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B.TECH – COMPUTER SCIENCE AND ENGINEERING (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING) COURSE STRUCTURE R22

SEMESTER VII

S.No	Course Class.	Course Code	Name of the subject	L	T	P	C	I	E	Total
1	PC	D77PC22	Knowledge Representation and Reasoning	3	0	0	3	40	60	100
2	PC	D77PC23	Big Data Analytics	3	0	0	3	40	60	100
3	PE	D77PE5	**Professional Elective V**	3	0	0	3	40	60	100
			A. Recommender Systems							
			B. Information Security							
			C. Social Network Analysis							
4	OE		Open Elective II	3	0	0	3	40	60	100
5	PC	D77PC24	Big Data Analytics Lab	0	0	2	1	40	60	100
6	PW	D77PW1	Project Work Phase 1	0	0	14	7	100	--	100
TOTAL				**12**	**0**	**16**	**20**	**300**	**300**	**600**

SEMESTER VIII

S.No.	Course Class.	Course Code	Name of the subject	L	T	P	C	I	E	Total
1	PC	D78PC25	Reinforcement Learning	3	0	0	3	40	60	100
2	PE	D78PE6	**Professional Elective VI**	3	0	0	3	40	60	100
			A. Quantum Computing							
			B. Medical Image Processing							
			C. Randomized Algorithms							
3	OE		Open Elective III	3	0	0	3	40	60	100
4	OE		Open Elective IV	3	0	0	3	40	60	100
5	PW	D78PW2	Major Project Phase 2	0	0	16	8	40	60	100
TOTAL				**12**	**0**	**16**	**20**	**200**	**300**	**500**

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VII **L/T/P C**
3/0/0 3

KNOWLEDGE REPRESENTATION AND REASONING (D77PC22)

Course Objective:

Investigating Knowledge Representation techniques and notations, integrating KR as a knowledge engineering approach for organizational knowledge modeling, introducing ontologies as a KR paradigm and their applications, and understanding KR techniques, processes, knowledge acquisition, and ontology sharing.

Course Outcomes:

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

1. Analyse and design knowledge-based systems intended for computer implementation. L3
2. Apply theoretical knowledge about principles for logic-based representation and reasoning. L3
3. Analyse knowledge representations such as knowledge engineering, examining how structures are represented in frames. L4
4. Analyse implement production systems, frames, inheritance systems and approaches to handle uncertain or incomplete knowledge. L4
5. Make use of the Knowledge Soup, Semiotics Knowledge Acquisition and Sharing. L3

UNIT I

The Key Concepts:

Knowledge, Representation, Reasoning, Why knowledge representation and reasoning, Role of logic

Logic:

Historical background, Representing knowledge in logic, Varieties of logic, Name, Type, Measures, Unity Amidst diversity

UNIT II

Ontology:

Ontological categories, Philosophical background, Top-level categories, Describing physical entities, Defining abstractions, Sets, Collections, Types and Categories, Space and Time

UNIT III

Knowledge Representations:

Knowledge Engineering, Representing structure in frames, Rules and data, Object-oriented systems, Natural language Semantics, Levels of representation

UNIT IV
Processes:
Times, Events and Situations, Classification of processes, Procedures, Processes and Histories, Concurrent processes, Computation, Constraint satisfaction, Change Contexts: Syntax of contexts, Semantics of contexts, First-order reasoning in contexts, Modal reasoning in contexts, Encapsulating objects in contexts.

UNIT V
Knowledge Soup:
Vagueness, Uncertainty, Randomness and Ignorance, Limitations of logic, Fuzzy logic, Nonmonotonic Logic, Theories, Models and the world, Semiotics Knowledge Acquisition and Sharing: Sharing Ontologies, Conceptual schema, Accommodating multiple paradigms, Relating different knowledge representations, Language patterns, Tools for knowledge acquisition

Text Books:

1. Knowledge Representation logical, Philosophical, and Computational Foundations by John F. Sowa, Thomson Learning.
2. Knowledge Representation and Reasoning by Ronald J. Brachman, Hector J. Levesque, Elsevier.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VII **L/T/P C**
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BIG DATA ANALYTICS (D77PC23)

Course objective:
To equip students with a comprehensive understanding of the tools, technologies & programming languages which is used in day to day analytics cycle.

Course outcomes:
Upon completion of the course student will be able to:
1. Analyze the characteristics of Big data by making use of data collection, preparation, and visualization. L4
2. Apply Big data patterns in their applications to solve problems encountered in the domain of big data analytics. L3
3. Analyze Data Acquisition and Big Data Storage by exploring HDFS, SCALA and SPARK. L4
4. Apply high level APIs, using resilent distributed data sets and perform batch analysis applications using Apache. L3
5. Make use of Relational and Non-Relational data bases to develop web application models emphasizing on Django Framework. L3

UNIT I
Introduction to Big Data:
What is Analytics, What is Big Data, Characteristics of Big Data, Domain Specific Examples of Big Data, and Analytics flow for Big Data-Data Collection, Data Preparation, Analysis Types, Analysis Modes, Visualizations, Big Data Stack.

UNIT II
Bigdata Patterns:
Analytics architecture components & Design styles-Load Leveling with Queues, Load Balancing with Multiple Consumers, Leader Election, Sharding, CAP, Lambda Architecture, Scheduler Agent Supervisor, Pipes & Filters, MapReduce Patterns.

UNIT III
Big Data Analytics Implementations
Data Acquisition:
Data Acquisition Considerations, Publish -Subscribe Messaging Frameworks, Big Data Collection Systems.

Big Data Storage:
HDFS- Architecture, SCALA and SPARK

UNIT IV
Batch Analysis:
Hadoop and Map Reduce,Hadoop – Map Reduce Examples, Pig, Case Study: Batch Analysis of News Articles, Apache Oozie, and Apache Spark.

UNIT V
Serving Databases and Web frameworks:
Relational (SQL) Databases, Non-Relational (NoSQL) Databases, and Python Web Application Framework– Django.
NoSQL:
Key-Value Databases, Document Databases, Column Family Databases, Graph Databases.

Text Book:

1. Big Data Science and Analytics AHands-on Approach. By Arshdeep Bahga,VijayMadisetti

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VII **L/T/P C**
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RECOMMENDER SYSTEMS (D77PE5A)

Course Objective:
To learn the significance of machine learning and data mining algorithms for Recommender systems

Course Outcomes:
Upon completion of this course the student will be able to:
1. Apply the knowledge of dimensionality reduction techniques and understand how it helps in designing a recommender system. L3
2. Develop content based recommendation system using a given domain knowledge. L3
3. Implement the Collaborative Filtering technique to study the performance evaluation of recommender systems based on various metrics. L3
4. Develop security features for effective use of recommender systems and study the potential impact of attacks on user experience and trust. L3
5. Experiment formally with different paradigms used for evaluating recommender systems. L3

UNIT I
Introduction
Introduction and basic taxonomy of recommender systems - Traditional and non-personalized Recommender Systems - Overview of data mining methods for recommender systems- similarity measures- Dimensionality reduction – Singular Value Decomposition (SVD)

UNIT II
Content-Based Recommendation Systems
High-level architecture of content-based systems - Item profiles, Representing item profiles, Methods for learning user profiles, Similarity-based retrieval, and Classification algorithms

UNIT III
Collaborative Filtering
A systematic approach, Nearest-neighbor collaborative filtering (CF), user-based and item-based CF, components of neighborhood methods (rating normalization, similarity weight computation, and neighborhood selection

UNIT IV

Attack-Resistant Recommender Systems

Introduction – Types of Attacks – Detecting attacks on recommender systems – Individual attack – Group attack – Strategies for robust recommender design - Robust recommendation algorithms.

UNIT V

Evaluating Recommender Systems

Evaluating Paradigms – User Studies – Online and Offline evaluation – Goals of evaluation design – Design Issues – Accuracy metrics – Limitations of Evaluation measures

Text Books:

1. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. Dietmar Jannach , Markus Zanker , Alexander Felfernig and Gerhard Friedrich , Recommender Systems: An Introduction, Cambridge University Press (2011), 1st edition.
3. Francesco Ricci , Lior Rokach , Bracha Shapira , Recommender Sytems Handbook, 1st ed, Springer (2011),
4. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, 3rd edition, Cambridge University Press, 2020.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VII **L/T/P C**
3/0/0 3

INFORMATION SECURITY (D77PE5B)

Course Objective:
To understand and learn the objectives of Network security, Cryptographic algorithms.

Course Outcomes:
Upon completion of this course the student will be able to:
1. Make use of security concepts and classical encryption techniques to establish secured communications. L3
2. Implement symmetric and asymmetric key algorithms for designing the security features for transfer of information from one end to another end. L3
3. Apply the features of authentication for acknowledging the two way communication process using message authentication codes. L3
4. Develop Privacy using SSL and TLS for constructing applications which use web services. L3
5. Develop security Mechanism across system and IP layers of communication. L3

UNIT I
Security Concepts
Introduction, security trends, OSI Architecture, security attacks, security services, security mechanisms, AModel for Network Security.
Cryptography Concepts and Techniques:
Introduction, Plain Text and cipher text, substitution techniques (Caesar cipher, Playfair cipher, Hill cipher), transposition techniques, steganography.

UNIT II
Symmetric Key Ciphers
Block Cipher principles, DES, AES, Block Cipher Modes of Operation, Stream ciphers, RC4.
Asymmetric Key Ciphers:
Principles of public key cryptosystems, RSA algorithm, Difffie-Hellman Key Exchange, Elliptic Curve Cryptography and Arithmetic.

UNIT III
Cryptographic Hash Functions
Authentication requirements and Functions, Message Authentication Code, Secure Hash Algorithm

(SHA-512), Message authentication codes: HMAC, CMAC, Digital signatures, AUTHENTICATION APPLICATIONS: Kerberos, X.509 Authentication Service Public KeyInfrastructure.

UNIT IV

Web Security:

Web security considerations, Secure Socket Layer, and Transport Layer Security, Secure Electronic Transaction.

E-Mail Security:

F-Pretty Good Privacy, S/MIME.

UNIT V

IP Security:

IP Security overview, IP Security architecture, Authentication Header, Encapsulating Security Payload,Combining Security Associations, Key Management.

System Security:

Intruders, Intrusion Detection, Password Management.

Text Books:

1. Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 4th Edition
2. Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition

Reference Books:

1. Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan, Wiley India, 1st Edition.
2. Cryptography and Network Security: Forouzan, Mukhopadhyay, Mc Graw Hill,3rd Edition.
3. Information Security, Principles, and Practice: Mark Stamp, Wiley India.
4. Principles of Computer Security: WM, Arthur Conklin, Greg White, TMH.
5. Introduction to Network Security: Neal Krawetz, CENGAGE Learning.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VII **L/T/P C**
3/0/0 3

SOCIAL NETWORK ANALYSIS (D77PE5C)

Course Objective:

Gain insight into social network analysis mechanisms and explore the analysis of popular services including email, Wikis, Twitter, Flicker, YouTube, and more.

Course Outcomes:

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

1. Analyze the introduction of social media and social networks, examining how these platforms facilitate new forms of collaboration, and the process of social network analysis. L4
2. Apply NodeXL as a tool for social network analysis, critically assessing layout choices, visual design elements, and labeling strategies in enhancing network visualization. L3
3. Analyze as Email, understanding its significance as a cornerstone of modern communication, explore the mapping of message boards and email lists in Thread Networks, and examine Twitter's multifaceted role in facilitating conversation, entertainment, and information dissemination. L4
4. Make use of NodeXL use to perform social network analysis. L3
5. Apply Contrasting Patterns of Content Interaction. L3

UNIT I

Introduction:

Social Media and Social Networks

Social Media:

New Technologies of Collaboration

Social Network Analysis:

Measuring, Mapping, and Modelling collections of Connections

UNIT II

NodeXL, Layout, Visual Design, and Labelling, Calculating and Visualising Network Metrics, Preparing Data and Filtering, Clustering and Grouping.

UNIT III

CASE STUDIES:

Email: The lifeblood of Modern Communication.

Thread Networks: Mapping Message Boards and Email Lists

Twitter: Conversation, Entertainment and Information

UNIT IV
CASE STUDIES:
Visualizing and Interpreting Facebook Networks, WWW Hyperlink Networks

UNIT V
CASE STUDIES:
You Tube:
Contrasting Patterns of Content Interaction, and Prominence.
Wiki Networks:
Connections of Creativity and Collaboration

Text Book:

1. Hansen, Derek, Ben Sheiderman, Marc Smith, Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.

Reference Books:

1. Avinash Kaushik, Web Analytics 2.0: The Art of Online Accountability, Sybex, 2009.
2. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting and Using Metrics, 1st Edition, MGH, 2011.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VII **L/T/P C**
0/0/2 1

BIG DATA ANALYTICS LAB (D77PC24)

Course Objective:

The primary objective of the lab course is to provide students with practical, hands-on experience in using Scala and Apache Spark for data processing, analysis, and machine learning. Students will gain proficiency in both the Scala programming language and the Spark framework, enabling them to apply these skills to real-world data science challenges.

Course Outcomes:

1. Apply Scala & Spark Fundamentals. L3
2. Construct how to do Data Manipulation with Spark Data Frames and Machine Learning Implementation with MLlib. L3
3. Develop Real-time Data Processing with Spark Streaming and Integration with Big Data Ecosystem L3

List of Programs:

1. Introduction to Scala and Spark
   i. Install Scala, Spark, and set up the development environment
   ii. Explore basic Scala syntax, variables, and data types
   iii. Use Spark's interactive shell to execute basic Spark commands in Scala.
2. Scala Functional Programming
   i. Define and use functions in Scala
   ii. Explore higher-order functions and their applications
   iii. Work with immutable collections (List, Set, Map) in Scala
   iv. Perform common operations using Scala's functional programming style
3. Spark RDD Operations
   i. Create RDDs from different data sources
   ii. Perform basic RDD transformations (map, filter, reduce).
   iii. Introduce pair RDDs and perform key-based transformations.
4. Spark Data Frames and SQL
   i. Create and manipulate Spark Data Frames using Scala.
   ii. Perform common Data Frame operations (select, filter, groupBy).
   iii. Write SQL queries with Spark SQL in Scala

   iv. Register and query temporary tables.
5. Machine Learning with MLlib
   i. Implement a linear regression model using MLlib in Scala
   ii. Evaluate the model's performance.
   iii. Build a classification model (e.g., Logistic Regression) using MLlib in Scala
   iv. Evaluate the classification model.
6. Spark Streaming in Scala
   i. Set up a Spark Streaming application using Scala
   ii. Process and analyze real-time streaming data
   iii. Implement windowed operations on streaming data (e.g., windowed counts).
7. Advanced Spark and Scala Applications
   i. Explore the use of broadcast variables and accumulators in Spark.
   ii. Create and analyze a graph using Spark's GraphX library.
8. Capstone Project
   i. Develop a data science project showcasing data processing, analysis, and machine learning using Spark.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VIII **L/T/P C**
3/0/0 3

REINFORCEMENT LEARNING (D78PC25)

Course Objective:

To provide students with a comprehensive understanding of the principles of Reinforcement Learning (RL), policy-based reinforcement learning methods and meta-learning techniques for various applications.

Course Outcomes:

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

1. Make use of the basics of RL. L3
2. Apply RL Framework and Markov Decision Process. L3
3. Analyze the Dynamic Programming and Monte Carlo. L4
4. Make use of TD (0) algorithm, TD (λ) algorithm. L3
5. Apply n-step returns as a method for estimating the value of a state-action pair by considering rewards obtained over N consecutive time steps. L3

UNIT I

Basics of probability and linear algebra, Definition of a stochastic multi-armed bandit, Definition of regret, Achieving sublinear regret, UCB algorithm, KL-UCB, Thompson Sampling.

UNITII

Markov Decision Problem, policy, and value function, Reward models (infinite discounted, total, finite horizon, and average), Episodic & continuing tasks, Bellman's optimality operator, and Value iteration & policy iteration.

UNIT III

The Reinforcement Learning problem, prediction and control problems, Model-based algorithm, Monte Carlo methods for prediction, and Online implementation of Monte Carlo policy evaluation.

UNIT IV

Bootstrapping: TD(0) algorithm; Convergence of Monte Carlo and batch TD(0) algorithms; Model-free control: Q-learning, Sarsa, Expected Sarsa.

UNIT V

n-step returns: TD(λ) algorithm; Need for generalization in practice; Linear function approximation and geometric view; Linear TD(λ). Tile coding; Control with function approximation; Policy search; Policy gradient methods; Experience replay; Fitted Q Iteration; Case studies.

Text Books:

1. “Reinforcement learning: An introduction,” First Edition, Sutton, Richard S., and Andrew G. Barto, MIT press 2020.
2. “Statistical reinforcement learning: modern machine learning approaches,” First Edition, Sugiyama, Masashi. CRC Press 2015.

Reference Books:

1. “Bandit algorithms,” First Edition, Lattimore, T. and C. Szepesvári. Cambridge University Press. 2020.
2. “Reinforcement Learning Algorithms: Analysis and Applications,” Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters First Edition, Springer 2021.
3. Alexander Zai and Brandon Brown “Deep Reinforcement Learning in Action,” First Edition, Manning Publications 2020.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VIII **L/T/P C**
3/0/ 0 3

QUANTUM COMPUTING (D78PE6A)

Course Objective:

To provide students with a comprehensive understanding of quantum computing principles and applications

Course Outcomes:

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

1. Identify the significance of mathematics, physics, and biology in the development of quantum computing and compare Bits and Qubits, Classical Vs Quantum logical operations. L3
2. Apply the basics of linear algebra, quantum mechanics, and the principles of genomics and proteomics to analyze quantum computing concepts. L3
3. Design quantum circuits using Qubits, single and multiple qubit gates and Bell states. L4
4. Compare quantum and classical complexity classes and implement various quantum algorithms L4
5. Utilize quantum cryptography protocols for secure communication and apply quantum error correction techniques to mitigate noise and errors in quantum systems. L3

UNIT I

History of Quantum Computing:

Importance of Mathematics, Physics and Biology. Introduction to Quantum Computing: Bits Vs Qubits, Classical Vs Quantum logical operations

UNIT II

Background Mathematics:

Basics of Linear Algebra, Hilbert space, Probabilities and measurements.

Background Physics:

Paul's exclusion Principle, Superposition, Entanglement and super-symmetry, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis. Background Biology: Basic concepts of Genomics and Proteomics (Central Dogma)

UNIT III
Qubit:
Physical implementations of Qubit. Qubit as a quantum unit of information. The Bloch sphere Quantum Circuits: single qubit gates, multiple qubit gates, designing the quantum circuits. Bell states.

UNIT IV
Quantum Algorithms:
Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor's factorization algorithm, Grover's search algorithm.

UNIT V
Noise and error correction:
Graph states and codes, Quantum error correction, fault-tolerant computation. Quantum Information and Cryptography: Comparison between classical and quantum information theory. Quantum Cryptography, Quantum teleportation

Text Book:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge.

Reference Books:

1. Quantum Computing for Computer Scientists by Noson S. Yanofsky and Mirco A. Mannucci
2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol.I: Basic Concepts, Vol II.
3. Basic Tools and Special Topics, World Scientific. Pittenger A. O., An Introduction to Quantum Computing Algorithms.

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Semester VIII **L/T/P C**
3/0/0 3

MEDICAL IMAGE PROCESSING (D78PE6B)

Course Objective:
The course in Medical Image Processing with the fundamental theories, techniques, and practical skills necessary for processing and analyzing medical images effectively.

Course Outcomes:
Upon completion of this course the student will be able to:

1. Apply Image Processing Techniques and Utilize Dirac distributions, convolution, and Fourier transform techniques to perform image processing tasks, such as filtering and transformation, to enhance and analyze digital images. L3
2. Apply techniques for contrast manipulation, including histogram equalization, to enhance image features and improve visual quality in various types of images. L3
3. Analyze different approaches to optimal thresholding, comparing their performance and suitability for different types of images and segmentation tasks. L4
4. Apply Restoration Techniques in Biomedical Applications: Implement image restoration techniques specifically tailored for biomedical applications, such as improving the quality of medical images for diagnostic purposes. L3
5. Evaluate Image Coding Standards and assess various image coding and compression standards, analyzing their effectiveness in different contexts, including biomedical applications, and their impact on image quality and data management. L4

UNIT I
Digitized Image Functions:
Dirac distributions, convolution, Fourier transform, Images as linear system. Image digitization, sampling, Quantization, color images. Digital image properties, Metric and topological properties, Histogram visual perception, Image quality, Noise. Nature of Biomedical images, Objectives of biomedical image analysis, Difficulties in biomedical image acquisition and analysis.

UNIT II
Image Enhancement:
Contrast manipulation, histogram equalization, Laplacian derivatives, Sobel and Klisch operators, rank operators –textural analysis. Image pre processing – pixel brightness transformations,

Geometric transformations, local pre processing, Image restoration. Imaging filters. Biomedical applications.

UNIT III
Thresholding and Segmentation:
Detection methods, optimal thresholding, multi-spectral thresholding. Edge based segmentation, Region based segmentation, Matching, Advanced optimal border and surface detection approaches.

UNIT IV
Restoration:
Deterministic, geometric linear filtration, inverse filtering, power spectrum equalization, stochastic. Wiener filtering. Registration, anatomy based, object based, scene based. Biomedical applications..

UNIT V
Image Reconstruction:
Image reconstruction from projections, Radon transform, Methods for generating projection data, Transmission tomography, Reflection tomography, Emission tomography, Magnetic resonance imaging, Fourier slice theorem, Back-projection theorem. Image Coding and Compression: Lossy verses lossless compression, Fundamental concepts of coding, Image coding and compression standards, Biomedical applications.

Text Books:
1. John C Russ, “The image processing handbook”, CRC and IEEE press, 1999.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image processing, analysis and machine vision”, 2nd Edition, Brooks Cole publishing Co., 1999.

Reference Books:
1. Jayaram, Kudupa and Gabor,T Herman, “3D imaging in medicine”, 2nd Edition, CRC press, 2000.
2. Craig A.Hindley,” Practical image processing in C”, John Wiley and Sons, 1991.
3. R C Gonzalez, Wintz Paul, “Digital Image Processing”, Addision Wesley, 2nd Edition, 1987.
4. A K Jain, “Fundamental of Digital Image Processing”, Prentice Hall, 2002.
5. Rangaraj M. Rangayyan, “Biomedical Image Analysis”, CRC Press, 2000.
6. Sid-Ahmed Maher A, “Image Processing Theory, Algorithms and Architecture”, McGraw Hill, 1994.

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CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

Semester VIII **L/T/P C**
3/0/0 3

RANDOMIZED ALGORITHMS (D78PE6C)

Course Objective:
Analyze the correctness and performance of randomized algorithms, understand their applications in various domains such as optimization, graph theory, cryptography, and machine learning, and critically evaluate their advantages and limitations compared to deterministic approaches.

Course Outcomes:
Upon completion of this course the student will be able to:

1. Apply the fundamentals of randomized algorithm design. L3
2. Make use of the fundamentals of Markov chains and the Monte Carlo method. L3
3. Apply high probability analysis to selected randomized algorithms. L3
4. Analyze the Fingerprint and Pattern Matching techniques. L4
5. Analyze Geometric Algorithms and Randomized Incremental Construction. L4

UNIT I
Introduction:
A Min-Cut algorithm, Las Vegas and Monte Carlo, Binary Planar Partitions, A Probabilistic Recurrence.
Game-Theoretic Techniques:
Game Tree Evaluation, The Minimax Principle

UNIT II
Moments and Deviations:
Occupancy Problems, The Markov and Chebyshev Inequalities, Randomized Selection, Two Point sampling, The Coupon Collector's problem. Markov Chains and Random Walks: A 2-SAT example, Markov Chains, Random Walks on Graphs, Graph Connectivity

UNIT III
Algebraic Techniques:
Fingerprinting and Freivald's Technique, Verifying Polynomial Identities, Perfect Matching in

Graphs, Verifying Equality of Strings, A Comparison of Fingerprinting Techniques, Pattern Matching

UNIT IV
Data Structures:
The Fundamental of Data-structures, Random Treaps, Skip Lists, Hash Tables Graph Algorithms: All Pairs Shortest Path, The Min- Cut Problem, Minimum Spanning Trees

UNIT V
Geometric Algorithms:
Randomized Incremental Construction, Convex Hulls in the Plane, Duality, Half- Space Intersections, Dalaunay Triangulations, Trapezoidal Decompositions, Parallel and Distributed Algorithms: The PRAM Model, Sorting on a PRAM, Maximal Independent Sets, Perfect Matchings

Text Books:

1. Randomized Algorithms: Rajeev Motwani, Prabhakar Raghavan, Cambridge University Press
2. Probability and Computing: Randomization and Probabilistic Techniques in Algorithms and Data Analysis by Eli Upfal and Michael Mitzenmacher

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