOGY AND IPR **L T P E C**
2 0 0 0 2

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand research problem formulation.
CO2: Analyze research related information.
CO3: Understand the research ethics.
CO4: Understand when IPR would take such important place in growth of individuals & Nation.
CO5: Recognize the importance of Report writing.

RESEARCH FORMULATION AND DESIGN **6**

Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review - primary and secondary sources, reviews, monographs, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research databases, development of working hypothesis – Case study

DATA COLLECTION AND ANALYSIS **6**

Method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statistical packages (SigmaSTAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing – Data Mining (case studies)

RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING **6**

Ethics - ethical issues, ethical committees (human and animal); IPR- intellectual property rights and patent law, commercialization, copyright, royalty, trade related aspects of intellectual Property rights (TRIPS); scholarly publishing - IMRAD concept and design of research papers; citation and acknowledgement, plagiarism, reproducibility; and accountability

CONTEMPORARY ISSUES IN IPR **6**

Interface between IPR and Human Rights -Interface between IPR and Competition Law -IPR and sustainable development – Impact of Internet on IPR - IPR of Biological systems & E-Commerce.

INTERPRETATION AND REPORT WRITING **6**

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology-Ⅱ, RBSA Publishers, 2015

2. Kothari, C.R., Research Methodology: Methods and Techniques‖, New Age International, 2018 (Unit 1, Unit 2, Unit 5).
3. Wadehra, B.L. Law relating to patents, trademarks, copyright designs and geographical indications‖. Universal Law Publishing, Reprint, 2011. (Unit 3, Unit 4)
4. Anthony, M., Graziano, A.M. and Raulin, M.L. Research Methods: A Process of Inquiry, Allyn and Bacon 2012.
5. Carlos, C.M., Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York, 2000.

23CT13C ADVANCED NETWORK SECURITY

L	T	P	E	C
3	1	0	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: identify and analyze security problems in computer systems and networks.
CO2: protect and defend computer systems and networks from cyber security attacks.
CO3:gain knowledge of digital signatures and authentication protocols to find practical solutions to security issues
CO4: implement, verify and troubleshoot ACLs in an enterprise network environment.
CO5: evaluate the principles of Network Security in real time applications

BASIC CONCEPT OF NETWORK SECURITY **12**

Introduction – Overview of Network Attacks, Network Protection -IDS, Types of IDS's, Issues in Intrusion Detection, Challenges in Intrusion Detection, Taint Analysis, Network Based IDS, Problems in NIDS, Impact Analysis

NETWORK SECURITY THREATS AND ISSUES **12**

Protocol Vulnerabilities: DoS and DDoS - SYN Flooding - Session Hijacking - ARP Spoofing - Attack on DNS - Wireless LAN: Frame spoofing - Violating MAC - Software Vulnerabilities - Phishing Attack - Buffer Overflow - Cross-site Scripting - SQL Injection – Virus – Worm – Malware – Botnets – Eavesdropping - Password Snooping and IP Masquerade

SECURITY AT NETWORK LEVEL **12**

Authentication: password-based, certificate-based, Centralize – Kerberos – Biometrics – SSL - IP Security - IKE - Virtual Private Network - Open SSL - Wireless LAN Security: WEP –TKIP - CCMP.

ACCESS CONTROL LIST **12**

Introduction -Implementation Rules- Routing Protocols & ACL - Time-Based Access Control List - Remote Access Security - Monitoring SYN-Attack with Attacker IP & MAC Address - Dynamic ACL-LOCK & KEY - Reflexive Access-List - IOS Firewall -Context-Based Access Control - Zone Based Firewall - Unicast Reverse Path Forwarding- TCP Intercept - Intercept & Watch Mode

SECURITY AND NETWORK APPLICATIONS **12**

Electronic Payment: Payment types – SET - Chip Card Transaction Mobile Payments - Electronic Mail Security - Web Security: SSL and TLS - Web Service Security: Token Type - XML Encryption - XML Signatures – SAML - Intrusion detection and prevention systems - honey pots.

L: 45; T: 15; TOTAL: 60 PERIODS

REFERENCES

1. Raymond R.Panko, "Corporate Computer and Network Security", Pearson Education. 2009
2. B.A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill, 3rd Edition, 2016.
3. William Stallings," Network Security Essentials: Applications and Standards", Pearson Education, 6th Edition, 2018.
4. Eric Maiwald, "Fundamentals of Network Security", Tata McGraw Hill, 1st Edition, 2017.
5. Bernard Menezes, Network Security and Cryptography, Cengage Learning, 2010
6. William Stallings, "Cryptography and Network Security", Pearson Education, 7th Edition, 2017.
7. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill Publishers, 3rd Edition, 2017.
8. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communication in a public world", 2nd Edition, Prentice Hall, 2002.
9. Eric Rescoria, "SSL and TLS: Designing and Building Secure Systems", Addison-Wesley Professional, 2000.
10. Jonathan Katz, Yahuda Lindell, Introduction to Modern Cryptography, CRC Press

23CT14C **ADVANCED DATA STRUCTURES**

L	T	P	E	C
3	1	0	0	4

(Common to M.E CSE and M.Tech ICW Programmes)

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply hashing techniques to efficiently store and retrieve data in dictionaries.
CO2: implement heap data structures and skip lists for optimization problems.
CO3: implement algorithms for red-black trees, B-trees and Splay trees.
CO4: implement ontology-based graphs to solve different real-time problems.
CO5: apply suitable data structures for computational geometry problems.

CO1: Apply hashing techniques to efficiently store and retrieve data in dictionaries **12**

Hashing: Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing, Recent Trends in Hashing. **Dictionaries:** Dictionary Abstract Data Type, Hash tables for dictionary - Implementation of Dictionaries – Tries

CO2: Implement heap data structures and skip lists for optimization problems **12**

Heaps: d-Heaps - Leftist Heaps - Binomial Heaps - Fibonacci Heaps - Pairing Heaps-Binomial Queue-Priority Queue. **Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists

CO3: implement algorithms for red-black trees, B-trees and Splay trees **12**

Trees: Red Black Trees, Splay Trees 2-3-4 Trees, Suffix Trees and Suffix Arrays, Geometric data structures: Quad Trees and Octrees, Treaps, Range query data structure: Priority Range Trees, k-D Trees

CO4: implement ontology-based graphs to solve different real-time problems **12**

Text Processing: Strongly Connected Components - Kosaraju's Algorithm- Network Flows - Edmonds-Karp Algorithm - Planar Graphs - Randomized Minimum Spanning Tree - Graph Traversal on Ontology Based Graphs - Graph Traversal on Ontology-Based Graphs - Ontology-Based Metadata Management.

CO5: apply suitable data structures for computational geometry problems **12**

Computational Geometry: Geometric Optimization: closest pair of points, farthest pair of points - Binary Space Partitioning (BSP) Tree - Convex Hull Data Structures - Computational Geometry in Higher Dimensions - Algorithms for higher-dimensional geometric problems: d-D Voronoi diagrams, Delaunay triangulations.

L: 45; T:15; TOTAL: 60 PERIODS

REFERENCES

1. Anchit Bijalwa, “Network Forensics Privacy and Security”, 1st Edition, Taylor & Francis, CRC Press, 2022.
2. Bill Nelson, Amelia Phillips, Christopher Steuart, “Guide to Computer Forensics and Investigations”, 6th Edition, 2019.
3. John Peterson, “Data Structures and Algorithms in Java: A Comprehensive Guide”, Kindle Edition, 2023.
4. G.A.Vijayalakshmi Pai, “A Textbook of Data Structures & Algorithms, Volume 3”, Wiley, 2023.
5. Debasish Ray Chawdhuri, “Java 9 Data Structures and Algorithms”, Packet Publishing, 2017.
6. Yashavant Kanetkar, “Data Structures Through C++”, 3rd Edition, 2019.

23CT15C **ADVANCED DATA STRUCTURES LABORATORY**

(Common to M.E CSE and M.Tech ICW Programmes)

L	T	P	E	C
0	0	2	2	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Implement applications based on the concept of heap, skip list and hashing techniques.
CO2: Develop programs for red-black trees, B-trees, AVL and Binary Search trees.
CO3: Develop algorithms for text processing applications.
CO4: Identify suitable data structures and develop algorithms for computational geometry problems

List of Lab Experiment

1. Imagine you are designing a contact management system for a large corporation. The system should allow employees to quickly search for contact information based on the employee's ID number. The system should support the following operations:
   a. Insert: Add a new employee's contact information, including their ID number, name, email, and phone number, into the dictionary.
   b. Retrieve: Given an employee's ID number, retrieve their contact information from the dictionary.
   c. Update: Given an employee's ID number, update their contact information in the dictionary.
   d. Delete: Given an employee's ID number, remove their contact information from the dictionary.
2. Consider the following elements and perform Extendible Hashing: 16,4,6,22,24,10,31,7,9,20,26. Bucket Size: 3 (Assume). Hash Function: Suppose the global depth is X. Then the Hash Function returns X LSBs.
3. With Tries data structures, develop a program that can be used in the web browser to auto complete the text or show many possibilities of the text the user is trying to write.
4. Read the marks obtained by students of second year in an online examination of particular subject. Find out maximum and minimum marks obtained in that subject. Use heap data structure.

5. For a given set of elements (3 6 7 9 12 17 19 21 25 26) create skip list. Find the element in the set that is closest to some given value.
    a. Implement the random_level() function to generate a random level for each inserted node.
    b. Modify the insert() function to handle duplicates. Allow multiple nodes with the same value to be inserted.
    c. Add a function get_level_counts() that returns the number of nodes at each level of the Skip List.
    d. Implement the search() function to find a specific value in the Skip List.
    e. Add a function count_occurrences(value) that returns the number of occurrences of a given value in the Skip List.
    f. Implement the delete() function to remove a specific value from the Skip List.
    g. Add a function remove_duplicates() that removes all duplicate values from the Skip List.
    h. Implement a function get_min() that returns the minimum value in the Skip List.
    i. Implement a function get_max() that returns the maximum value in the Skip List.
    j. Add a function get_range(start, end) that returns a list of values between a given start and end range.
6. Implement the Insertion, count the number of nodes, Search, Clear Tree, Traversal operations in the Red-Black Tree.
7. You are supposed to build a Social Cop in your smartphone. Social Cop helps people report crimes to the nearest police station in real-time. Use k-d tree to search for the police station nearest to the crime location before attempting to report anything by constructing a 2 dimensional k-d tree from the locations of all the police stations in your city, and then querying the k-d tree to find the nearest police station to any given location in the city.
8. Implement the Edmonds-Karp algorithm for finding the maximum flow in a network.
9. Implement Randomized Minimum Spanning Tree
10. Binary Space Partitioning (BSP) Tree
11. Implement a data structure to represent Delaunay triangulations in d-Dimensional space.
12. Implement an algorithm to compute the Voronoi diagram from the Delaunay triangulation.

Mini Projects

1. Web Browser History
2. Tree Visualization and Manipulation
3. Pattern Matching and Text Indexing
4. Dynamic Graph Connectivity
5. Priority range tree
6. Cash Flow Minimiser (Graphs/Multisets/Heaps)
7. File Zipper(Greedy Huffman Encoder)
8. Data Clustering and Pattern Recognition with d-Dimensional Voronoi Diagrams and
9. Delaunay Triangulation.

P: 45; TOTAL: 45 PERIODS

Course Code	ADVANCED ALGORITHMS	L	T	P	E	C
23CT21C		3	1	0	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory components

CO1: formulate a profound comprehension of advanced algorithmic analysis.
CO2: apply advanced algorithmic design techniques to solve complex problems.
CO3: implement efficient data processing techniques to reduce time and space complexity.
CO4: apply probabilistic and parallel algorithms to solve complex problems.
CO5: develop approximation algorithms for NP-hard problems.

CO1: formulate a profound comprehension of advanced algorithmic analysis **L:9; T:3**

Space and Time Complexity - Asymptotic Notations - Average and Worst-Case Analysis - Amortized Analysis – Empirical Analysis - Probabilistic and Randomized Analysis - Streaming Algorithm Analysis

CO2: apply advanced algorithmic design techniques to solve complex problems. **L:9; T:3**

Divide and Conquer Techniques: Fast Fourier Transform - Greedy Algorithms: Shortest superstring problem - Dynamic Programming Strategies: Longest common subsequence – Backtracking: Knight's Tour problems - Branch and Bound Algorithms: integer programming - Case study on role of dynamic programming in machine learning and artificial intelligence

CO3: implement efficient data processing techniques to reduce time and space complexity. **L:9; T:3**

Graph-based algorithms: Bellman-Ford algorithm – Ford-Fulkerson Algorithm - Dictionary Data Structures: Hash Tables – Cuckoo Hashing Algorithm - String Matching Algorithms : Knuth-Morris-Pratt and Boyer-Moore Algorithms – Data Compression Algorithms: Lempel-Ziv Compression - Case Study on Graph-based algorithms in AI and robotics

CO4: apply probabilistic and parallel algorithms to solve complex problems. **L:9; T:3**

Probabilistic algorithms: Monte Carlo algorithm - randomized algorithm - Las Vegas algorithm – Bloom filters - skip lists.
parallel sorting algorithms: parallel merge sort, parallel quicksort, parallel matrix multiplication

CO5: develop approximation algorithms for NP-hard problems **L:9; T:3**

NP-hard problems : Knapsack algorithm - Approximation algorithms : Online algorithms – Bin packing - Polynomial Time Approximation Schemes (PTAS) - Fully Polynomial Time Approximation Schemes (FPTAS) - Case study on applications of approximation in quantum computing

REFERENCE BOOKS

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms", 4th Edition, MIT Press, 2022.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorihms", 2nd Edition Pearson India, 2017.

3. Michael T. Goodrich, Roberto Tamasia, "Algorithm Design and applications", 1st edition, John Wiley and sons, 2001.
4. Robert Sedgewick and Kevin Wayne, "Algorithms", 4th Edition, 2019.
5. Grama, George Karypis, Vipin Kumar, and Anshul Gupta, "Introduction to Parallel Computing", 2nd Edition, 2003.
6. Vijay V. Vazirani, "Approximation Algorithms", Springer, 2013.
7. Himanshu B. Dave, "Design and analysis of Algorithms", 2nd Edition Pearson India, 2013
8. A.V. Aho, J. E. Hopcroft and J. D. Ullman, "The Design and Analysis of Computer Algorithms", Pearson Education Asia, 2003.

L: 45; T: 15; TOTAL: 60 PERIODS

Course Code	MACHINE LEARNING ALGORITHMS	L	T	P	E	C
23CT22C		3	1	0	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory component

CO1: demonstrate the mathematical foundations of machine learning
CO2: analyze linear and non-linear supervised learning techniques for classification
CO3: apply the unsupervised algorithms for clustering the data
CO4: design reinforcement learning models for adaptive learning
CO5: apply probabilistic and evolutionary algorithms for handling uncertainty

CO1: demonstrate the mathematical foundations of machine learning **L:9; T:3**

Machine Learning–Types of Machine Learning: Supervised Learning, Unsupervised Learning – Machine Learning process - Testing machine learning algorithms - Parametric Vs non-parametric models - Mathematical Basics for Machine Learning: Probability and Statistics for Machine Learning – Probability Distributions – Decision Theory – Information theory – Bias Variance tradeoff.

CO2: analyze linear and non-linear supervised learning techniques for classification **L:9; T:3**

Regression: Introduction - Linear Regression-Lasso Regression-Logistic Regression; Classification: Support Vector Machines - Kernel Methods; K-Nearest Neighbours; Learning with Trees: constructing Decision Tree using ID3 - Classification and regression trees (CART) – Soft-SVM with Kernels- Neural Networks: Perceptron learning algorithm; Multi-Layer Perceptron: Back propagation algorithm-Case Study: Face Recognition

CO3:apply the unsupervised algorithms for clustering the data **L:9; T:3**

Clustering- K-means – Mixtures of Gaussians – Vector Quantization – The Self Organizing Feature Map- Dimensionality Reduction, Linear Discriminant Analysis, Principal Components Analysis, Independent Components Analysis - Partitional Clustering and Hierarchical Clustering- Density-based clustering algorithms-DBSCAN algorithm –Case Study: Planning a Vacation

CO4: design reinforcement learning models for adaptive learning **L:9;**

Reinforcement Learning : Q learning, Deterministic and Nondeterministic Rewards and Actions Temporal Difference Learning - Markov Decision Process- applications in game playing.- Adaptive Dynamic Programming – Active reinforcement learning: exploration – learning an actionutility function – Generalization in reinforcement learning – policy search – Case Study:Applications in game playing **T:3**

CO5: apply probabilistic and evolutionary algorithms for handling uncertainty **L:9; T:3**

Graphical Models – Undirected Graphical Models : Markov Random Fields – Directed Graphical Models : Bayesian Networks – Markov Random Fields, Hidden Markov Models - Evolutionary Learning : The Genetic Algorithm , Generating offspring - Map Colouring, Punctuated Equilibrium - Knapsack problem - Limitations of the GA-Case Study: Social Network Analysis

REFERENCE BOOKS

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (2016)
2. Tom Mitchell, "Machine Learning", McGraw-Hill, 2017.
3. Andreas C.Muller and Sarah Guido, —Introduction to Machine Learning with Pythonll, O'Reilly Media, 2017
4. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems" by Aurélien Géron (2020)
5. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron (2021)
6. https://www.coursera.org/specializations/machine-learning-introduction
7. https://www.udemy.com/course/data-science-machine-learning-mastery

L: 45; T: 15; TOTAL: 60 PERIODS

Course Code	ADVANCED DATABASE TECHNOLOGY	L	T	P	E	C
23CT23C		3	0	2	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: relate thefunctional blocks of distributed databases for effective implementation
CO2: demonstrate DDL/DML queries using different NoSQL databases
CO3: relateobject-based and XML databases for application development
CO4: analyze the various data handling mechanisms using intelligent and mobile databases
CO5: formulate queries for deductive databases

Practical Component

CO6: apply basic operations in SQL and NoSQL databases
CO7: develop OQL queries and XML Schema
CO8: demonstrate the design of data handlers in intelligent and mobile databases

CO1:relate the functional blocks of distributed databases for effective implementation **L:9; P:4**

CO6: apply basic operations in SQL and NoSQL databases

Introduction – Functionality of Distributed DBMS (DDBMS) – Architecture – Distributed data storage –query processing – SQL query operations in a relational database – Transaction Management – Concurrency control – Replication Servers – Case study on distributed database design– Implementation

CO2:demonstrate DDL/DML queries using different NoSQL databases **L:9;**
CO6: apply basic operations in SQL and NoSQL databases **P:8**

NoSQL – CAP Theorem – Sharding - Document based – MongoDB Operation: Insert, Update, Delete, Query, Indexing, Application, Replication, Sharding, Deployment – Using MongoDB with PHP / JAVA – Advanced MongoDB Features – Cassandra: Data Model, Key Space, Table Operations, CRUD Operations, CQL Types – HIVE: Data types, Database Operations, Partitioning – HiveQL – OrientDB Graph database – OrientDB Features

CO3: relate object-based and XML databases for application development **L:9;**
CO7: develop OQL queries and XML Schema **P:8**

Concepts of ObjectOriented Databases – Need for complex Datatype – Collection Types and Structured Types – ODMG Model – Object Definition Language Object Query Language - Structured, Semi structured, and Unstructured Data – XML Hierarchical Data Model – XML Documents – Document Type Definition – XML Schema – XML Documents and Databases – XML Querying – XPath – XQuery

CO4:analyze the various data handling mechanisms using intelligent and mobile databases **L:9; P:10**

CO8:demonstrate the design of data handlers in intelligent and mobile databases

Active DatabasesConcepts and Triggers –Syntax and Semantics – Temporal Databases – Overview – Spatial Databases – Spatial Representation – Data types – Relationships – Query Processing in Spatial and temporal databaseMobile Databases: Location and Handoff Management – Effect of Mobility on Data Management – Location Dependent Data Distribution – Mobile Transaction Models – Query Processing using mobile database

CO5: formulate queries for deductive databases **L:9**

Deductive Databases: Logic of Query Languages – Datalog Recursive Rules-Syntax and Semantics of Data log Languages- Implementation of Rules and Recursion- Recursive Queries in SQL

REFERENCE BOOKS

1. Dr.Sanjeev Sharma, Dr.Jitendra Agrawal, Dr.Shika Agrawal, —Advanced Database Management System, Dreamtech press, New Delhi, 2017.
2. R. Elmasri, S.B. Navathe, —Fundamentals of Database Systems, Global Edition, Pearson Education, 2016.
3. Henry F Korth, Abraham Silberschatz and S. Sudharshan, —Database System Concepts, 6th Edition, McGraw Hill, 2013.
4. ShashankTiwari, “Professional NoSQL”, O’Reilly Media, 1st Edition, 2011.
5. International Workshop on Intelligent Techniques in Distributed Systems (ITDS-2014) Distributed Database Design: A Case Studyll, www.sciencedirect.com

6. http://www.ijcstjournal.org/volume-4/issue-5/IJCST-V4I5P28.pdf, ǁ Spatial Data System: Architecture and Applications

L: 45; P: 30; TOTAL: 75 PERIODS

Course Code	MACHINE LEARNING ALGORITHMS LABORATORY	L	T	P	E	C
23CT24C		0	0	2	2	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to
CO1: implement supervisedmodels for classification
CO2: develop unsupervised and reinforcement models for different categorize of data
CO3: design a probabilistic and evolutionary models with uncertainty

LIST OF EXPERIMENTS **P:10;**
CO1:implement supervised models for classification **E:10**

1. Implement the non-parametric Linear Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
2. Building and training Neural networks using back propagation algorithm with gradient descent.
3. Implement SVM algorithm in leaf disease prediction

CO2: develop unsupervised and reinforcement models for different categorize of data **P:12; E:12**

1. 1.Application of dimensionality reduction techniques for numeric and text and image data
2. Apply k-Means algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using Fuzzy C-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.
3. 3.Write a program to implement Reinforcement Learning algorithm to classify the iris data set. Print both correct and wrong predictions.
4. 4. Game development and robotic application development using reinforcement learning model.

CO3: design a probabilistic and evolutionary models with uncertainty **P:8;**

1. Implement Bayesian Inference in Gene Expression Analysis **E:8**
2. Implement Sequential Learning using Hidden Markov Model

SOFTWARE REQUIREMENTS

1. Python 3.X
2. Anaconda Navigator

P: 30; E: 30; TOTAL: 60 PERIODS

Course Code	MINI PROJECT WITH SEMINAR	L	T	P	E	C
23CT25C		0	0	0	4	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

CO1: demonstrate the proficiency in persuasive project presentations and comprehensive technical reports.

Handling the course based on the following:

- A faculty member will be assigned to guide and monitor the progress of each student.
- During the seminar sessions, each student is expected to prepare and present a research based topic within duration of 15 to 20 minutes.
- Every student is required to present at least three times during the semester, and their evaluation will be based on presentation skills, comprehension of concepts, and the ability to address queries.
- By the end of the semester, the student should submit a report on the topics of the seminar and marks will be given based on the quality of report.
- The seminar will be assessed by a committee comprising of the guide, coordinator, and Head of the Department (HOD).

E:60

E: 60; TOTAL: 60 PERIODS

Course Code	PROJECTWORK -I	L	T	P	E	C
23CT31C		0	0	0	12	6

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Experiential Components

CO1:formulate a problem that pertains to a newly emerging research issue.(PDL2)

CO2:perform literature study with a comparative analysis of the existing approaches.(PDL2)

CO3: devise the novel methodology to address the research gaps and challenges of the identified problem. (PDL2)

CO4:identify the software and hardware requirements for developing the solution.(PDL1)

CO1: formulate a problem that pertains to a newly emerging research issue. **E: 45**

- Each student individually selects their area of interest and work under the supervision of their allotted guide approved by Head of the department.
- Students can select any topic which is related to engineering design.

CO2: perform literature study with a comparative analysis of the existing **E: 45**

approaches.

- Identify appropriate peer reviewed, SCI indexed journals/Scopus indexed conference articles in the relevant area.
- Carry out literature study based on approaches, dataset, experimental setup, performance analysis metric by considering computational complexity.

CO3: devise the novel methodology to address the research gaps and challenges of the identified problem. **E: 45**

- Explore the research gap and challenges with respect to dataset, experimental setup
- Identify novel methodology that addresses the identified gaps and challenges to enhance the performance.

CO4: identify the software and hardware requirements for developing the solution. **E: 45**

- Recognize the software tools and hardware requirements for implementing the identified problem.
- Students should submit a project report in the standard prescribed format.
- The progress of the project is evaluated based on minimum of three reviews and a final Viva-voce examination.

E: 180;TOTAL: 180 PERIODS

Course Code	PROJECTWORK - II	L	T	P	E	C
23CT41C		0	0	0	24	12

COURSE OUTCOMES

Upon the successful completion of the course, the students will be able to

Experiential Components

CO1: design methodology for identified research problem to address emerging issues. (PDL2)
CO2: develop experimental setup, conduct research and compare the performance with SOTA analysis. (PDL2)
CO3: demonstrate the research outcomes in peer reviewed Journals / Conferences. (PDL2)

Softskill Components

Disseminate the research competency, project management, function as an efficient individual.

Each student individually extends the selected research idea during Project Work - I and work under the supervision of the domain expertise related guide approved by Head of the department. Review Committee will be conducted by the Project Co-ordinator, respective Guide and domain specific reviewers being nominated by the Head of department.

CO1: design novel methodology for identified research problem to address emerging issues

- Review – I, will focus mainly on the critical hypothesis design of methodology for the research problem identified and bring valid conclusion for the appropriateness of novelty in solving the research problem by addressing the research gaps and **L: 9**

challenges with the support of investigating the recent related works.

CO2: develop experimental setup, conduct research and compare the performance with SOTA analysis

- Based on the domain chosen, appropriate selection of standard experimental data sets and their quality has to be validated. Based on the research method proposed, experimental steps have to be arrived in addition to the various ways of performance metrics that can help to measure the improvement in system modeling. To bring hope for the novel approach, the comparison with State-of-the-art (SOTA) analysis is to be carried out. **E:120**
- Review – II, will assure the quality of experimental data and conduct of research with originality. The performance metrics will be gauged based on existing research works to analyze the SOTA comparisons

CO3: demonstrate the research outcomes in peer reviewed Journals / Conferences.

- Identify appropriate peer reviewed SCI / ESCI / Scopus indexed Journals / Conference avenues, to bring highlights for the successful conduct of project work.
- Review – III, will ensure the plagiarism checks using Grammarly / Turnitin tools and validate the template requirements as per the submission guidelines of the identified Journal / Conference. Overall demonstration of the arrived solution and it's suitability for solving real-time challenges to be verified. **E:150**
- Final Project report of project may include the title, theory/hypothesis, literature review, research gaps & challenges, objectives, materials required, methodology, experimental observations, results and discussions, SOTA analysis, conclusion, future work, and references.

E: 360; TOTAL: 360 PERIODS

Course Code	INFORMATION RETRIEVAL TECHNIQUES	L	T	P	E	C
23CT01E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: apply the basic information retrieval principles to explore the retrieval process
CO2: relate the knowledge of various retrieval models and performance evaluation for IR systems
CO3: analyze the efficient indexing techniques to perform document retrieval
CO4: design the multimedia IR systems for handling multimedia data
CO5: implement features of retrieval systems for web-based and other search tasks

CO1: apply the basic information retrieval principles to explore the retrieval process **L:8**

Historical overview of IR - importance and recent developments and challenges in IR. Contemporary information retrieval techniques - Retrieval Process – Architecture of Boolean Retrieval – Vector Model Term Weighting – Scoring and Ranking - Retrieval Evaluation - Practical Issues - Open source Search engine Elastic search, Solr

CO2: relate the knowledge of various retrieval models and performance evaluation for IR systems **L:9**

Classical Retrieval Models - Neural Models for IR - Distributed and Federated Retrieval - Information Retrieval and Multimodal Data - Semantic Search and Knowledge Graphs - Personalized and Context-Aware Retrieval - AI-Powered Retrieval and Chatbots - Evaluation Metrics and User-Centric Evaluation

CO3: analyze the efficient indexing techniques to perform document retrieval **L:9**

Introduction to Document Indexing - Inverted Indexing in Modern IR - Indexing Multimodal and Structured Data - Distributed and Parallel Indexing - Graph-Based Indexing - Semantic Indexing and Ontologies - Indexing for Privacy-Preserving IR - Indexing for Personalization and Context - Ethical Considerations in Data Indexing

CO4: design the multimedia IR systems for handling multimedia data **L:9**

Data models – Multimodal Data Representation - Query languages – Spatial access models – Generic approach – One dimensional time series – Twodimensional color images – Feature extraction - Deep Learning for Multimedia IR - Cross-Modal and Cross - Media Retrieval

CO5: implement features of retrieval systems for web-based and other search tasks **L:10**

Web Retrieval Systems - Search Engine User Interaction – Browsing - Query Expansion and Reformulation - Entity Recognition and Disambiguation -Web Crawler – Taxonomy – Architecture and Implementation - Personalization in Web Search - Voice and Conversational Search- Semantic Web and Linked Data - Search Engine Ranking – Link based Ranking – Simple Ranking Functions – Learning to Rank – Evaluation.

REFERENCE BOOKS

1. Christopher D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2017 (available at http://nlp.stanford.edu/IR-book).
2. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, "Modern Information Retrieval: The Concepts

and Technology", The MIT Press, Cambridge, Massachusetts London, 2nd Edition, 2011.
3. Bruce Croft, Donald Metzler, and Trevor Strohman, "Search Engines: Information Retrieval in Practice", 1st Edition, 2020.
4. Henning Müller, Paul Clough, and Thomas Deselaers, "Multimodal Information Retrieval: Theory, and Applications", 2nd Edition, 2021.
5. Amanda Spink and Bernard J. Jansen, "Web Search: Multidisciplinary Perspectives", 2nd Edition, 2016.
6. G.G. Chowdhury, Introduction to Modern Information Retrieval, 3rd Edition, Facet Publishing, 2010.
7. David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms, and Heuristics, Edition, Springer, 2012.
8. Charles T. Meadow, Bert R. Boyce, Donald H. Kraft and Carol L. Barry, Text Information Retrieval Systems, 3rd Edition, Academic Press, 2006.

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT02E	**CLOUD MANAGEMENT AND SECURITY**	**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1:explore the components of cloud security and management (CDL 1)
CO2: address the core issues of privacy and storage security (CDL 1)
CO3: analyze insight into the security issues related to multi-tenancy cloud model (CDL 2)
CO4: apply the security prevention and protection strategies to cloud (CDL 2)
CO5: apply appropriate legal data and compliance policy to cloud environment (CDL 2)

CO1: Explore the components of cloud security and management

Cloud Security: definition- benefits and challenges. cloud deployment: private, public and hybrid cloud - Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types - security and disaster recovery next generation cloud applications - Case study: DVWA **L:9**

CO2: Address the core issues of privacy and storage security

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Devices Security - Risk management - Physical Security Essentials. **L:9**

CO3: Analyze insight into the security issues related to multi-tenancy cloud model

Multi tenancy: Isolation of users/VMs from each other - 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. **L:9**

CO4: Apply the security prevention and protection strategies to cloud

Cloud attacks - types - Cloud Security issues, challenges, threats - Security risks - management of cloud security risks - Cloud Cyber attacks: Prevention and Protection Strategies - DDoS Network Protection. **L:9**

CO5: Apply appropriate legal data and compliance policy to cloud environment

Responsibility - data ownership - right to penetration test - local law on data storage - modern Security Standards - Standards for cloud services and virtualization compliance for the cloud provider compliance for the customer. **L:9**

REFERENCE BOOKS:

1. John R. Vacca, Computer and Information Security Handbook, 3rd Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, 7th Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. ”Cloud Native Security" by Patrick Bay and Chetan Conikee. Published in 2020.
5. "Hands-On Cloud Security:Implementing and Managing Security Policies" by Jim O'Gorman Published in 2019.
6. Eric Fettman, Shiraz Asif, FerasAlhlou , —Google Analytics Breakthrough‖, John Wiley & sons, 1st Edition, 2016.

WEB RESOURCES:

1. https://analytics.google.com/analytics/web/
2. https://www.optimizely.com/optimization-glossary/web-analytics/
   https://www.tutorialspoint.com/web_analytics/web_analytics_introduction.html

L: 45; TOTAL: 45 PERIODS

Course Code	BLOCKCHAIN TECHNOLOGY	L	T	P	E	C
23CT03E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: generalize the principles of Blockchain, Blocks, and Bitcoin Transactions.
CO2: relate the basic security and its significance in Bitcoin.
CO3: develop the consensus using development tools and frameworks.
CO4: implement the different consensus mechanisms used in Permissioned Blockchains.
CO5: apply the consensus mechanism in Hyperledger and Ethereum.

CO1: generalize the principles of Blockchain, Blocks, and Bitcoin Transactions.

History of Blockchain and Bitcoin – Types of Blockchain – Blockchain Consensus Mechanism – Structure of a Block – Block Header - Genesis Block –Permission-less Model and Permissioned Model – Creations of Bitcoin – Sending Payments, Double Spending - Bitcoin Transaction Life Cycle – Transaction Data Structure – Types of Transaction – Mining in Bitcoin Network – Life of a Miner – Mining Difficulty – Mining Pool methods - P2P Network - PoW, PoS, PoB - Bitcoin Scripts. **L:9**

CO2: relate the basic security and its significance in Bitcoin.

Introduction to cryptography – Cryptographic primitives – Symmetric cryptography – Asymmetric key cryptography – Public and Private keys – Encryption and decryption using RSA - Elliptic Curve Cryptography – Hash functions – Secure Hash Algorithms (SHA) - Merkle trees – Distributed Hash Tables – RSA Digital Signatures algorithm – Elliptic Curve Digital Signature algorithm - Zero Knowledge Proofs. **L:9**

CO3: develop the consensus using development tools and frameworks.

Solidity Language – Value types – Literals – Enums – Function Types – Reference Types – Global Variables – Control Structures – Solidity Compiler – Remix IDE – Tools and Libraries – Ganache – MetaMask – Truffle - Smart Contract Development and Deployment – Ecommerce, ToDo List, E-Voting, Crowd Funding. **L:9**

CO4: implement the different consensus mechanisms used in Permissioned Blockchains.

Consensus in Bitcoin – Proof of stack – Proof of Burn – Proof of Elapsed Time - State Machine Replication – Distributed Consensus – Different Algorithms – PAXOS – RAFT – Byzantine General Problem (BGP) – Practical Byzantine Fault Tolerance (PBFT) **L:9**

CO5: apply the consensus mechanism in Hyperledger and Ethereum.

Hyperledger Fabric Architecture – Key benefits - Characteristics - Components – Consensus in Hyperledger Fabric –Transaction Life Cycle - Ethereum vs Bitcoin - Endorsement Policies – Ethereum Virtual Machine (EVM) – Membership Service Provider (MSP) – Chaincode design and implementation – Corda Architecture and Components. **L:9**

REFERENCE BOOKS

1. Imran Bashir, “Mastering Blockchain” Packt Publisher, 4th Edition, 2022.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldffeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016.
3. Andreas M. Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, 2nd Release, 2015.
4. Kumar Saurabh, Ashutosh Saxena “Blockchain Technology Concepts and Applications”, Wiley Publisher, 2020.
5. Hyperledger Tutorials – https://www.hyperledger.org/use/tutorials
6. Ethereum Development Resources – https://ethereum.org/en/developers

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT04E	**WEB ANALYTICS**	3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1: explore web analytics concepts, data collection methods, and outcomes analysis techniques. (CDL1)

CO2: apply a variety of web analytics parameters and gauge their impact (CDL1)
CO3: employ web analytics tools for informed decision-making and optimization strategies (CDL1)
CO4: apply web analytics to track visitors, demographics, and custom reporting (CDL1)
CO5: experiment the potentials of web analytics in real time applications (CDL1)

CO1: explore web analytics concepts, data collection methods, and outcomes analysis techniques **L:9**

Introduction - Traditional Ways – Expectations – Data Collection – Click stream Data – Weblogs – Beacons – JavaScript Tags – Packet Sniffing –Outcomes data – Competitive data – Search Engine Data.

CO2: apply a variety of web analytics parameters and gauge their impact **L:9**

Customer Centricity – Site Visits – Surveys – Questionnaires –Website Surveys – Post visits – Creating and Running- Benefits of surveys – Critical components of successful strategy.

CO3: employ web analytics tools for informed decision-making and optimization strategies **L:9**

URLS – Cookies – Time on site – Page views – Understand standard reports – Website content quality – Navigation reports – Search Analytics – Internal search, SEO and PPC –Measuring Email and Multichannel Marketing - Competitive intelligence and Web 2.0 Analytics – Segmentation – Connectable reports.

CO4: apply web analytics to track visitors, demographics, and custom reporting **L:9**

Analytics - Cookies - Accounts vs Property - Tracking Code -Tracking Unique Visitors - Demographics - Page Views & Bounce Rate Acquisitions Custom Reporting.

CO5: experiment the potentials of web analytics in real time applications **L:9**

Filters - Ecommerce Tracking - Real Time Reports - Customer Data Alert - Adwords Linking - Adsense Linking -Attribution Modeling – Segmentation - Campaign Tracking - Multi-Channel Attribution.

CO1: explore web analytics concepts, data collection methods, and outcomes analysis techniques **L:9**

Introduction - Traditional Ways – Expectations – Data Collection – Click stream Data – Weblogs – Beacons – JavaScript Tags – Packet Sniffing – Outcomes data – Competitive data – Search Engine Data.

REFERENCE BOOKS

1. Anil Maheshwari, "It's an excellent introduction if you're just getting started in data analytics," 2024 Edition.
2. Joel J. Davis and Alexa L. Mokalis, "Google Analytics Demystified", 4th Edition, 2018.
3. Brigitte Edelman, Paul Watkins, and Matt Schiffman, "Driving Digital Decisions: How to Build and Use Facts-Based Strategy in the Age of Algorithms", 1st Edition, 2023.
4. Alistair Croll and Jacqueline Bell, "Lean Analytics: Use Data to Solve the Right Problems", 1st Edition 2018.

5. Brian Clifton, "Advanced Web Analytics with Google Analytics", 1st Edition, 2018.
6. Eric Fettman, Shiraz Asif, and Feras Alhlou, "Google Analytics Breakthrough", 1st Edition, 2016.
7. Michael Beasley, "Practical Web Analytics for User Experience: How Analytics can help you Understand your Users", 1st Edition, 2013.
8. https://analytics.google.com/analytics/web/
9. https://www.optimizely.com/optimization-glossary/web-analytics/
10. https://www.tutorialspoint.com/web_analytics/web_analytics_introduction.html

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT05E	ADVANCED DIGITAL IMAGE PROCESSING	3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components:

CO1: apply the basic 2D transforms and morphological algorithms in image processing(CDL 1)
CO2: analyze various suitable segmentation techniques and perform image analysis (CDL 2)
CO3: apply the feature extraction techniques for advanced image processing (CDL 1)
CO4: design new enhanced images using image restoration and fusion (CDL 2)
CO5: develop applications that deploy 3D image visualization techniques (CDL 2)

CO1: apply the basic 2D transforms and morphological algorithms in image processing. **L: 9**

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of Morphological image processing- Basic morphological Algorithms. Image Morphology:

Binary and Gray level morphology operations Erosion, Dilation, Opening and Closing Operations Distance Transforms

CO2: analyze various suitable segmentation techniques and perform image analysis. **L: 9**

Detection of Discontinuities –Edge Operators– Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation–Motion Segmentation-Fuzzy clustering, Watershed algorithm, Active contour models, Texture feature based segmentation, Graph based segmentation, Wavelet based Segmentation Applications of image segmentation.

CO3: apply the feature extraction techniques for advanced image processing. **L: 9**

First and second order edge detection operators, Phase congruency, Localized feature extraction detecting image curvature, shape features, Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Run length features, Fractal model based features, Gabor filter, wavelet features.

CO4: design new enhanced images using image restoration and fusion. **L: 9**

Model of the Image Degradation/Restoration Process –Noise Models –Restoration in the Presence of Noise Only –Spatial Filtering –Periodic Noise Reduction by Frequency Domain Filtering – Linear, Position–Invariant Degradations –Estimating the Degradation Function – Inverse Filtering – Minimum Mean Square Error (Wiener) Filtering – Constrained Least Squares Filtering – Geometric Transformations-Image Fusion-Overview of image fusion, pixel fusion, wavelet based fusion and region based fusion.

CO5: develop applications that deploy 3D image visualization techniques. **L: 9**

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiple connected surfaces, Image processing in 3D, Measurements on 3D images.

Case Study: Impulse Noise Reduction Using Morphological Image Processing with Structuring Elements, Web platform using digital image processing and geographic information system tools.

REFERENCE BOOKS

1. Scott E Umbaugh, — Digital Image Processing and Visual Perception, CRC Press, 4th Edition, 2022.
2. Rafael C. Gonzalez, Richard E. Woods, —Digital Image Processing‖, Pearson Education, Inc., 4th Edition, 2018.
3. JC Russ and FB Neal, —The Image Processing Handbook‖, 7th Edition., CRC Press, 2015
4. Ardeshir Goshtasby, —2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications-‖, John Wiley and Sons, 2005.
5. Rick S.Blum, Zheng Liu, —Multi sensor image fusion and its Applications, Taylor & Francis, 2005.
6. Anil K. Jain, —Fundamentals of Digital Image Processing‖, Pearson Education, Inc., 2004.
7. Mark Nixon, Alberto Aguado, Feature Extraction and Image Processing‖, Academic Press, 2004.

L : 45; TOTAL : 45 PERIODS

Course Code	INTELLIGENT SYSTEMS	L	T	P	E	C
23CT06E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components:

CO1: comprehend different types of problem solving and search algorithms and its applications (CDL 1)
CO2: realize the concepts and Knowledge representation and reasoning (CDL 1)
CO3: acquire in-depth knowledge about the reasoning (CDL 1)
CO4: implement different reinforcement technique (CDL 2)
CO5: analyze the case study of artificial intelligence applications (CDL 2)

CO1: comprehend different types of problem solving and search algorithms and its applications **L:9**

Overview of AI problems, The Turing test, Rational versus non-rational reasoning. Search Strategies: Problem spaces, problem solving by search. Uninformed search: Breadth First search, Depth First search. Heuristics and informed search: A* search, D* Search, Alpha-beta pruning, Min-max search.

CO2: realize the concepts and Knowledge representation and reasoning **L:9**

Propositional logic, First Order Logic, Forward and Backward Chaining, Resolution Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bayes theorem, Belief Networks, Simple Inference in Belief Networks.

CO3: acquire in-depth knowledge about the reasoning **L:9**

Inductive and deductive learning, unsupervised and supervised learning, explanation based Learning, concept learning from examples, Quinlan's ID3, C4.5 decision trees, classification and regression trees, Bayesian methods.

CO4: implement different reinforcement technique **L:9**

Introduction, Passive reinforcement learning, Active reinforcement learning, Generalization in reinforcement learning, Policy search, Applications of reinforcement learning.

CO5: analyze the case study of artificial intelligence applications **L:9**

Case study on Intelligent systems in automation, Health care, Pattern recognition, Natural Language Processing, Sentiment Analysis, Information Retrieval, Robotics

REFERENCE BOOKS

1. S.Russel, P.Norvig, “Artificial Intelligence - A Modern Approach”, 4th Edition, Pearson Education Ltd., 2020.
2. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, 1st Edition, Pearson Education, 2015.
3. Christopher M.Bishop, “Pattern Recognition and Machine Learning”, 1st Edition, Springer, 2016.
4. Rajendra Akerkar, “Foundations of the Semantic Web, Narosa Publishing House, New Delhi and Alpha Science Intern, 2009.
5. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems. 2nd Edition, Addison Wesley, 2011.

L: 45; TOTAL: 45 PERIODS

Course Code	PREDICTIVE DATA ANALYTICS	L	T	P	E	C
23CT07E		3	0	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: analyse the key concepts in predictive data analytics and get to know about the techniques for data cleaning, preprocessing, and feature selection.

CO2: apply association rules and descriptive modeling techniques to real-world datasets to extract meaningful insights.

CO3: develop regression models using appropriate techniques and algorithms for making predictions and forecasting trends.

CO4: construct predictive models using various algorithms to solve business challenges and make data-driven decisions.

CO5: demonstrate the understanding in developing forecasting models using time series data.

CO1: analyse the key concepts in predictive data analytics and get to know about the techniques for data cleaning, preprocessing, and feature selection L:9

Overview - Predictive Analytics vs. Statistics - Setting Up the Problem - Predictive Analytics Processing Steps: CRISP-DM - Business Understanding - Defining Data for Predictive Modeling - Defining the Target Variable - Defining Measures. Data Understanding - Single Variable Summaries - Data Visualization in One Dimension - Histograms - Multiple Variable Summaries - Data Visualization, Two or Higher Dimensions. Data Preparation - Variable Cleaning - Feature Creation.

CO2: apply association rules and descriptive modeling techniques to real-world datasets to extract meaningful insights. L:9

Itemsets and Association Rules - Parameter Settings - How the Data Is Organized - Measures of Interesting Rules - Deploying Association Rules - Problems with Association Rules - Building Classification Rules from Association Rules. Descriptive Modeling - Data Preparation Issues with Descriptive Modeling - Principal Component Analysis - Clustering Algorithms. Interpreting Descriptive Models

CO3: develop regression models using appropriate techniques and algorithms for making predictions and forecasting trends. L:9

Simple Linear Regression - Correlation analysis - Estimation and interpretation of Coefficients - Assessing the Accuracy of the Coefficient Estimates - Least Square Method - Assessing the Accuracy of the Model. Multiple Linear Regression - Estimation of Regression Parameters - Estimation and interpretation of coefficients, validation of MLR model. Logistic Regression - Estimating the Regression Coefficients - Making Predictions - Multiple Logistic Regression. Resampling Methods - Cross-Validation - Bootstrap Regression.

CO4: construct predictive models using various algorithms to solve business challenges and make data-driven decisions L:9

Decision Trees – Gini Impurity index and Entropy – CHI-Square Automatic Interaction Detectors (CHAID) – Classification and Regression Tree (CART) – Bagging, Random Forests, Boosting - Neural Networks – K-Nearest Neighbor – Naive Bayes Classification.

CO5: demonstrate the understanding in developing forecasting models using time series data. L:9

Time-series data components - Time Series Regression - Decomposition Methods - Exponential smoothing techniques - Forecasting techniques - Additive & Multiplicative models - Forecasting Accuracy - Auto-regressive and Moving average models.

REFERENCE BOOKS:

1. Dean Abbott, "Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst", Wiley, 2014.
2. Trevor Hastie, Robert, Jerome, "The elements of statistical learning: Data mining, Inference and Prediction", 2nd Edition, 2017.
3. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2017.
4. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", Prentice Hall, 9th Edition, 2022.
5. Dr.Anasse Bari, Mohamed Chaouchi and Tommy Jung, "Predictive Analytics For Dummies", John Wiley & Sons, 2014.
6. NPTEL Course :https://archive.nptel.ac.in/courses/111/106/111106164/

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT08E	**GPU COMPUTING**	**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1: apply the core principles of parallel computing and pipeline visualization to Graphics Processing Units (GPUs). (CDL1)
CO2: analyze GPU architecture to identify potential software optimizations. (CDL2)
CO3: apply synchronization techniques and memory models for GPU programming. (CDL2)
CO4: design GPU programs with front-end and back-end compiler. (CDL3)
CO5: demonstrate utilization of GPU computing methodologies for real-world scenarios. (CDL2

CO1: apply the core principles of parallel computing and pipeline visualization to Graphics Processing Units (GPUs). **L:8**

Introduction-The OpenCL programming model-Host program and device kernel-OpenCL objects - Basic program: vector addition.

CO2: analyze GPU architecture and identify potential software optimizations based on knowledge of then GPU architecture. **L:10**

The AMD Southern Islands instruction set architecture-SIMD (Single-Instruction Multiple-Data) execution model-Scalar and vector instructions-Thread divergence-Nested control flow-The Multi2Sim simulation framework- Disassembler, emulator, timing simulator, and pipeline visualization.

CO3: analyze and apply synchronization techniques and memory models for GPU programming **L:9**

Square matrix transpose-Square matrix multiplication-Work-groups-OpenCL synchronization model -OpenCL memory model-Matrix multiplication with local memory-Parallel reduction algorithms-Sorting algorithms.

CO4: design GPU programs with front-end and back-end compiler **L:9**

Memory hierarchies and coherence protocols on APUs-Interconnection networks on GPUs- Rendering graphics using OpenGL-The GPU graphics pipelines-Simulation of new GPU architectures-OpenCL/CUDA to LLVM compiler front-ends-LLVM to NVIDIA/Intel/AMD compiler back-ends and optimizers.

CO5: demonstrate utilization of GPU computing methodologies for real-world scenarios. **L:9**

Graphic processing unit computing for large-scale data mining- GPU architecture for dataminingtasksandtechniques–applications-GPUcomputingandmapreduce-Apriori

REFERENCE BOOKS

1. Wen-mei W. Hwu, David B ,Programming Massively Parallel Processors. A Hands-on Approach. Book ,4th edition , 2022
2. Nicholas Wilt, "UDA Handbook: A Comprehensive Guide to GPU Programming", Addison - Wesley, 2013.
3. Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General Purpose GPU Programming", Addison - Wesley,2010.
4. AlbertoCano,—Asurveyongraphicprocessingunitcomputingforlargescaledatamining,Wiley2017.
5. Raphael Couturier, "Designing Scientific Applications on GPUs", CRC Press, 21-Nov-2013
6. B.Gaster,L.Howes,D.Kaeli,P.Mistry,D.Schaa,—HeterogeneousComputingwith OpenCL‖, Morgan Kaufmann, 1st edition, August 31,2011.
7. AaftabMunshi, Benedict R. Gaster, Timothy G. Mattson, and James Fung, "OpenCL Programming Guide" ,1st edition 2011.
8. B.Gaster,L.Howes,D.Kaeli,P.Mistry,D.Schaa,—HeterogeneousComputingwith OpenCL‖, Morgan Kaufmann, 1st edition, August 31,2011.
9. http://www.nvidia.com/object/cuda_home_new.html
10. https://www.class-central.com/tag/gpu-programming

L: 45; TOTAL: 45 PERIODS

Course Code	QUANTUM COMPUTING	L	T	P	E	C
23CT09E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1: recognize the importance of Quantum Computation in Computer Science(CDL 1)

CO2: comprehend the basics of linear algebra and foundation principle of quantum mechanics (CDL 1)

CO3: implement the potency of the Quantum algorithms and protocols in research perspective (CDL 2)

CO4: design simple quantum algorithms by analyzing the computational complexity and considering fault tolerance (CDL 2)
CO5: implement error correction techniques by analyzing the quantum computational complexity and assess their ethical implication (CDL 2)

CO1: recognize the importance of Quantum Computation in Computer Science. **L:9**

Overview of traditional computing – Church-Turing thesis – circuit model of computation – reversible computation – quantum physics – quantum physics and computation – Dirac notation and Hilbert Spaces – dual vectors – operators – the spectral theorem – functions of operators – tensor products – Qubits versus classical bits - Schmidt decomposition theorem

CO2: comprehend the basics of linear algebra and foundation principle of quantum mechanics **L:9**

Quantum Measurements Density Matrices - Positive-Operator Valued Measure - Fragility of quantum information: Decoherence - Quantum Superposition and Entanglement - Quantum Gates and Circuits - No cloning theorem

CO3: implement the potency of the Quantum algorithms and protocols in research perspective. **L:9**

Superdense coding – Quantum teleportation – Applications of teleportation – Probabilistic versus quantum algorithms – Phase kick-back – Bell‘s inequality and its implications - Deutsch and Deutsch-Jozsa algorithm –Simon's algorithm – Quantum phase estimation - Quantum Fourier Transform – Eigenvalue estimation

CO4: design simple quantum algorithms by analyzing the computational complexity and considering fault tolerance. **L:9**

Order-finding problem – Shore‘s factorization algorithm – Finding discrete logarithms – Hidden subgroups – Grover's quantum search algorithm – Amplitude amplification – Quantum amplitude estimation – Quantum counting

CO5: implement error correction techniques by analyzing the quantum computational complexity and assess their ethical implication. **L:9**

Scalability in quantum computing - NMR Quantum Computing - Spintronics and QED approaches - Linear Optical Approaches - Nonlinear Optical Approaches - Polynomial method – Block sensitivity – Adversary methods - Fault tolerance – Quantum error correction

REFERENCE BOOKS:

1. "Quantum Computing: An Applied Approach" by Jack D. Hidary – 1st Edition, 2019.
2. Micheal A.Nielsen and Issac L.Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2013.
3. David McMahon, Quantum Computing Explained, Wiley, 2016.
4. Richard J. Lipton Kenneth W. Regan, “Quantum algorithms via linear ALGEBRAA Primer”, The MIT Press Cambridge, Massachusetts London, England, 2014.
5. Michael A. Nielsen and Issac L. Chuang, “Quantum Computation and Quantum Information”, Cambridge, 2011.
6. Riley Tipton Perry, “Quantum Computing from the Ground Up”, World Scientific Publishing Ltd., 2012.

7. Scott Aaronson, "Quantum Computing since Democritus", Cambridge, 2013.
8. P.Kok, B.Lovett, "Introduction to Optical Quantum Information Processing", Cambridge, 2010.

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT10E	SOFTWARE DEFINED NETWORKS	3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components:

CO1: analyze the evolution of software defined networks (CDL 1)
CO2: comprehend the advanced and emerging networking technologies (CDL 1)
CO3: apply and analyze the network functions and virtualization. (CDL 2)
CO4: obtain skills to do advanced networking research and programming (CDL 1)
CO5: design and develop various applications of SDN (CDL 1)

CO1: analyze the evolution of software defined networks **L:9**

History of Software Defined Networking (SDN) – Modern Data Center – Traditional Switch Architecture – Evolution of Switches and Control Planes-Data Center Innovation-Data Center Needs- SDN Fundamental Characteristics-Operation-Devices-Controller– Centralized and Distributed Control and Data Planes.

CO2: comprehend the advanced and emerging networking technologies **L:9**

Open Flow Specification – Drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor-Based Overlays – SDN via Opening up the Device – General Concepts SDN Controllers

CO3: apply and analyze the network functions and virtualization **L:9**

Multitenant and Virtualized Multitenant Data Center – SDN Solutions for the Data Center Network – VLANs – EVPN – VxLAN – Network Virtualization using Generic Routing Encapsulation (NVGRE).

CO4: obtain skills to do advanced networking research and programming **L:9**

Programming SDNs- Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs – Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

CO5: design and develop various applications of SDN **L:9**

Juniper SDN Framework – IETF SDN Framework – Open Daylight Controller – Floodlight Controller – Bandwidth Calendaring – Data Center Orchestration.

REFERENCE BOOKS

1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", 2nd Edition, Morgan Kaufmann publishers, 2016.
2. Patricia A. Morreale, James M. Anderson, "Software Defined Networking design and deployment", First Edition, CRC Press publishers, 2015.
3. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks", First Edition, O'Reilly Media publishers, 2013.
4. Oswald Coker and Siamak Azodolmolky, "Software Defined Networking with Open Flow, Packt Publishing Limited", Second Edition, 2017.

5. Fei Hu, Editor, "Network Innovation through Open Flow and SDN: Principles and Design", CRC Press, 2014.
6. Siamak Azodolmolky, "Software Defined Networking with Open Flow", 1st edition, Packet publishing, 2013.
7. Vivek Tiwari, "SDN and Open Flow for Beginners", Amazon Digital Services, Inc., 2013.
8. Vishal Shukla, "Introduction to Software Defined Networking - Open Flow & VxLAN", Create space Independent Publishing Platform, 2013.

L: 45; TOTAL: 45 PERIODS

Course Code	GAME THEORY	L	T	P	E	C
23CT11E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

CO1: demonstrate the conceptual overview of game theory and Nash equilibrium.

CO2: analyze the situations in which the players interact with each other in the context of complete information.

CO3: analyze the static situations involving conflict and/or cooperation in the context of incomplete information.

CO4: analyze the dynamic situations involving conflict and/or cooperation in the context of incomplete information.

CO5: utilize the social choice theory for collective decision making.

CO1: demonstrate the conceptual overview of game theory and Nash equilibrium **L:9**

Introduction – Decision Theory – Strategic Game - Nash Equilibrium – Multiple Nash Equilibrium Applications - Mixed Strategy Equilibrium.

CO2: analyze the situations in which the players interact with each other in the context of complete information **L:9**

Extensive Form Games – strategies and equilibrium in extensive form games – Backward Induction and sub game perfection.

CO3: analyze the static situations involving conflict and/or cooperation in the context of incomplete information **L:9**

Bayesian Games – Bayesian Nash Equilibrium – Applications

CO4: analyze the dynamic situations involving conflict and/or cooperation in the context of incomplete information **L:9**

Perfect Bayesian Equilibrium – Signaling Games – Applications

CO5: utilize the social choice theory for collective decision making **L:9**

Social choice and social welfare functions - Condorcet's paradox - Desirable properties of social choice procedures (Pareto condition, independence of irrelevant alternatives) – Popular voting procedures (Borda) – Arrow's theorem

REFERENCE BOOKS

1. Martin Osborne, "An Introduction to Game Theory", Oxford University Press, 2nd Edition, 2012.
2. G.Chalkiadakis, E.Elkind, and M.Wooldridge, "Computational Aspects of Cooperative Game Theory", Morgan & Claypool, 2011.

3. Michael Maschler, Eilon Solan, Shmuel Zamir, “Game Theory”, Cambridge University Press, 1st Edition, 2013.
4. Y. Shoham and K. Leyton-Brown, “Multiagent Systems”, Cambridge University Press, 2009.
5. Drew Fundenberg and Jean Tirole, “Game Theory”, MIT Press, 1st Edition, 2005.
6. Y. Narahari, “Game Theory and Mechanism Design”, IISc Press and the World Scientific, 2014.

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT12E	MALWARE DETECTION AND PREVENTION	3	0	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

Theory Components:

CO1: illustrate the nature of malware, its capabilities, types and its analysis
(CDL1) CO2: recognize web application security threats and vulnerabilities (CDL1)
CO3: utilize executable formats,windows internals and API, its detection and prevention techniques (CDL1)
CO4: apply the techniques of signature-based and non signature based of malware detection (CDL1)
CO5: apply intrusion prevention techniques to real world malware problems (CDL2)

CO1: illustrate the nature of malware, its capabilities, types and its analysis L:9

Introduction to malware - OS security concepts - malware threats - evolution of malware - Malware types - viruses - worms, rootkits, Trojans, bots, spyware, adware, logic bombs.

CO2: recognize web application security threats and vulnerabilities L:9

Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures.

CO3: utilize executable formats, windows internals and API, its detection and prevention techniques L:9

Downloaders and Launchers, Backdoors, Credential Stealers - Persistence Mechanisms, Privilege Escalation, Covering - Its Tracks - User - Mode Rootkits - Covert malware launching
- Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC injection

CO4: apply the techniques of signature-based and non signature based for malware detection L:9

Signature - based techniques: malware signatures, packed malware signature, metamorphic and polymorphic malware signature - Non-signature based techniques: similarity - based techniques

CO5: apply intrusion prevention techniques to solve real world malware problems Machine learning methods - invariant inferences **-** Case Studies – Plankton, Droid Kung Fu, AnserverBot, Smartphone (Apps) Security **L:9**

REFERENCE BOOKS

1. Dang, Gazet, Bachaalany, "Practical Reverse Engineering", 1st Edition, Wiley, 2014.
2. Michael Sikorski and Andrew Honig, "Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software", No Starch Press, 2012.
3. Reverend Bill Blunden, "The Rootkit Arsenal : Escape and Evasion in the Dark Corners of the System" 2nd Edition, Jones & Bartlett, 2012.
4. Jamie Butler and Greg Hoglund, "Rootkits:Subverting the Windows Kernel", Addison-Wesley, 2005.

L:45; TOTAL:45 PERIODS

Course Code		L	T	P	E	C
23CT13E	WIRELESS BODY AREA NETWORKS	3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components:

CO1: recognize the wireless body area network Characteristics (CDL 1)
CO2: exemplify the WBAN Technologies and protocols. (CDL 1)
CO3: analyze the fundamental design and security of wearable sensors (CDL 2)
CO4: integrate wearable and cloud computing standards (CDL 1)
CO5: apply wireless sensor Network concept to implement healthcare Applications(CDL 2)

CO1: recognize the wireless body area network Characteristics **L:8**

Introduction to WBAN- Standard-characteristics-Requirements of BAN-BAN Standardization- Architecture-WBAN layers- Drawback of WBAN. Sensor design – Hardware Architecture of a Sensor Node-Power Consumption Consideration biocompatibility - number of nodes. Typical m-Health System Architecture-Hardware Architecture of Sensor Node-Power Consumption - Consideration - Commercial Sensor Node Platforms - Biophysiological Signals and Sensors.

CO2: exemplify the WBAN Technologies and protocols. **L:10**

Physical (PHY) layer technologies – Narrow band and UWB – Medium access control (MAC) technologies for WBAN – Unified MAC design independent of underlying PHY technologies- Standardization with IEEE802.15.6, IEEE 11073, and ETSI eHealth Project. Network topologies and configuration -Traffic characteristics – Scheduled protocol – Random access protocol-Hybrid MAC protocol - Energy management in WBAN-Performance analysis of WBAN.

CO3: analyze the salient features and hardware requirements of wearable sensors and its security **L:8**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional - Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable- Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor. Security Attacks in Wireless Healthcare System- Attacks at Data Collection Level- Attacks at Transmission Level- Attacks at Storage Level.

CO4: integrate wearable and cloud computing standards **L:9**

Introduction-Cloud Computing-Architectures for Sensor Stream Management-BSN/Cloud Computing Integration Challenges-Architecture for Cloud Assisted BSNs-Sensor Data Collection-Sensor Data Management-Scalable Processing Framework-Persistent Storage- Decision Making Process-Integration of WSNs and Cloud Computing- Integration of BSNs and Cloud Computing.

CO5: apply wireless sensor Network concept to implement the Healthcare Applications. **L:10**

General approach to WSN in Healthcare – Key Principles, Methodology – Architecting WSN Solutions for Healthcare – Hardware, Firmware and Software Choices-applications- Privacy Requirements in Healthcare Systems - Wireless Healthcare Systems' Reliability : Monitoring patients with chronic disease, Hospital patients, Elderly patients, Multi patient monitoring systems - simulation in NS2

REFERENCES BOOKS

1. R.Maheswar, G.R.Kanagachidambaresan, R.Jayaparvathy, Sabu M.Thampi, Body Area Network Challenges and Solutions, Springer Cham, 2019.
2. Giancarlo Fortino, Stefano Galzarano, Raffaele Gravina ,Wearable Computing: From Modeling to Implementation of Wearable Systems based on Body Sensor Networks, Wiley- IEEE Press, 2018.
3. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
4. https://link.springer.com/book/10.1007/978-3-030-00865-9
   https://core.ac.uk/download/pdf/38101617.pdf

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT14E	**CELLULAR AUTOMATA PARADIGM**	**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1: apply the mathematical preliminaries of cellular automata to solve basic problems(CDL 1)
CO2: analyze cellular automata rules and build reaction diffusion system(CDL 2)
CO3: integrate the relationship among formal languages, formal grammars and automata (CDL 1)
CO4: analyze the concepts of quasi linear cellular automata(CDL 2)

CO1: apply the mathematical preliminaries of cellular automata to solve basic problems

Introduction - Computation - Powerful Computation Engines - Discrete Dynamical System Simulators - Mathematical Preliminaries - Set Theory - Information Theory - Graph Theory - Graphs Rings And Fields - Abstract Automata - One Dimensional And Two Dimensional CA **L:11**

CO2: analyze cellular automata rules and build reaction diffusion system

Simple Binary Cellular Automata Rules - Reversible Rules - Parameterizing The Space Of CA Rules - simulating cellular automata - extensions of cellular automata - examples of cellular automata models - Quantum Cellular Automata - Reaction Diffusion Systems **L:11**

CO3: integrate the relationship among formal languages, formal grammars and automata

Regular Languages - Finite Automata - Context Free Languages - Push Down Automata - Finite State Transition Graph - Regular Language Complexity - Entropy–Power Spectra Of Regular Languages - Numerical Estimates - Reversible Computation - Universal Logic Gates, The Billiard Ball Model **L:12**

CO4: **analyze the concepts of quasi linear cellular automata**

Cellular automata analysis - sizes of rule space and phase space - phase space visualization - mean-field approximation - renormalization group analysis - characteristic polynomial - matrix algebra - analysis and synthesis - Quasi linear CA - nonlinear CA - fuzzy - multi-valued CA **L:11**

REFERENCE BOOKS:

1. New Methods and Paradigms for Modeling Dynamic Processes Based on Cellular Automata Hardcover by Stepan Mykolayovych Bilan (Author), Mykola Mykolayovych Bilan (Author), Ruslan Leonidovich Motornyuk (Author) - 2020
2. Academic Insights and Perspectives: Cellular Automata and Production Scheduling, Purushothaman Damodaran, 2020
3. Quantum-Dot Cellular Automata Based Digital Logic Circuits: A Design Perspective Authors: Dr. Trailokya Nath Sasamal, Prof. Ashutosh Kumar Singh, Prof. Anand Mohan, Springer Singapore,2020
4. https://math.libretexts.org/Bookshelves/Scientific_Computing_Simulations_and_Modeling/Introduction_to_the_Modeling_and_Analysis_of_Complex_Systems_(Sayama)
5. http://users.utu.fi/jkari/ca2024
6. https://nanohub.org/resources/148
7. https://www.researchgate.net/publication/330254585_Cellular_Automata_and_Its_Applications

L : 45; TOTAL: 45 PERIODS

Course Code	VEHICULAR ADHOC NETWORKS	L	T	P	E	C
23CT15E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1: explore the basic principles and challenges of VANET (CDL1)

CO2: implement the concepts of link layer protocols and wireless access technologies (CDL1)

CO3: analyze various routing protocols and connectivity techniques (CDL1)

CO4: demonstrate the evolving security issues and the range of encryption techniques (CDL1)

CO5: apply diverse mobility models and simulation tools in VANET (CDL2)

CO1: explore the basic principles and challenges of VANET **L:9**

Introduction - System architecture - Protocol Stack: Layering and Standards – Fundamental principles of layering - communication domains: Vehicle to Vehicle Communication, Vehicle to Infrastructure- Infrastructure to Infrastructure. Characteristics- Challenges and issues in VANET- Enabling Technologies- Applications in VANET.

CO2: implement the concepts of link layer protocols and wireless access technologies **L:9**

MAC Approaches for VANETs-Single Channel MAC Protocol: Centralised and distributed MAC protocols - Distributed and location-based TDMA MAC (DTMAC)- Cluster-Based TDMA (CBT)- Multi Channel MAC Protocol: Centralised and distributed MAC protocols - Improved Coordinated multi-channel MAC (IC-MAC Wireless Access Technologies WLAN/Wi-Fi- WiMAX- DSRC/WAVE- Cellular systems.

CO3: analyze various routing protocols and connectivity techniques **L:9**

Information Dissemination: Introduction, Information Transport & Geographical Data Aggregation Local and summarizing the measurements -VANET Routing protocols-Topology based routing-proactive: CGSR and reactive protocols: DYMO-Hybrid:ZRP-Broadcast routing protocol-UMB-Connectivity in VANET–performance modeling-Node connectivity-Road side connectivity –connectivity in urban area and highways.

CO4: : **demonstrate the evolving security issues and the range of encryption techniques** Introduction-security threats - Classification of attacks: Sybil Attack Impersonation Attack and Masquerade - Timing Attack - Global Positioning System (GPS) Spoofing , Hidden vehicle and Tunnel Attack-Illusion Attack - Denial of Service(DOS) - security requirements-VANET Security Threats and Challenges-VANET Security Schemes & Concepts: Symmetric Key Approaches- Public Key Approaches-Identity Based Cryptosystem for VANETs. **L:9**

CO5: apply diverse mobility models and simulation tools in VANET **L:9**

Mobility Models: Random Models, Flow Models, Traffic Models, Trace or survey-based Models and Behavioral Model - Overview of Simulators - General Features - Simulator Architecture- Types of Simulators: Mobility Simulator, Network Simulator – SUMO.

REFERENCE BOOKS

1. Stephan Olariu and Michele C. Weigle, “Vehicular Ad-Hoc Networks for Smart Cities”, 1st Edition, 2020.
2. Stefan Valentin and Mesut Güneş, “Vehicular Networks: Models and Algorithms”, 1st Edition, 2021.
3. Dijiang Huang and David J. Wu,” Security and Privacy in Wireless and Mobile Networks: Third IFIP WG 11.2 International Workshop”, 1st Edition, 2022.
4. W. Stallings, "Wireless Communications & Networks", 2nd Edition 2009.
5. T.S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, 2010.
6. Luca Delgrossi and Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy", 1st Edition 2012.
7. http://www.irma-international.org/viewtitle/43163/
8. https://en.wikipedia.org/wiki/Vehicular_ad_hoc_network
9. http://comp.ist.utl.pt/~rmr/WSN/CaseStudies2007-no/WSN_Transportation

L: 45; TOTAL: 45 PERIODS

Course Code	PATTERN RECOGNITION	L	T	P	E	C
23CS16E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory components:

CO1: visualize machine perception systems using pattern classification, Bayesian decision theory(CDL1)
CO2: apply advanced machine learning techniques (CDL1)
CO3: implement neural network techniques for pattern recognition (CDL1)
CO4: analyze non metric and other methods for improved accuracy (CDL 2)
CO5: utilize unsupervised learning techniques for clustering, density estimation, Bayesian learning, and dimensionality reduction (CDL 2)

CO1: visualize machine perception systems using pattern classification, Bayesian decision theory **L:9**

Machine Perception-approaches to pattern classification-pattern recognition system-the design cycle- learning and adaptation-Bayesian Decision Theory-Minimum error rate classification -classifiers, Discriminant Functions and Decision Surfaces -error probabilities and integrals- Maximum-likelihood estimation-Bayesian estimation

CO2: apply advanced machine learning techniques **L:9**

Probability of dimensionality-hidden Markov models-Non-Parametric Techniques-K-nearest neighbor estimation-The nearest neighbor rule-Metrics and Nearest-Neighbor classification-Fuzzy classification-Linear discriminant functions and decision surfaces-The Ho-Kashyap procedures-Support Vector Machine

CO3: implement neural network techniques for pattern recognition **L:9**

Artificial Neural Networks-Feedforward operation and classification-Backpropagation Algorithm- Backpropagation as Feature Mapping -Backpropagation, Bayes Theory and Probability-practical Techniques for improving backpropagation-Additional Networks and Training methods-Deep Neural networks for pattern recognition

CO4: analyze non metric and other methods for improved accuracy **L:9**

Non metric methods-CART-other Tree methods-Recognition with strings-Algorithm-Independent machine learning-Bias and variance-performance metrics-estimating and comparing classifier- combining classifiers

CO5: utilize unsupervised learning techniques for clustering, density estimation, Bayesian learning, and dimensionality reduction+ **L:9**

Unsupervised learning and clustering -mixture densities and Identifiability-Maximum likelihood estimates-application to normal mixtures-unsupervised Bayesian learning- Data Description and Clustering-criterion functions for clustering-Hierarchial clustering-on line clustering-Graph theoretic methods-component analysis-low dimensional representations and multidimensional scaling(MDS)

REFERENCE BOOKS:

1. Pattern Classification, 2nd Edition, Richard O. Duda, Peter E. Hart, and David G. Stork. Wiley, 2021.
2. Pattern Recognition, Jürgen Beyerer, Matthias Richter, and Matthias Nagel. 2018
3. Pattern Recognition and Machine Learning, Christopher M. Bishop. Springer, 2010
4. Pattern Recognition and Classification, Dougherty, and Geoff. Springer, 2013
5. Practical Machine Learning and Image Processing, Himanshu Singh. Apress, 2019

L:45; TOTAL:45 PERIODS

23CT17E	DATASCIENCE	L	T	P	E	C
		3	0	2	2	5

COURSEOUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand fundamentals, and statistical concepts for data science
CO2: Analyze the key concepts in predictive data analysis
CO3: Apply data visualization concepts for data science
CO4: Understand exploratory data analysis concepts
CO5: Analyze the classification & clustering concepts

DATA SCIENCE FUNDAMENTALS **12**

Linear Algebra for data science, Probability, Descriptive statistics: histogram charts–scatter plots measures of central tendency, measuring a symmetry: skewness – Measuring variability: Variance. Standard deviation, Covariance. Correlation coefficient Chi-Square test-t-Test Distributions: Normal distribution, standard normal distribution, Central Limit Theorem, Hypothesis Testing

PREDICTIVE DATA ANALYSIS **6**

Predictive models: Regression: Linear Regression, Multiple linear regression, logistic regression, time series forecasting, association rule mining, text mining: Sentimental Analysis

DATA VISUALISATION **9**

Introduction – Data visualization methods: Mapping Time series Connection sand correlations – Scatter plot maps Trees, Hierarchies and Recursion – Data visualization using Tableau

EXPLORATORY DATA ANALYSIS **9**

Dimensionality reduction: Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA), Principal Components Analysis (PCA), Probabilistic Latent Semantic Analysis (PLSA), Expectation - Maximization (EM) algorithm, E-step and M-step, Hidden variables, Hill climbing, Local maximum, Latent Dirichlet Allocation (LDA)

CLASSIFIERS AND CLUSTERING **9**

Ensemble of classifiers: Classification–Prediction–Voting, Bagging, Boosting, Stacking, Cascading, Random forest, Semi supervised Learning. Clustering: Similarity and Distance Measures, Hierarchical Algorithms, Clustering Large Datasets, clustering with Categorical Attributes – Outlier analysis

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Vijay Kotu, Bala Deshpande, Data Science: Concepts and Practice, 2nd Edition, Morgan Kaufmann Publishers, 2018
2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline, O'Reilly, 2014
3. Lillian Pierson, Data Science For Dummies, John Wiley & Sons, 2017
4. Hadley Wickham, Garrett Grolemund, R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, O'Reilly Media Inc, 2017.

L T P E C

23CT18E	DATA SCIENCE LABORATORY	0	0	2	2	2

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Work with data science fundamentals using various statistical models.

CO2: Implement data models and visualization using tools

LIST OF EXPERIMENTS

1. Develop a data model using statistical method for appropriate data set and draw modeling graph
2. Implement data preprocessing using data preparation techniques with appropriate data set within complete data
3. Implement simple linear regression algorithm with appropriate data set.
4. Implement multivariate linear regression model for a real world application.
5. Perform LDA/PCA analysis for dimensionality reduction.
6. Implement association rule mining/sentimental analysis using python
7. Implement outlier analysis concepts using python
8. Implementation of data visualization using Tableau
9. Mini Project: Develop a real-world application with all the above data analytics concepts usingstandard data set.

P: 45; TOTAL: 45 PERIODS

Software Requirements

Open source Tool: R tool

Course code	BIGDATA ANALYTICS AND MANAGEMENT	L	T	P	E	C
23CT19E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: develop a solid understanding of the fundamental concepts, principles and methodologies of analytics

CO2: apply the NoSQL procedures for big data management

CO3: develop practical skills in working with HDFS, including file storage, retrieval, and manageme

CO4: implement MapReduce algorithms for various data processing tasks

CO5: demonstrate Hadoop-related tools such as HBase, Pig, and Hive for data visualization

CO1: develop a solid understanding of the fundamental concepts, principles, and methodologies of analytics. **L:9**

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

CO2: apply the NoSQL procedures for big data management

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schema less databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients **L:9**

CO3:develop practical skills in working with HDFS, including file storage, retrieval, and management **L:9**

Introduction about Hadoop- Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra – Hadoop integration.

HDFS: The Design of HDFS-HDFS Concepts- Command Line Interface-Hadoop file system interfaces-Data flow-Data Ingest with Flume and Scoop and Hadoop archives-Streaming- Real time applications hadoop.

CO4: implement MapReduce algorithms for various data processing tasks **L:9**

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

CO5: demonstrate Hadoop-related tools such as HBase, Pig, and Hive for data visualization **L:9**

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. 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.

REFERENCE BOOKS

1. RajKamal and Preeti Saxena, “BigData Analytics Introduction to Hadoop, Spark, and Machine-Learning”, McGraw Hill Education, 2020
2. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", 1st Edition, Wiley, 2018.
3. Douglas Eadline,"Hadoop2 Quick-tart Guide: Learn the Essentials of BigData Computing in the Apache Hadoop 2 Ecosystem", 1st Edition, Pearson Education, 2016. ISBN 13: 978-9332570351
4. Tom White, “Hadoop: The Definitive Guide”, 4th Edition, O"Reilly Media, 2015.ISBN-13: 978-9352130672.
5. P.J.Sadalage and M.Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", 1st Edition, Addison-Wesley Professional, 2015.

L: 45; TOTAL: 45 PERIODS

Course Code	BIG DATA ANALYTICS AND MANAGEMENT LABORATORY	L	T	P	E	C
23CT20E		0	0	2	2	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Practical Component

CO1: demonstrate the knowledge of big data analytics and implement different file management tasks in Hadoop.
CO2: implement the Mapreduce algorithms.
CO3: showcase different operations on relations and databases using Hive and Cassandra.

CO1: demonstrate the knowledge of big data analytics and implement different file management tasks in Hadoop. **P:10; E:10**

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting file

CO2: implement the Mapreduce algorithms. **P:10; E:10**

1. Implementing Matrix Multiplication with Hadoop Map Reduce.
2. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm

CO3: showcase different operations on relations and databases using Hive and Cassandra. **P:10; E:10**

1. Installation of Hive along with practice examples.
2. Installation of HBase, Installing thrift along with Practice examples
3. Practice importing and exporting data from various databases.

Software Requirements:

1. Java
2. Hadoop
3. Map Reduce
4. Cassendra

P: 30; E: 30; TOTAL: 60 PERIODS

Course Code	CYBER SECURITY	L	T	P	E	C
23CT21E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory component

CO1: relate and categorize the computer security threats, malwares, and attacks.
CO2: use an appropriate network defense tools and solutions to mitigate threats and vulnerabilities.
CO3: implement common threats and attacks in e-payment systems.
CO4: integrate the cybersecurity policies and standards to protect the digital assets
CO5: analyze various challenges and threats in emerging trends and technologies.

CO1: relate and categorize the computer security threats, malwares and attacks. **L:9**

Introduction -Computer Security - Threats -Harm - Vulnerabilities - Controls - Authentication - Access Control and Cryptography – Browser Attacks - Website Data -

Email Attacks - Network Vulnerabilities - vulnerability scanning - Open Port / Service Identification - Banner /Version Check - Traffic Probe - Vulnerability Probe - OpenVAS – Metasploit - Networks Vulnerability Scanning (Netcat, Socat) - Network Sniffers and Injection tools.

CO2: use an appropriate network defense tools and solutions to mitigate threats and vulnerabilities. **L:9**

Network Defense tools - Firewalls and Packet Filters - Stateless Vs Stateful Firewalls - Network Address Translation (NAT) and Port Forwarding - Virtual Private Networks - Snort:Detection System - Security in Operating Systems - Rootkit - Wireless Network Security - Denial of Service - Distributed Denial-of-Service

CO3: implement common threats and attacks in e-payment systems **L:9**

Introduction to E-Payment Security, Importance of Security in E- Payment, Common threats and attacks in E- Payment, Case Studies of Threats associated with E-Cash, Debit Card, Credit Card, Smart Card, ATM Machines, Mobile Payment, E-Wallet, Online Banking, SMS Banking

CO4: integrate the cybersecurity policies and standards in protecting an organization's digital assets and sensitive information. **L:9**

Introduction to Security Policies, Need for Security Policy, Stakeholders of Policy Makers, Security Policy Audit, Security Policy Enforcement, Security Policy Awareness, Importance of Security Standards, ISO/IEC 27001 and 27002, NIST Cyber Security Framework, Common Criteria

CO5:analyze various challenges and threats in emerging trends and technologies **L:9**

Introduction to Cyber Security Challenges: Ransom ware, Block chain, Internet of Things (IoT), Artificial Intelligence, Server less Apps - Security Analysis benefits and steps - Quantitative and Qualitative Security Risk Analysis

REFERENCE BOOKS

1. Charles J. Brooks, Christopher Grow, Philip Craig"**,** Cybersecurity Essentials", John Wiley and Sons, 2018
2. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition, Pearson Education , 2015
3. Mayank Bhusan, Rajkumar Singh Rathore, Aatif Jamshed, “Fundamentals of Cyber Security: Principles, Theory and Practices”, BPB Publications, 2018
4. Paul A.Watters, Cyber Security: Concepts and Cases, Create Space Independent Publishing Platform, 2012.
5. Peter W. Singer, Allan Friedman, Cybersecurity: What Everyone Needs to Know, Oxford University Press, 2014
6. David Sutton, Cyber Security: A Practitioner's Guide, BCS Learning & Development Limited, 2017.
7. Martti Lehto, Pekka Neittaanmäki, Cyber Security: Analytics, Technology and Automation edited, Springer International Publishing Switzerland 2015

L: 45; TOTAL: 45 PERIODS

Course Code	CYBER SECURITY LABORATORY	L	T	P	E	C
23CT22E		0	0	2	2	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Practical Component

CO1: implement the secure networks, firewalls, and assess vulnerabilities
CO2: demonstrate competence in network security for traffic interception
CO3: manage the network devices to defend against threats.

LIST OF EXPERIMENTS

CO1: implement secure networks with Infrastructure and firewalls, and assess vulnerabilities **P:10; E:10**

1. Configure a small network with routers, switches, and firewalls for Setting Up a Secure Network
2. Utilize port scanning tools (e.g., Nmap) to identify open ports and services running on a target system and analyze the implications of open ports and services for network security.
3. Conduct vulnerability scans on a network using tools like OpenVAS or Nessus and perform penetration testing to exploit vulnerabilities and assess the network's security posture.
4. Set up a firewall using software like iptables on Linux or Windows Firewall on Windows. Create and configure rules to control incoming and outgoing traffic and test the firewall's effectiveness using penetration testing tools like Nmap or Metasploit.

CO2: demonstrate competence in network security used to intercept traffic **P:10; E:10**

1. Practice intercepting wireless traffic and cracking Wi-Fi passwords in a controlled environment.
2. Create a web application and implement secure coding practices to prevent common web vulnerabilities like SQL injection and Cross-Site Scripting (XSS).

Use packet capture tools like Wireshark to analyze network traffic and identify suspicious or malicious activities within captured packets

CO3: manage the network devices, detecting, mitigating and defending against threats. **P:10; E:10**

1. Configure NAT and port forwarding on a firewall to allow internal network devices to access services on the internet.
2. Simulate a rootkit infection and practice detecting and removing rootkits using security tools and procedures.
3. Send the phishing email to the victim VM, simulating the delivery of the malicious email to a potential target

Software Requirements: Kali Linux Distros

- Cisco Packet Tracer / GNS3
- Nmap (for port scanning and service discovery and for firewall testing) / iptables (for Linux firewall configuration)
- Wireshark (for capturing and analyzing network traffic)
- OpenVAS or Nessus (for vulnerability scanning)/ Metasploit (for penetration testing and exploiting vulnerabilities)

- Visual Studio Code

P: 30; E: 30; TOTAL: 60 PERIODS

Course Code	DEEP LEARNING	L	T	P	E	C
23CT23E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: relate neural network architectures and its model parameters.
CO2: design and evaluate CNN and RNN models for various applications.
CO3: implement methods of optimization & regularization for Deep Forward Neural Networks.
CO4: demonstrate the understanding of auto-encoders, GAN and GCN models.
CO5: construct deep model capabilities to solve real-world problems

CO1: relate neural network architectures and its model parameters. **L:9**

Introduction to Machine Learning – Machine Learning models : Regression (Linear & Logistic) – Classification – Clustering – Learning algorithms – capacity, Underfitting and Overfitting – Hyper parameters and validation sets – Estimators, Bias and variance – Maximum Likelihood Estimation - Optimization – Evaluating the models - Introduction to Neural Networks – Perceptron – Multilayer Feed forward networks – Back propagation – Activation functions – Loss Function – Regularization: Data Augmentation - Noise Robustness – Early Stopping – Bagging – Dropout – batch normalization

CO2: design and evaluate CNN and RNN models for various applications. **L:9**

Convolutional Neural Networks – Convolution Operation – Architecture Overview – Input layers – Convolutional layers – pooling layers – fully connected layers
Recurrent Neural networks – LSTM – Bidirectional RNNs – RNN Language model – Word Level RNN - Deep Recurrent Networks – Recursive Neural Networks.

CO3: implement methods of optimization & regularization for Deep Forward Neural Networks. **L:9**

Optimization in deep learning– Non-convex optimization for deep networks- Stochastic Optimization- Generalization in neural networks- Spatial Transformer Networks
Tuning Deep Networks – Basic Concepts – Matching input data and network architecture – relating model goal and output layers – Working layer count, parameter count and Memory – weight initialization strategies – using activation functions – applying loss function – Dealing with overfitting.

CO4: demonstrate the understanding of auto-encoders, GAN and GCN models **L:9**

Encoder Decoder Models - Attention Mechanism - Attention over images – Hierarchical Attention – Variational auto encoders – Autoregressive models – NADE – MADE - PixelRNN – Generative Adversarial Networks (GANs) – Graph Convolution Network – Deep Belief Network.

CO5:construct deep model capabilities to solve real-world problems **L:9**

Object Detection: RCNN, Faster RCNN, and Yolo – MobileNet – DarkNet – Object Tracking - Audio WaveNet Natural Language Processing Word2Vec Joint Detection -

Face Recognition - Scene captioning Language Transformer Models.

REFERENCE BOOKS

1. Josh Patterson, Adam Gibson," Deep Learning: A Practitioner's Approach", 1st Edition, O'Reilly Media, Inc, 2017.
2. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning." An MIT Press book in preparation, 2016.
3. Dr.Adrian Rosebrock, Deep Learning for Computer Vision with Python: Starter Bundle‖, PyImage Search, 1st Edition, 2017.
4. Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
5. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

ONLINE COURSES

1. CS7015: Deep Learning (iitm.ac.in)
2. Deep Learning - Course (nptel.ac.in)
3. Deep Learning Part 1 (IITM) - Course (nptel.ac.in)
4. Deep Learning - IIT Ropar - Course (nptel.ac.in)

L: 45; TOTAL: 45 PERIODS

Course Code	DEEP LEARNING LABORATORY	L	T	P	E	C
23CT24E		0	0	2	2	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Practical Component

CO1: implement CNN and RNN models for image and text classification.

CO2: develop encoder and transformer models to solve real world problems.

CO1: implement CNN and RNN models for image and text classification. **P: 15; E: 15**

1. Implementation of Linear and Logistic regression models.
2. Create a simple classifier using Feed forward network.
3. Implement CNN for image classification.
4. Implement a language model using RNN.
5. Mini Project

a. Facemask Detection using CNN
b. Text Generation using RNN
c. Text to Speech using LSTM

CO2: develop encoder and transformer models to solve real world problems. **P: 15; E: 15**

1. Implement optimization techniques for CNN and RNN models.
2. Implementation of Encoder Decoder model.
3. Implementation of Graph Convolution network.
4. Implement Faster RCNN.
5. Implementation of object tracking.
6. Mini Project
    a. Object detection using Yolo algorithms.
    b. Diseases prediction using GCN models
    c. Sentiment analysis using BERT models.

SOFTWARE REQUIREMENTS

- Python 3.x
- Anaconda Navigator / Google Colab

P: 30; E: 30; TOTAL: 60 PERIODS

Course Code		L	T	P	E	C
23CT25E	**OPTIMIZATION TECHNIQUES**	3	0	0	0	3

COURSE OUTCOMES

Upon the completion of this course, the student will be able to,

CO1: apply the basic mathematical concepts to solve linear and dynamic programming problems(CDL 1)

CO2: apply various optimization techniques to solve complex engineering problems.(CDL 1)

CO3: analyze different classical optimization techniques to solve single and multivariate problems(CDL 2)

CO4: analyze optimization problems and apply the concept of optimality criteria for various types of optimization problems. (CDL 2)

CO5:derive the computational complexity of search heuristics using biologically inspired computing.(CDL 2)

CO1: apply the basic mathematical concepts to solve linear and dynamic programming problems. **L:8**

Liner Programming (LP): revised simplex method, duel simplex method, sensitivity analysis dynamic programming (DP): multistage decision processes. Concepts of sub optimization, recursive relation-calculus method, tabular method, LP as a case of DP.

CO2: apply various optimization techniques to solve complex engineering problems. **L:10**

Introduction, Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Optimization Techniques, Engineering Optimization Literature

CO3: analyze different classical optimization techniques to solve single and multivariate problems. **L:10**

Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints, Multivariable Optimization with Inequality Constraints, Convex Programming Problem

CO4: analyze optimization problems and apply the concept of optimality criteria for various types of optimization problems. **L:10**

Swarm Intelligence – PSO Algorithm – Accelerated PSO – Convergence Analysis: Dynamic System – Markov Chain Approach – Binary PSO

CO5: derive the computational complexity of search heuristics using biologically inspired computing **L:7**

Introduction to Intelligent Optimization, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO), Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

References

1. Mykel J.Kochenderfer, Tim A.Wheeler, “Algorithms for Optimization”, MIT Press, 2019.
2. Mongi A. Abidi, Andrei V. Gribok, Joonki Paik, “Optimization Techniques in Computer Vision: Ill-Posed Problems and Regularization (Advances in Computer Vision and Pattern Recognition)”, 1st Edition, 2016.
3. Xin – She Yang, “Nature Inspired Optimization Algorithms”, 1st Edition, Elsevier Insights, 2014.
4. S.S.Rao, “Engineering Optimisation: Theory and Practice”, Wiley, 2013.
5. Kalyanmoy Deb, “Optimization for Engineering Design: Algorithms and Examples”, PHI Learning Private Limited, 2nd edition, 2012.
6. Enrique Alba, Christian Blum,et.al., “Optimization Techniques for Solving Complex
7. Problems”, Wiley, 2009.
8. S.Rajasekaran and G.A.Vijaylakshmi Pai., “Neural Networks Fuzzy Logic, and Genetic Algorithms”, Prentice Hall of India, 2006
9. Arora J. “Introduction to Optimization Design”, Elsevier Academic Press, New Delhi, 2004.
10. Fredrick S.Hillier and G.J.Liberman, “Introduction to Operations Research”, McGraw Hill Inc. 1995.
11. D. E.Goldberg, Genetic algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Longman Publishing, 1989.

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23CT26E/ 23IC32E	**DYNAMIC WEB PROGRAMMING**	2	0	2	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: implement dynamic front-end web applications using React. (CDL1)
CO2: design interactive application with server-side frameworks integration. (CDL1)
CO3: develop a deployable web application with database connectivity. (CDL2)
CO4: design secure web applications addressing vulnerabilities. (CDL1)

Practical Component

CO5: develop multi-versatile web applications using React and Flask. (PDL2)
CO6: construct a real time secured web application.(PDL2)
CO7: design and deploy a real time dynamic web application.(PDL2)
CO8: develop web applications that defend security attacks.(PDL2)

CO1: Implement dynamic front-end web applications using React. (CDL1) L: 8; P:8

Component based Architecture – Built-in DOM components – Life of Component – Custom Function and Class Components – State Management. Table Component – Function Component – JSX and Forms. App development – Routing.

CO5: Build dynamic single page applications using React.(PDL2)

Design a single page application with components, states, event handling and routing.

CO2: Design interactive application with server-side frameworks integration. (CDL1) L:8;
P:8

Basic Application Structure – Templates - Web Forms - Handling – Security mechanism – Session handling – Message Flashing. Server side - Image manipulation - Symmetric and Asymmetric Key Encryption - Object detection using Machine Learning Techniques.

CO6: Develop multi-versatile web applications using React and Flask. (PDL2)

Design web application with Image Conversion and Filtering - Encryption techniques - Integrating Machine Learning models.

CO3: Develop a deployable web application with database connectivity. (CDL2) L: 8;
P: 8

SQL Databases - NoSQL- Python Database Frameworks - Database Operations - Integration.

Database roles assignment - verification. Deployment - Hosting.

CO7: Design and deploy a real time dynamic web application. (PDL2)

Design end-to-end real time web applications. (Email application - Blogging Application)

CO4: Design secure web applications addressing vulnerabilities. (CDL1) L: 6;
P: 6

Common web vulnerabilities - Cross-site Scripting - Cross site request Forgery - SQL Injection - Denial of Service. Securing Web applications - Architecture - Authentication and Authorization - Future trends - Progressive Web Applications - Serverless Architecture.

CO8: Develop web applications that defend security attacks. (PDL2)

Analyse web applications for XSS, CSRF, DOS and Injection attacks and implement security measures.

REFERENCES:

1. Stoyan Stefanov, “React: Up & Running - Building Web Applications”, O’Reilly, 2nd Edition, 2022.
2. Miguel Grinberg, “Flask Web Development - Developing Web Applications with Python”, O’Reilly, 2nd Edition, 2018.
3. Andrew Hoffman, “Web Application Security - Exploitation and Countermeasures for Modern Web Applications”, O’Reilly, 2020.

L: 30; P: 30; TOTAL: 60 PERIODS

Course Code	ENERGY AUDIT	L	T	P	E	C
23GD01E		3	0	0	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Components

CO1: comprehend the need for Energy Management
CO2: evaluate the Energy cost and Load management methods
CO3: perform building load estimates and design the energy efficient landscape system
CO4: gain knowledge to utilize an appliance/device sustainably
CO5: compare the status and current technological advancement in energy storage field

CO1: comprehend the need for Energy Management. **L:9**

Need for energy management – energy basics – designing and starting an energy management program – energy accounting – energy monitoring, targeting and reporting-energy audit process-Primary energy resources - Sectorial energy consumption-Energy pricing-Energy conservation and its importance-Energy Conservation Act-2001 and its features – Energy star rating

CO2: evaluate the Energy cost and Load management methods **L:9**

Important concepts in an economic analysis – economic models – time value of money – utility rate structures – cost of electricity – loss evaluation. Load management: demand control techniques – utility monitoring and control system-HVAC and energy management – economic justification.

CO3: perform building load estimates and design the energy efficient landscape system. **L:9**

Systems and equipment – electric motors – transformers and reactors – capacitors and synchronous machines-Systems and equipment – electric motors – transformers and reactors – capacitors and synchronous machines.

CO4: gain knowledge to utilize an appliance/device sustainably. **L:9**

Conventional versus Energy efficient buildings – Landscape design – Envelope heat loss and heat gain – Passive cooling and heating – Renewable sources integration-Relationships between parameters – Units of measure – typical cost factors – utility meters – timing of meter disc for kilowatt measurement-metering techniques and practical examples

CO5: compare the status and current technological advancement in energy storage field **L:9**

Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

REFERENCE BOOKS

1. ASHRAE Handbook 2020 – HVAC Systems & Equipment
2. Yogi Goswami, Frank Kreith, Energy Efficiency and Renewable energy Handbook, CRC Press, 2016
3. Handbook on Energy Audit and Environment Management , Y P Abbi and Shashank Jain, TERI, 2006
4. Handbook on Energy Audit and Environment Management by Y.P. Abbi and Shashank Jain (2009)

5. Handbook of Energy Audits, Ninth Edition By Albert Thumann, Terry Niehus, William J. Younger 2012

L: 45; TOTAL: 45 PERIODS

Course Code	**INDUSTRIAL SAFETY**	**L**	**T**	**P**	**E**	**C**
23GD02E		**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Components:

CO 1: list out important legislations related to health, Safety and Environment.

CO 2: list out requirements mentioned in factories act for the prevention of accidents.

CO 3: understand the health and welfare provisions given in factories act.

CO 4: understand the statutory requirements for an Industry on registration, license and its renewal.

CO 5: prepare onsite and offsite emergency plan.

CO1: list out important legislations related to health, Safety and Environment. **L:9**

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

CO2: list out requirements mentioned in factories act for the prevention of accidents. **L:9**

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – lay out of stand pipes – fire station- fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills– notice-first aid for burns. Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO2 system, foam system, dry chemical powder(DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers –flammable liquids – tank farms – indices of inflammability-fire fighting systems.

CO3: understand the health and welfare provisions given in factories act **L:9**

Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries.

CO4: understand the statutory requirements for an Industry on registration, license and its renewal. **L:9**

Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling

Methods of Control Engineering Control, Design maintenance considerations, design specifications General Control Methods training and education

CO5: prepare onsite and offsite emergency plan **L:9**

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes,welfare, working hours, employment of young persons – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948, Occupational Safety and Health act of USA (The Williames Steiger Act of 1970) –Health and safety work act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000 – American National Standards Institute (ANSI).

REFERENCE BOOKS

1. Practical Industrial Safety, Risk Assessment and Shutdown Systems, 1st Edition, Dave Macdonald, Elsevier publications, 2003
2. Occupational Ergonomics: Practical Approach, Theresa Stack, LeeT.Ostrom, Chery A. Wilhelmsen, Wiley Publications, 2016
3. The Handbook of Safety Engineering: Principles and Applications, Frank R. Spellman and Nancy E. Whiting, Government Institutes, 2009
4. Benjamin O.Alli, Fundamental Principles of Occupational Health and Safety, ILO Geneva, 2nd edition, 2008.
5. Danuta Koradecka, Handbook of Occupational Health and Safety, CRC, 2010.
6. National seminar on hazardous waste management organized by National Safety council, Ministry of environment and forests, Government of India, United States – Asia environmental partnership, Tamilnadu pollution control board and Indian chemical manufacturers association, April 2001.

L: 45; TOTAL: 45 PERIODS

Course Code	**OPERATIONS RESEARCH**	**L**	**T**	**P**	**E**	**C**
23GD03E		**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Components:

CO1: apply the dynamic programming to solve problems of discrete and continuous variables (CDL 2)
CO2: apply the concept of non-linear programming (CDL 2)
CO3: carry out sensitivity analysis(CDL 1)
CO4: model the real world problem and simulate it.(CDL 1)

CO1: apply the dynamic programming to solve problems of discrete and continuous variables. **L:9**

Optimization Techniques- Model Formulation- models, General L.R Formulation- Simplex Technique-Sensitivity Analysis

CO2: apply the concept of non-linear programming. **L:12**

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

CO3: carry out sensitivity analysis **L:9**

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

CO4: model the real-world problem and simulate it. **L:15**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models Geometric Programming. Finite Queuing Models: Introduction, Finite Queuing Models, infinite Queuing Models: Introduction, Queuing Theory, Operating Characteristics of a Queuing System, Constituents of a Queuing System, Service Facility, Queue Discipline

REFERENCE BOOKS

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

L: 45; TOTAL: 45 PERIODS

Course Code	**COST MANAGEMENT OF ENGINEERING PROJECTS**	**L**	**T**	**P**	**E**	**C**
23GD04E		**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Components:

CO1:apply the dynamic programming to solve problems of discreet and continuous variables (CDL 1)

CO2: apply the concept of non-linear programming Students to carry out sensitivity analysis (CDL 1)

CO3:model and simulate the real-world problem (CDL 2)

CO1:apply the dynamic programming to solve problems of discreet and continuous variables **L:15**

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. Project: meaning, Different types, why to manage, cost overruns centers, various stages of project, Execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities.

CO2:apply the concept of non-linear programming Students should able to carry out sensitivity analysis **L:15**

Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis.

CO3:model and simulate the real-world problem **L:15**

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

REFERENCE BOOKS

1. Charles T. Horngren, Srikant M. Datar, Cost Accounting A Managerial Emphasis, Prentice Hall of India, 14th Edition, New Delhi. 2011
2. Charles T. Horngren and George Foster, Advanced Management Accounting. Pearson Education India; 16th Edition, 2013.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, A.H.Wheeler publisher, Delhi
4. N.D. Vohra, Quantitative Techniques in Management Tata McGraw Hill Book Co. Ltd.

L: 45; TOTAL: 45 PERIODS

Course Code	WASTE TO ENERGY	L	T	P	E	C
23GD05E		3	0	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Components:

CO1: analyze the various aspects of Waste to Energy Management Systems(CDL 1)
CO2: comprehend the biochemical conversion of biomass for energy application, bioenergy systems and process integration.(CDL 1)
CO3: comprehend the management of e-waste (CDL 1)

CO1: analyze the various aspects of Waste to Energy Management Systems **L:15**

Solid waste sources solid waste sources, types, composition, properties, global warming; Municipal solid waste: Physical, chemical and biological properties, waste collection and, transfer stations, waste minimization and recycling of municipal waste, segregation of waste, size reduction, managing waste, status of technologies for generation of energy from waste treatment and disposal aerobic composting, incineration, furnace type and design, medical waste / pharmaceutical waste treatment technologies, incineration, environmental impacts, measures to mitigate environmental effects due to incineration

CO2: understand biochemical conversion of biomass for energy application, bioenergy systems and process integration. **L:15**

Land fill method of solid waste disposal land fill classification, types, methods and sitting consideration, Layout and preliminary design of landfills: Composition, characteristics, generation, movement and control of landfill leach ate and gases, environmental monitoring system for land fill gases. Energy generation from waste bio-chemical conversion: Sources of energy generation, anaerobic digestion of sewage and municipal waste, direct combustion of MSW-refuse derived solid fuel. Industrial waste, agro residues and anaerobic digestion.

CO3: understand the management of e-waste **L:15**

Biogas production, land fill gas generation and utilization, thermo-chemical conversion: Sources of energy generation, gasification of waste using gasifies briquetting, utilization and advantages of briquetting, environmental benefits of bio-chemical and thermo-chemical conversion. E-waste: E-waste in the global context: Growth of electrical and electronics industry in India, environmental concerns and health hazards; Recycling e-waste: A thriving economy of the unorganized sector, global trade in hazardous waste, impact of hazardous e-waste in India; Management of e-waste: E-waste legislation, government regulations on e-waste management, international experience, need for stringent health safeguards and environmental protection laws of India.

REFERENCE BOOKS

1. Nicholas P Cheremisin off, Handbook of Solid Waste Management and Waste Minimization Technologies, An Imprint of Elsevier, New Delhi, 2003.
2. Paul Breeze, Energy from Waste‖, An Imprint of Elsevier, New Delhi, 2018.
3. P Aarne Vesilind, William A Worrell and Debra R Reinhart, Solid Waste Engineering, 2nd Edition 2002.
4. C Parker and T Roberts (Ed), Energy from Waste, An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
5. KL Shah, Basics of Solid and Hazardous Waste Management Technology, Prentice Hall, Reprint Edition, 2000.
6. M Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.

L: 45; TOTAL: 45 PERIODS

23AC01E **TECHNICAL REPORT WRITING**

L	T	P	C
2	0	0	0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Enhance the knowledge of the research objectives and research process
CO2: Develop the level of readability for formulating rationale and improve writing skills
CO3: Formulate suitable sentences and key words for the research paper
CO4: Develop the skill of chapterisation and research writing
CO5: Interpretation of data through various strategies
CO 6: Implementation of basic rules and methods of citation

INTRODUCTION TO RESEARCH **5**

Research – Writing Definitions – Framing Objectives – Research process - Formulating Research problem – Technical terms and extended definition - Breaking up long sentences--structuring paragraphs and sentences - being concise and removing redundancy avoiding ambiguity and vagueness.

IDENTIFICATION & COLLECTION OF SOURCES **5**

Preparing manuscript – Skimming and Scanning – Review of literature- Identifying the problem - writing problem statements – writing hypothesis- Formulating Rationale – Research Design - linking phrases – Observation and Interview method – Framing Questionnaire – Case study

WRITING AND DRAFTING ABSTRACT **5**

Processing and data analysis – Identifying threats and challenges to Good Research - key skills needed to write a title - writing abstracts writing key words and introduction- Introductory phrases - Clarity in imperative sentences instruction writing – useful phrases to draft a perfect paper

CHAPTERISATION **5**

Main divisions and Subdivisions – Paragraph writing - coherence - Highlighting the findings - Analyzing Data collection - hedging and criticizing sections - Topic sentence --Paraphrasing and framing key points – Suitable section wise headings

INTERPRETATION OF DATA **5**

Non-verbal interpretation – Interpretation of Data - Abbreviations – Symbols Tables – graphs – charts - deriving result – Phrases used to Compare and Contrast -result and discussion-- skills needed to write the conclusions – avoiding common mistakes.

BIBLIOGRAPHY **5**

Citation methods – Writing Foot note – End note - bibliography – citation rules Basic reference format - plagiarism – acknowledgement – IEEE Research format – Research review Research paper Publication

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Brent, Doug. Reading as Rhetorical Invention: Knowledge, Persuasion, and the Teaching of Research-based Writing. Urbana, National Council of Teachers of English, 1992.
2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht, 2016
3. Robert A. Day and Barbara Gastel, How to Write and Publish a Scientific Paper‖, Cambridge University Press, 7th Edition, 2012
4. Thiel, David V. Research Methods for Engineers. United Kingdom, Cambridge University Press, 2014.

23AC02E **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and manitarian response.

CO2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

INTRODUCTION 4

Disaster: Definition- Factors and Significance- Difference Between Hazard and Disaster- Natural and Manmade Disasters: Difference-Nature- Types And Magnitude.

REPERCUSSIONS OF DISASTERS AND HAZARDS 6

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

DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones: Areas Prone To Floods And Droughts-Landslides and Avalanches Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami- Post Disaster Diseases and Epidemics.

DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard-Evaluation Of Risk Application Of Remote Sensing- Data from Meteorological and other Agencies'-Media Reports Governmental and Community Preparedness.

RISK ASSESSMENT AND DISASTER MITIGATION 8

Disaster Risk: Concept and Elements- Disaster Risk Reduction- Global and National Disaster Risk Situation-Techniques of Risk Assessment-Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment- Strategies for Survival. Meaning: Concept and Strategies Of Disaster Mitigation-Emerging Trends In Mitigation-Structural Mitigation and Non-Structural Mitigation-Programs of Disaster Mitigation In India.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Singhal J.P. —Disaster Managementǁ, Laxmi Publications, ISBN-10: 9380386427 ISBN-13: 978-9380386423, 2010
2. Tushar Bhattacharya, —Disaster Science and Managementǁ, McGraw Hill India Education Pvt. Ltd., ISBN-10: 1259007367, ISBN-13: 978-125900736, 2012.
3. Gupta Anil K, Sreeja S. Nair, "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011.
4. Kapur Anu, "Vulnerable India: A Geographical Study of Disasters", IIAS and Sage Publishers, New Delhi, 2010.

5. National Disaster Management Plan, 2018, https://ndma.gov.in/images/pdf/NDMP-2018-Revised-Draft-1-2018OCT16-A.pdf
6. National Disaster Management Authority, Government of India, 2018, https://ndma.gov.in/images/pdf/Draft-Guidelines-thunderstorm-final.pdf

23AC03E SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Learn the Sanskrit sources of technical knowledge
CO2: Drawing their attention to a different dimension of Sanskrit literary tradition
CO3: Create awareness of the contemporary relevance of the Sanskrit sources of traditional wisdom

INTRODUCTION 7

Scope and meaning of study of technical literature in Sanskrit. Different disciplines-interdisciplinary approach-dimensions-contemporary relevance- important works in this direction-scientific methodology in ancient India.

AYURVEDA 7

Beginnings of Ayurveda in Atharvaveda-Ayurvedic literature-basic principles of Ayurveda-Pancabhutasiddhanta-Tridosasiddhanta-eight anga-s of Ayurveda- Rasacikitsa-contribution of Kerala to Ayurveda

ASTRONOMY AND MATHEMATICS 8

Major texts in Vedic and classical period-Vedangajyotisa-Sulbasutra-s-Aryabhatiya- Aryabhata's contribution-Varahamihira-Brahmagupta-Lalla-etc. Suryasiddhanta- Kerala school Parahita and drk systems-Later astronomical works commentaries.

VASTUSASTRA AND ARTHASASTRA 8

Principles of Vastusastra-Basic texts-Vastuvidya and Ecology-Iconography and sculpture-Kerala tradition of Vastusastra. Arthasastra, a historical and sociaological perspective-structure and contents of the text-emphasis to aspects of agriculture and architecture.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Ramakrishna Mission Institute ,"Cultural Heritage of India", (Vol. i and iii), Calcutta, 2010
2. Dr.P.C. Muraleemadhavan and Dr.N.K.Sundareswaran," Sanskrit in Technological Age,(Ed.)", New Bharatiya Book Corporation, Delhi, 2006
3. https://sanskritdocuments.org/articles/ScienceTechSanskritAncientIndiaMGPrasad.pdf
4. http://www.vedanta.gr/wp-content/uploads/2012/03/3_GlossaryOfCommonSanskrit Terms.pdf

23AC04E VALUE EDUCATION L T P C
2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand the need of values and its classification in contemporary society
CO2: Become aware of role of education in building value as dynamic social reality.

CO3: Know the importance of value education towards personal, national and global development.

10

Values and self-development –Social values and individual attitudes- Work ethics- Indian vision of humanism-Moral and non- moral valuation- Standards and principles-Value judgements.
Importance of cultivation of values-Sense of duty- Devotion- Self-reliance- Confidence-Concentration -Truthfulness-Cleanliness- Honesty- Humanity- Power of faith- National Unity-Patriotism-Love for nature- Discipline.

10

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

10

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

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Sharma, S.P., "Moral and Value Education: Principles and Practices", Kanishka publishers, 2013.
2. Kiruba Charles & V.Arul Selvi.," Value Education", Neelkamal Publications, New Delhi, 2012.
3. Passi, B.K. and Singh, P.,"Value Education", National Psychological Corporation, Agra. 2004.
4. http://cbseportal.com/exam/e-books/download-free-ncert-e-book-education-for-values-in-school-a-framework/
5. http://cbseacademic.in/web_material/ValueEdu/Value%20Education%20Kits.pdf

23AC05E CONSTITUTION OF INDIA L T P C
2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.

CO2: 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.

CO3: address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

HISTORY AND PHILOSOPHY OF INDIAN CONSTITUTION 6

History-Drafting Committee, (Composition & Working). - Preamble- Salient Features.

CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 6

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.

ORGANS OF GOVERNANCE **6**

Parliament- Composition-Qualifications and Disqualifications- Powers and Functions- Executive-President-Governor-Council of Ministers- Judiciary- Appointment and Transfer of Judges-Qualifications-Powers and Functions**.**

LOCAL ADMINISTRATION **6**

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

ELECTION COMMISSION **6**

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.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Subhash .C, kashyap "Our Constitution", 5th Edition, 2017
2. www.ieagreements.org/IEA-Grad-Attr-Prof-Competencies.pdf
3. The Constitution of India, 1950 (Bare Act), Government Publication.
4. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
5. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
6. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

23AC06E **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the pedagogical practices used by teachers in formal and informal classrooms

CO2: Understand the effectiveness of these pedagogical practices, in what conditions, and with what population of learners

CO3: Analyze how teacher education (curriculum and practicum) and the school curriculum with guidance materials support effective pedagogy

INTRODUCTION AND METHODOLOGY **8**

Aims and rationale, Policy background, Conceptual framework and terminology-Theories of learning, Curriculum, Teacher education.Conceptual framework, Research questions**.** Overview of methodology and Searching. Thematic overview- Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries- Curriculum- Teacher education.

EFFECTIVENESS OF PEDAGOGICAL PRACTICES **8**

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

PROFESSIONAL DEVELOPMENT **7**

Alignment with classroom practices and follow-up support- Peer support-Support from the head teacher and the community-Curriculum and assessment-Barriers to learning: limited resources and large class sizes.

RESEARCH GAPS AND FUTURE DIRECTIONS **7**

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

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Dr.S.K.Bhatia and Dr.Sonia Jindal, “A Text Book of Curriculum, Pedagogy and Evaluation”, Paragon International Publications, 2016.
2. Ackers J, Hardman F Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261, 2001.
3. Agrawal M, "Curricular reform in schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361-379, 2004.
4. Akyeampong K, "Teacher training in Ghana - does it count?", Multi-site teacher education research project (MUSTER) country report 1. London: DFID, 2003.
5. 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.
6. Alexander RJ,"Culture and pedagogy: International comparisons in primary education", Oxford and Boston: Blackwell, 2001.
7. Chavan M, "Read India: A mass scale, rapid, ‘learning to read’", campaign, 2003.
8. www.pratham.org/images/resource%20working%20paper%202.pdf.

23AC07E **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: achieve overall health of body and mind

CO2: overcome stress

INTRODUCTION **10**

Introduction to Stress-Concept of Stress-Solutions through Mandukya karika - Relaxation and stimulation combined as the core for stress management-Practice of Stimulation and relaxation.

ASAN AND PRANAYAM **10**

Definitions of Eight parts of yoga. (Ashtanga)-Various yoga poses and their benefits for mind & body-Regularization of breathing techniques and its effects-Types of pranayam.

YOGA AND STRESS MANAGEMENT **10**

Concepts and Techniques of Stress Management in Ashtanga Yoga of Patanjali - specific practices for stress management-breathe awareness.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Swami Vivekananda, Advaita Ashrama ,“Rajayoga or conquering the Internal Nature”, 2016.
2. K.N.Udupa**, “**Stress and Its Management by Yoga”, Edited by R.C.Prasad, Motilal Banarashidass Publishers, Delhi, 2010.
3. Lisa Shea,”Yoga for Stress Relief and Forgiveness”, Kindle Edition, 2015.
4. BKS Iyengar, “Yoga: The path to Holstic Health”, DK Publication, 2019
5. https://www.longdom.org/open-access/stress-and-yoga-2157-7595.1000109.pdf

23AC08E	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: learn to achieve the highest goal happily

CO2: become a person with stable mind, pleasing personality and determination (K1)

CO3: awaken wisdom in students

INTRODUCTION TO PERSONALITY DEVELOPMENT **10**

The concept of personality - Dimensions of personality – Theories of Freud & Erickson- Significance of personality development. The concept of success and failure: What is success? - Hurdles in achieving success - Overcoming hurdles - Factors responsible for success – What is failure - Causes of failure-SWOT analysis.

LIFE ENLIGHTENMENT SKILLS **10**

Neetisatakam-Holistic development of personality, Verses 19,20,21,22 (wisdom), Verses 29,31,32 (pride & heroism), Verses 26,28,63,65 (virtue), Verses 52,53,59 (dont’s), Verses 71,73,75,78 (do’s).Approach to day to day work and duties, Shrimad Bhagwad Geeta, Chapter 2-Verses 41, 47,48, Chapter 3 Verses 13, 21, 27, 35, Chapter 6 Verses 5,13,17, 23, 35, Chapter 18 Verses 45, 46, 48.

SHRIMAD BHAGWAD GEETA STATEMENTS **10**

Statements of basic knowledge, Shrimad Bhagwad Geeta: Chapter2 Verses 56, 62, 68, Chapter 12 Verses 13, 14, 15, 16,17, 18, Personality of Role model. Shrimad Bhagwad Geeta, Chapter2 Verses 17, Chapter3 Verses 36, 37, 42, Chapter4 Verses 18, 38,39, Chapter18 Verses 37,38,63

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Swami Swarupananda Advaita Ashram, “Srimad Bhagavad Gita”, Publication Department, Kolkata.
2. P.Gopinath, Rashtriya Sanskrit Sansthanam, "Bhartrihari’s Three Satakam (Niti-sringar-vairagya) ", New Delhi.