DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ALGORITHM DESIGN TECHNIQUES & ANALYSIS
62241201

COURSE OBJECTIVE:

- ☐ To introduce the topic of algorithms as a precise mathematical concept.
- ☐ To demonstrate the familiarity with major algorithm design paradigms and methods of analysis.
- ☐ To design efficient algorithms for common computer engineering problems.
- ☐ To enhance the skills using well-known algorithms and data structures for solving real-life problems.

UNIT I

Introduction: What is an algorithm, Functions and Relations, Vectors and Matrices, Linear Inequalities and Linear Equations, Asymptotic Notations and Basic Efficiency Classes, Master's Theorem, Mathematical Analysis of Recursive and Non-recursive Algorithms, Empirical Analysis of Algorithms. Brute Force and Exhaustive Search- Sequential Search and Brute-Force, String Matching, Closest-Pair and Convex-Hull Problems.

UNIT II

Decrease-and-Conquer: Topological Sorting, Fake-Coin Problem, Russian Peasant Multiplication, Josephus Problem, Computing a Median and the Selection Problem, Game of Nim. **Transform-and-Conquer:** 2-3 Trees, B-Trees, B+ Trees, **Various Algorithms:** Krushkal & Prim's Algorithm, Huffman Encoding, Job Scheduling Algorithm, Kirchoff's Law, Travelling Salesman Problem

UNIT III

Space and Time Trade-Offs: Sorting by Counting, Input Enhancement in String Matching, Boyer-Moore Algorithm, Open Hashing (Separate Chaining), Closed Hashing (Open Addressing), Problem Solving using Dynamic Programming – Calculating the Binomial Coefficient, Making Change Problem, Assembly Line Scheduling, Knapsack problem, Matrix chain multiplication

UNIT IV

Iterative Improvement: Simplex Method, Maximum-Flow Problem, Maximum Matching in Bipartite Graphs, Stable Marriage Problem. **Limitations of Algorithm Power:** Lower-Bound Arguments, Trivial Lower Bounds, Information-Theoretic Arguments,

Adversary Arguments, Problem Reduction, Decision Trees, Decision Trees for Sorting, Decision Trees for Searching a Sorted Array.

UNIT V

Introduction to P, NP, NP-Hard and NP-Complete, P and NP Problems - Partition problem, Bin-packing problem, NP-Complete Problems, Travelling Salesman problem, Hamiltonian problem, Approximation algorithms.

Recommended Books:

1. Introduction to Design and Analysis of Computer Algorithms, 3rd Edition, Anany Levitin, Pearson Education
2. Fundamentals of Computer Algorithms, Horowitz & Sahani, Universities press.
3. Introduction to Algorithms, Coremen Thomas, Leiserson CE, Rivest RL, PHI.
4. Design & Analysis of Computer Algorithms, Ullmann, Pearson.
5. Algorithm Design, Michael T Goodrich, Robarto Tamassia, Wiley India.

COURSE OUTCOMES

After completion of this course, the students would be able to:
CO1: Recall fundamental algorithm concepts and mathematical foundations.
CO2: Explain algorithm design strategies with examples.
CO3: Apply techniques like dynamic programming to solve problems.
CO4: Analyze complexity and trade-offs of algorithms.
CO5: Evaluate algorithm limitations and classify problems (P, NP, NP-Hard).

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	---	---	---	---	---	---	---	---	---	1	3	2
CO2	2	3	1	---	2	---	---	---	1	1	---	2	3	2
CO3	3	3	3	2	3	---	---	---	1	1	2	2	3	3
CO4	3	3	2	3	3	---	---	---	---	---	1	3	3	2
CO5	2	3	2	3	2	---	---	---	---	---	---	2	3	3

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DIGITAL WATERMARKING & STEGANALYSIS
62241202

COURSE OBJECTIVES

- To provide the importance of digital watermarking and Steganography
- To discuss the properties of watermarking and steganography systems
- To discuss the different models of watermarking and steganography
- To understand the various evaluation metrics
- To examine various applications of watermarking and steganography

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UNIT-I

INTRODUCTION: Information Hiding, Steganography, and Watermarking. History of Watermarking. History of Steganography, Importance of Digital Watermarking. Importance of Steganography, Applications and Properties.

UNIT-II

WATERMARKING: Evaluating watermarking systems. Notation, Communications, Communication-based models, Geometric models, Mapping messages into message vectors, Error correction coding, Detecting multi-symbol watermarks, Attacks.

UNIT-III

MODELS OF WATERMARKING: Notation, Communications, Components of Communications Systems, Classes of Transmission Channels, Secure Transmission, Communication-Based Models of Watermarking, Basic Model, Watermarking as Communications with Side Information at the Transmitter, Watermarking as Multiplexed Communications, Geometric Models of Watermarking, Distributions and Regions in Media Space, Marking Spaces, Modeling Watermark Detection by Correlation, Robust Watermarking Approaches.

UNIT-IV

STEGANOGRAPHY & STEGANALYSIS: Steganographic Communication, The Channel, The Building Blocks, Notation and Terminology, Information – Theoretic Foundations of Steganography, Cachin's Definition of Steganographic Security, Practical Steganographic Methods, Statistics Preserving Steganography, Model-Based Steganography, Steganalysis Scenarios, Detection, Forensic Steganalysis, The Influence of the Cover Work on Steganalysis, Some Significant Steganalysis Algorithms, LSB Embedding, and the Histogram Attack.

UNIT-V

APPLICATIONS: Applications of Watermarking, Broadcast Monitoring, Copyrights, Proof of Ownership, Transaction Tracking, Content Authentication, Copy Control, Device Control, Legacy Enhancement. Applications of Steganography, Steganography for Dissidents, Steganography for Criminals.

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RECOMMENDED BOOKS

- Ingemar J. Cox, Mathew L. Miller, Jefrey A. Bloom, Jesica Fridrich, Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann Publishers, New York, 2008.
- Ingemar J. Cox, Mathew L. Miller, Jefrey A. Bloom, "Digital Watermarking", Morgan Kaufmann Publishers, New York, 2003.
- Ingemar Cox, Mathew Miller, Jefrey Blom, Jesica Fridrich and Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann Publishers, Nov 2007.
- Juergen Seits, "Digital Watermarking for Digital Media", IDEA Group Publisher, New York, 2005.
- Jesica Fridrich, "Steganography in Digital Media: Principles, Algorithms, and Applications", Cambridge University press, 2010.
- Michael Arnold, Martin Schmucker, Stephen D. Wolthusen, "Techniques and Applications of Digital Watermarking and Content Protection", Artech House, London, 2003.
- Peter Wayner, "Disappearing Cryptography – Information Hiding: Steganography & Watermarking", Morgan Kaufmann Publishers, New York, 2002.
- Stefan Katzenbelser and Fabien A. P. Peticolas, "Information hiding techniques for Steganography and Digital Watermarking", ARTECH House Publishers, January 2004.

COURSE OUTCOMES

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

CO1. Describe watermarking and steganography fundamental concepts and principles

CO2. Explain & Detect different watermarking attacks.

CO3. Identify and assess the different models of watermarking.

CO4. Carry out system security for various threat environments using steganography techniques.

CO5. Explain the various applications of watermarking and steganography.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3												
CO2			2				3						1	
CO3					2				2			2	2	
CO4					1								1	
CO5					2							1	3	1

1 - Slightly; 2 - Moderately; 3 – Substantially

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

NATURAL LANGUAGE PROCESSING
62241203

COURSE OBJECTIVES

- Develop a comprehensive understanding of fundamental concepts and techniques in Natural Language Processing.
- Introduce advanced machine learning and deep learning approaches for NLP tasks.
- Prepare students for designing and implementing NLP solutions for real-world applications.

Unit-I

Introduction to Natural Language Processing: Foundations of NLP, levels of linguistic analysis (phonology, morphology, syntax, semantics, pragmatics), challenges in NLP, applications of NLP, brief history and evolution of NLP, ethics in NLP.

Unit-II

Text Processing and Language Modeling: Text preprocessing techniques, tokenization, stemming, lemmatization, part-of-speech tagging, named entity recognition, n-gram models, statistical language models, neural language models, transformers and attention mechanisms.

Unit-III

Syntactic and Semantic Analysis: Constituency and dependency parsing, context-free grammars, probabilistic context-free grammars, semantic role labeling, word sense disambiguation, lexical semantics, distributional semantics, word embeddings (Word2Vec, GloVe, FastText).

Unit-IV

Machine Learning for NLP: Supervised learning algorithms for text classification and sequence labeling, unsupervised learning for topic modeling and clustering, deep learning architectures for NLP (RNNs, LSTMs, GRUs, CNNs), transfer learning and fine-tuning in NLP, evaluation metrics for NLP tasks.

Unit-V

Advanced NLP Applications: Machine translation (statistical and neural approaches), sentiment analysis and opinion mining, text summarization, question answering systems, dialogue systems and chatbots, information retrieval and extraction, multi-modal NLP (text-to-speech, speech recognition, image captioning), recent advancements in NLP (e.g., GPT, BERT, XLNet).

RECOMMENDED BOOKS

- Daniel Jurafsky, James H. Martin, "Speech and Language Processing", Prentice Hall.
- Christopher D. Manning, Hinrich Schütze, "Foundations of Statistical Natural Language Processing", MIT Press.
- Yoav Goldberg, "Neural Network Methods for Natural Language Processing", Morgan & Claypool Publishers.
- Emily M. Bender, Alex Lascarides, "Linguistic Fundamentals for Natural Language Processing: 100 Essentials from Morphology and Syntax", Morgan & Claypool Publishers.
- Jacob Eisenstein, "Introduction to Natural Language Processing", MIT Press.

COURSE OUTCOMES

After completion of the course students would be able to:

CO1. Explain the fundamental concepts of Natural Language Processing, including linguistic levels of analysis and challenges in NLP.
CO2. Apply various text processing techniques and implement language models for NLP tasks.
CO3. Analyse and **implement** syntactic and semantic analysis methods in natural language.
CO4. Design and **develop** machine learning and deep learning models for various NLP applications.
CO5. Evaluate and **implement** advanced NLP applications, addressing real-world problems and ethical considerations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1			1	2		2	3	2
CO2	3	3	3	3	3				2	2		2	3	3
CO3	3	3	3	3	3	1			2	2	1	2	3	3
CO4	3	3	3	3	3	2	1	1	2	2	2	2	3	3
CO5	3	3	3	3	3	3	2	2	3	3	2	3	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DEEP LEARNING
62241208

COURSE OBJECTIVES

- Introduce major deep neural network frameworks and issues in basic neural networks.
- To solve real world applications using Deep learning

Unit-I

Introduction to machine learning, scope and limitations, Types of machine learning, Linearity vs non linearity, Neural Networks Basics – layers in Neural networks – Activation function, Loss function - Function approximation - Classification and Clustering problems - Deep networks basics - Shallow neural networks,

Unit-II

Multilayer network, Gradient descent, backpropagation, weight initialization, training, testing, underfitting and overfitting, batch normalization, dropout, L1 and L2 regularization, unstable gradient problem tuning hyper parameters, momentum, Mini-batch Gradient Descent – Exponential Weighted Averages – Gradient Descent with Momentum – RMSProp and Adam Optimization – Hyperparameter tuning.

Unit-III

Foundations of Convolutional Neural Networks – CNN operations – Architecture – Simple Convolution Network – Deep Convolutional Models – ResNet, AlexNet, InceptionNet and others. data augmentation, Transfer Learning, Transfer Learning Models, Generative Adversarial Network.

Unit-IV

Recurrent neural network, long short-term memory, gated recurrent unit, translation, Auto encoders beam search and width, Bleu score, attention model.

Unit-V

Reinforcement Learning, RL-framework, MDP, Bellman equations, Value Iteration and Policy Iteration, Actor-critic model, Q-learning, SARSA

RECOMMENDED BOOKS

- Ian Goodfellow Yoshua Bengio Aaron Courville, Deep Learning, MIT Press, 2017.
- Michael Nielsen, Neural Networks and Deep Learning, Determination Press, first

Edition, 2013

- Deep Learning Foundations and Concepts, Christopher M. Bishop, Hugh Bishop

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COURSE OUTCOMES

After completing the course, the student will be able to:

CO1. **Understand** the fundamental concepts and types of machine learning, including linearity and non-linearity.
CO2: **Apply** principles of neural networks, including multilayer networks, gradient descent, and backpropagation, to solve real-world problems.
CO3: **Analyze and design** convolutional neural networks (CNNs) for image recognition.
CO4: **Evaluate** the use of recurrent neural networks (RNNs), LSTMs, and GRUs for sequence modeling tasks, and implement attention mechanisms for improved performance.
CO5**: Create** solutions using reinforcement learning algorithms, including Q-learning and SARSA.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	1	-	-	-	1	-	1	1	2	1
CO2	2	3	2	2	2	-	-	-	1	-	1	1	3	3
CO3	2	3	3	2	2	-	-	-	1	-	1	1	3	2
CO4	1	3	3	2	2	-	-	-	1	-	1	1	3	3
CO5	1	3	3	2	2	-	-	-	1	-	1	1	3	3

1 - Slightly; 2 - Moderately; 3 - Substantially