M.TECH.
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Curriculum

NATIONAL INSTITUTE OF

TECHNICAL TEACHERS TRAINING AND RESEARCH CHENNAI

Deemed to be University under Distinct Category – A Centrally Funded Technical Institute

CSIR Road, Taramani, Chennai-600113

Regulations 2024

NATIONAL INSTITUTE OF TECHNICAL TEACHERS TRAINING AND RESEARCH CHENNAI

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M. Tech. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

REGULATIONS 2024

The M.Tech in Artificial Intelligence (AI) and Machine Learning (ML) is to equip students with advanced knowledge and skills in designing, developing, and applying intelligent systems that can learn from data and make autonomous decisions. This program focuses on core areas like deep learning, natural language processing, computer vision, and data analytics, preparing graduates for solving complex real-world problems across industries such as healthcare, finance, robotics, and autonomous systems. It also fosters innovation, research, and technical leadership, opening avenues in academia, research institutions, and cutting-edge tech roles.

Program Education Objectives (PEOs)

Graduates will demonstrate ability:

- **PEO 1:** To establish a strong base in fundamental sciences, mathematics, and engineering principles, fostering comprehensive knowledge and proficiency.
- **PEO 2**: To nurture the capacity to grasp, interpret, and assess challenges in Artificial Intelligence while connecting them to real-world applications.
- **PEO 3**: To deliver extensive expertise for designing and creating novel products and innovative solutions to address real-world issues in the fields of Computer Science and Engineering
- **PEO 4**: To instil self-confidence, cultivate a professional and ethical mindset, foster effective teamwork, nurture leadership qualities, enhance proficiency in soft skills, and develop the ability to connect engineering with social issues.

Program Outcomes (POs)

Our graduates by the time of graduation will be able to

- **PO1**: An ability to independently carry out research /investigation and development work to solve practical problems.
- **PO2**: An ability to write and present a substantial technical report/document.

- **PO3**: An ability to demonstrate a degree of mastery over the CSE programme with Artificial Intelligence. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
- **PO4**: An ability to recognize the need for applying efficient AI based solutions to improve the quality of life.
- **PO5**: An ability to function effectively as an individual and a team member, in project and product development and to follow professional ethics in the career.
- **PO6**: The capability to construct Information Technology systems proficient in automated reasoning to address intricate challenges across diverse application domains.

Programme Credit Requirement

		PG Certificate	PG Diploma	PG Degree
PCC (Theory)	Credit	6	12	12
	Course	2	4	4
PCC (Lab)	Credit	4	8	8
	Course	2	4	4
PEC / OEC	Credit	9	9	18
	Course	3	3	6
FC	Credit		3	3
	Course		1	1
MC	Credit	3	3	3
	Course	1	1	1
Audit Course	Credit	0	0	0
	Course	2	2	2
IIP	Credit	0	0	8
	Course	0	0	2
PD	Credit	0	5	28
	Course	0	1	2

Minimum Credit Requirement to obtain
PG Certificate – 20 Credits; PG Diploma – 40 Credits; PG Degree – 80 Credits

PCC	Professional Core Courses
PEC	Professional Elective Courses
OEC	Open Elective
FC	Foundation Course
MC	Mandatory Course
AC	Audit Course
IIC	Industrial Integrated Courses
PD	Project Dissertation

Course Structure and Details

PROFESSIONAL CORE COURSES (Theory)			
S. No	Course Code	Course Title	Credits
1	AM24P11	Advanced Data Structure and Algorithms	3
2	AM24P12	Foundation of Data Science	3
3	AM24P13	Machine Learning	3
4	AM24P14	Artificial Intelligence	3
PROFESSIONAL CORE COURSES (Laboratory)			
1	AM24P21	Advanced Data Structure Laboratory	2
2	AM24P22	Machine Learning Laboratory	2
3	AM24P23	Deep Learning Laboratory	2
4	AM24P24	Big Data and Analytics Laboratory	2
FOUNDATION COURSE			
1	MA24M11	Statistics and Probability for Engineers	3
MANDATORY COURSE			
1	RM24K11	Research Methodology and IPR	3
INDUSTRY ORIENTED COURSE			
1	AM24G11	Framework for Artificial Intelligence and Machine Learning with Python	4
2	AM24G12	Full Stack Web application Development	4
3	AM24G13	Visualization Methods and Techniques	4
INDUSTRIAL TRAINING			
1	AM24G21	Internship Programme	4
PROJECT DISSERTATION			
1	AM24T21	Project Phase 1	12
2	AM24T22	Project Phase II	16

PROFESSIONAL ELECTIVE COURSE – ARTIFICIAL INTELLIGENCE			
S. No	Course Code	Course Title	Credits
1	AM24A11	Information Retrieval	3
2	AM24A12	Natural Language Processing	3
3	AM24A13	Artificial neural networks	3
4	AM24A14	Mixed Reality Techniques	3
PROFESSIONAL ELECTIVE COURSE – WEB APPLICATION AND DEVELOPMENT			

1	AM24B11	Web Services and API Design	3
2	AM24B12	Software Engineering and Architectural Patterns	3
3	AM24B13	Cloud Computing for ML Applications	3
PROFESSIONAL ELECTIVE COURSE – SECURITY PRACTICES			
1	AM24C11	Data Privacy	3
2	AM24C12	Blockchain Technologies	3
3	AM24C13	Digital Forensics	3
4	AM24C14	Web Application Security	3
PROFESSIONAL ELECTIVE COURSE – DATA SCIENCE			
1	AM24D11	Reinforcement Learning	3
2	AM24D12	Image Processing and Computer Vision	3
3	AM24D13	Recommender Systems	3
4	AM24D14	Computational Optimization	2
PROFESSIONAL ELECTIVE COURSE – DATA ANALYTICS			
1	AM24E11	Social Network Analysis	3
2	AM24E12	Business Data Analytics	3
3	AM24E13	Data Mining Techniques	3
4	AM24E14	Predictive Analytics	3
5	PD24E15	Wind Energy Conversion System	3
PROFESSIONAL ELECTIVE COURSE – IoT & ROBOTICS			
1	AM24F11	Building IoT Systems	3
2	AM24F12	Bio-Inspired Learning Algorithms	3
3	AM24F13	Ethics of AI and Robotics	3
OPEN ELECTIVE COURSE			
1	OE24W11	Design Thinking for Educators	3
2	OE24W12	Blue Economy and Entrepreneurship	3
3	OE24W13	Swachhata Campus: Clean, Green, and Sustainable Energy	3
4	OE24W14	Integration of AI Educational Practices	3

5	OE24W15	Extended Reality Technologies	3
AUDIT COURSE			
1	AC24H11	English For Research Paper Writing	0
2	AC24H12	Indian Knowledge System	0

- ✓ **Theory: 1 Credit = 15 hours;**
- ✓ **Practical: 1 Credit = 30 hours;**
- ✓ **Experiential learning including relevant experience and proficiency/ professional levels acquired 1 Credit – 40 -45 hours**.

- **The guidelines for attendance and assessment as stipulated in the PG regulations.**

Detailed Syllabus

I. PROFESSIONAL CORE COURSES (Theory)

AM24P11	ADVANCED DATA STRUCTURE AND ALGORITHMS	3 Credits

Course Description:

This course introduces the fundamental role of algorithms in computing, covering hierarchical data structures like trees and heaps, as well as graph theory and its applications. Students will learn to evaluate problems, choosing appropriate data structures and algorithms to design effective solutions. The course also covers NP-Completeness, helping students understand problem complexity and computational limitations.

Unit I Role of Algorithms in Computing & Complexity Analysis:

Algorithms – Algorithms as a Technology -Time and Space complexity of algorithms- Asymptotic analysis-Average and worst-case analysis-Asymptotic notation-Importance of efficient algorithms-Program performance measurement - Recurrences: The Substitution Method – The Recursion-Tree Method- Data structures and algorithms

Unit II Hierarchical Data Structures:

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B -trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Heap – Heap Implementation – Disjoint Sets - Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

Unit III Graphs:

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra‘s Algorithm; Dynamic Programming - All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm

Unit IV Algorithm Design Techniques:

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: – Elements of the Greedy Strategy- An Activity-Selection Problem - Huffman Coding.

UNIT V NP-Completeness:

Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.

Course Outcomes:

At the end of the course, students will be able to

- CO1 Design data structures and algorithms to solve computing problems.
- CO2 Choose and implement efficient data structures and apply them to solve problems.
- CO3 Design algorithms using graph structure and various string-matching algorithms to solve real-life problems.
- CO4 Design one's own algorithm for an unknown problem.
- CO5 Apply suitable design strategy for problem solving.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2		1	3
CO2	3	3	1	2	2	3
CO3	2	2		2	3	2
CO4	2	3	2	3		2
CO5	2		2	3	2	3

References:

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, —Data Structures and Algorithms||, Pearson Education, Reprint 2006.
2. Robert Sedgewick and Kevin Wayne, —ALGORITHMS, Fourth Edition, Pearson Education.
3. S.Sridhar, Design and Analysis of Algorithm, First Edition, Oxford University Press,2014.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, —Introduction to Algorithms, Third Edition, Prentice-Hall, 2011.

AM24P12	FOUNDATION OF DATA SCIENCE	3 Credits

Course Description:

This course provides a foundation in data science techniques and processes, focusing on the application of descriptive analytics and data visualization for diverse applications. It also covers inferential analytics, enabling students to draw insights and make data-driven decisions.

Unit I Introduction:

Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – build the model– presenting findings and building applications – Data Mining – Data Warehousing – Basic Statistical descriptions of Data

Unit II Describing Data:

Types of Data – Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages – Describing Variability – Normal Distributions and Standard (z) Scores

Unit III Describing Relationships:

Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean

Unit IV Python Libraries for Data Wrangling:

Basics of Numpy arrays –aggregations –computations on arrays –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables

Unit V Data Visualization:

Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting – Geographic Data with Basemap – Visualization with Seaborn.

Course Outcomes:

At the end of the course, students will be able to

- CO1 Explain the data analytics pipeline.
- CO2 Describe and visualize data.
- CO3 Perform statistical inferences from data.
- CO4 Analyse the variance in the data.
- CO5 Build models for predictive analytics.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	3	3		2	3
CO3	2		2	1	2	3
CO4	2	2	2	2	3	
CO5	3	2		3	1	2

References:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.
2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
3. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, "Fundamentals of Data Science", CRC Press, 2022.
4. Vineet Raina, Srinath Krishnamurthy, "Building an Effective Data Science Practice: A Framework to Bootstrap and Manage a Successful Data Science Practice", Apress, 2021.
5. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2020

AM24P13	MACHINE LEARNING	3 Credits

Course Description:

This course offers an in-depth understanding of machine learning, focusing on its mathematical foundations and various problem types it addresses. Students will explore supervised learning techniques, including ensemble methods, and delve into unsupervised and reinforcement learning. The course also covers the role of probabilistic methods in machine learning, alongside introducing neural networks and deep learning fundamentals.

Course Content:

UNIT I: INTRODUCTION

Machine Learning – Basic Concepts in Machine Learning – Types of Machine Learning – Basics of Learning Theory – Concept Learning - Hypothesis space - Heuristics space search - Find - Modelling in Machine learning - Learning Frameworks - PAC Framework

UNIT II: SUPERVISED LEARNING

Introduction-Discriminative and Generative Models -Linear Regression - Least Squares -Under-fitting / Overfitting -Cross-Validation – Lasso Regression- Classification - Logistic Regression- Gradient Linear Models -Support Vector Machines –Kernel Methods -Instance based Methods - K-Nearest Neighbours - Tree based Methods –Decision Trees –ID3 – CART - Ensemble Methods –Random Forest - Evaluation of Classification Algorithms

UNIT III: UNSUPERVISED LEARNING AND REINFORCEMENT LEARNING

Introduction - Clustering Algorithms -K – Means – Hierarchical Clustering - Cluster Validity - Dimensionality Reduction –Principal Component Analysis – Recommendation Systems - EM algorithm. Reinforcement Learning – Elements -Model based Learning – Temporal Difference Learning

UNIT IV: PROBABILISTIC METHODS FOR LEARNING

Introduction -Naïve Bayes Algorithm -Maximum Likelihood -Maximum Apriori -Bayesian Belief Networks -Probabilistic Modelling of Problems -Inference in Bayesian Belief Networks – Probability Density Estimation - Sequence Models – Markov Models – Hidden Markov Models.

UNIT V: NEURAL NETWORKS AND DEEP LEARNING

Neural Networks – Biological Motivation- Perceptron – Multi-layer Perceptron – Feed Forward Network – Back Propagation-Activation and Loss Functions- Limitations of Machine Learning – Deep Learning–Use cases.

Course Outcomes:

On completion of the course, the student is expected to be able to

CO1 Understand and outline problems for each type of machine learning.

CO2 Design a Decision tree and Random Forest for an application

CO3 Implement Probabilistic Discriminative and Generative algorithms for an application and analyse the results.

CO4 Use a tool to implement typical Clustering algorithms for different types of applications.

CO5 Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

Articulation matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	3
CO2	2	2	3	2	1	2
CO3	3	2		3	3	3
CO4	3	3	3	2	3	2
CO5	2	2	3	2	3	

References:

1. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Chapman & Hall/CRC, 2nd Edition, 2014.
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012
3. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
4. Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2013.
5. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
6. Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015
7. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2007
8. Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online)
9. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online)
10. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)

AM24P14	**ARTIFICIAL INTELLIGENCE**	**3 Credits**

Course Description:

This course introduces the foundational principles of Artificial Intelligence (AI), guiding students in designing intelligent agents. Key AI areas covered include problem-solving, knowledge representation, reasoning, and decision-making, equipping students to create systems that can perform complex tasks autonomously.

Course Content:

Unit I: **INTELLIGENT AGENTS AND SEARCH TECHNIQUES**:

Agents and Environments – Good Behaviour: The concepts of Rationality – The Nature of Environments – The Structure of Agents, Problem solving - Solving problems by searching - Search in Complex Environments - Adversarial Search and games - Constraint Satisfaction Problem

Unit II : **KNOWLEDGE AND REASONING**:

Logical Agents - Propositional Logic - Theorem proving, First Order Logic: Syntax and Semantics - Knowledge Engineering in First Order Logic, Inference in First Order Logic: Forward Chaining - Backward Chaining - Resolution, Knowledge Representation: - Ontological Engineering - Categories and Objects

Unit III : **BAYESIAN NETWORKS**:

Directed Graphical Models – Bayesian Networks – Exploiting Independence Properties – From Distributions to Graphs – Inference in Graphical Models - Bayes model - Generative and Discriminative model - Maximum-likelihood parameter learning: Continuous models - Bayesian parameter learning - Bayesian linear regression

Unit IV : **DECISION MAKING/ DECISION PROCESS**:

Decision Process formulation, utility theory, utility functions, decision networks, value of information, Making Complex Decisions: Sequential Decision Problems - Algorithms for MDPs - Bandit Problems - partially observable MDPs - Algorithms for Solving POMDPs - Reinforcement learning

Unit V : **AI APPLICATIONS**:

Learning AI model deployment - Containers - Dockers - Discussion of AI Applications - Natural Language Processing - Chatbots - Dialog Flow - Image Classification - Robotics - Model deployment with containers such as Docker.

Course Outcomes:

On completion of the course, the student is expected to be able to

CO1: Relate the type of agents and environments in the real-world scenarios

CO2: Analyse different search techniques with computational complexity

CO3: Understand the working of Bayesian techniques to solve AI problems

CO4: Use the decision-making process to solve simple and complex problems

CO5: Explain the different learning techniques and its applications.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	3	1	2
CO2	2	3	3	2	2	2
CO3	2	3	3	3	1	3
CO4	3	2		3	1	3
CO5	3	3	2	2	3	

References:

1. Stuart J. Russell, Peter Norvig, Artificial Intelligence – A Modern Approach, Pearson
2. Education, 4th Edition, 2021
3. Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence, Third Edition,
4. Tata McGraw-Hill, 2008.
5. Dheepak Khemani, “A First Course in Artificial Intelligence”, McGraw-Hill, 2013.
6. NPTEL Artificial Intelligence Course by Prof. Dasgupta – http://nptel.ac.in/courses/106105079/2
7. https://cloud.google.com/dialogflow
8. https://cloud.google.com/community/tutorials/kubernetes-ml-ops
9. https://www.tensorflow.org/tutorials/images/cnn

II. PROFESSIONAL CORE COURSES (Laboratory)

AM24P21	ADVANCED DATA STRUCTURE LABORATORY	2 Credits

Course Description:

This lab course focuses on the role of algorithms in computing, covering hierarchical data structures, graph applications, and the selection of optimal data structures and algorithms for specific problems. It also introduces NP-Completeness, helping students understand computational complexity and problem-solving challenges.

List of experiments:

1. Iterative and recursive algorithms and its complexity analysis.
2. Merge sort algorithm analysis using Divide and Conquer approach.
3. Quick sort algorithm using randomized algorithmic approach.
4. Matrix chain multiplication using Dynamic programming approach.
5. Activity selection and Huffman coding using Greedy approach.
6. Binary search tree and a Red-Black tree implementation.
7. Implementation of basic heap operations.
8. Implementation of Top-down Splay and Fibonacci Heap operations using
9. Amortized analysis.
10. Representation of Graphs and Graph traversals.
11. Implementation of a Spanning tree for a given graph using Prim's algorithm.
12. Implementation of a Shortest path of a given graph using Dijkstra's algorithm

Course Outcomes:

On completion of the course, the student is expected to be able to

CO1: Analyze and implement suitable iterative or recursive algorithms for a given problem with minimum complexity.

CO2: Create suitable design strategies to solve a problem in an efficient manner.

CO3: Implement hierarchical data structures to approach a real time problem and also to solve it in amortized runs.

CO4: Understand and develop algorithms using graph structures for suitable applications.

CO5: Solve NP Complete problems efficiently.

CO6: Apply appropriate data structures and suitable algorithmic design to implement real time applications.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1		3	3	
CO2		2		3	3	
CO3		3	2			2

CO4	2		3			3
CO5	2	1		3	3	

AM24P22	MACHINE LEARNING LABORATORY	2 Credits

Course Description:

This lab course introduces algorithms in computing, covering hierarchical data structures and graph applications. Students will learn to select and design suitable data structures and algorithms for different problems, with an overview of NP-Completeness to understand computational complexity.

List of experiments:

1. Use Beautiful Soup scrapping tool to extract text content from a given URL.
2. Write simple python scripts to remove missing/NULL values from the given variable in a
3. sample UCI dataset or to replace with the variable's mean.
4. Use excel sheet to perform t-hypothesis testing for a given sample data.
5. Download IRIS dataset from UCI repository and generate a box plot, scatter plot and
6. histogram using any tool.
7. Use simple python matplotblib functions to generate various types of plots.
8. Use python program to train a decision tree classification model and generate a decision tree
9. for Car Evaluation Dataset from UCI repository.
10. Develop a Linear regression model using Algerian Forest Fire Dataset using python.
11. Write a python program to generate the confusion matrix for classification using decision tree for car evaluation dataset. Also derive various metrics like accuracy, precision, recall,sensitivity and F-measure and give your inferences about the model's performance.
12. Implement classification algorithms with different datasets and check with evaluation metrics.
13. Implement clustering algorithms with different datasets and check with evaluation metrics.

Course outcomes:

CO1 Understand and outline problems for each type of machine learning.

CO2Design a Decision tree and Random Forest for an application

CO3 Implement Probabilistic Discriminative and Generative algorithms for an application and analyze the results.

CO4 Use a tool to implement typical Clustering algorithms for different types of applications.

CO5 Design and implement an HMM for a Sequence Model type of application and identify applications suitable for different types of Machine Learning with suitable justification.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1		3	3	
CO2	3	2		3	3	
CO3		3	2		3	2
CO4	2		3	2		3
CO5		2		2	1	2

AM24P23	DEEP LEARNING LABORATORY	2 Credits

Course Description:

This lab course lays the foundation for deep learning, guiding students in building neural networks and developing essential machine learning concepts for real-world applications.

List of experiments:

1. Setting up the Spyder IDE Environment and Executing a Python Program
2. Installing Keras, Tensorflow and Pytorch libraries and making use of them
3. Applying the Convolution Neural Network on computer vision problems
4. Image classification on MNIST dataset (CNN model with Fully connected layer)

5. Applying the Deep Learning Models in the field of Natural Language Processing
6. Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU notes
7. Applying the Autoencoder algorithms for encoding the real-world data
8. Applying Generative Adversial Networks for image generation and unsupervised tasks.

Course outcomes:

At the end of the course, students will be able to

CO1: Appy the Principles of Deep Learning.

CO2: Identify The Deep Learning Algorithms for Various Types of Learning Tasks in various domains.

CO3: Implement Deep Learning Algorithms and Solve Real-world problems.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	2	2
CO2	2	3	3	2	2	
CO3	3	2	3	2	2	3

AM24P24	**BIG DATA AND ANALYTICS LABORATORY**	**2 Credits**

Course Description:

This lab course equips students to process big data through MapReduce, utilize MongoDB for storage, and apply machine learning techniques like decision tree classification and clustering for big data analysis.

List of experiments:

1. 1. Use numPy and Pandas packages for data analytics and numerical operations.
2. Install, configure and run Hadoop and HDFS.
3. Visualize data using basic plotting techniques in Python.
4. Implement NoSQL Database Operations: CRUD operations, Arrays using MongoDB.
5. Implement Functions: Count – Sort – Limit – Skip – Aggregate using MongoDB.
6. Implement word count / frequency programs using MapReduce.
7. Implement a MapReduce program that processes a dataset.

8. Implement clustering techniques using SPARK.
9. Implement an application that stores big data in MongoDB / Pig using Hadoop / R.

Course Outcomes:

At the end of the course, students will be able to

CO1: To implement MapReduce programs for processing big data.

CO2: To realize storage of big data using MongoDB.

CO3: To analyze big data using machine learning techniques such as Decision tree classification and clustering.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		2	2	2	2
CO2	2	3	3	2	2	
CO3	3	2	3	2	2	3

III. FOUNDATION COURSE

MA24M11	STATISTICS AND PROBABILITY FOR ENGINEERS	3 Credits

Course Description:

This course aims to build a solid understanding of key concepts in Linear Algebra, Probability, and Random Variables. Students will explore two-dimensional random variables, the central limit theorem, and hypothesis testing for small and large samples. Additionally, they will learn about multivariate normal distribution and principal component analysis for data interpretation.

Course Content:

Unit I LINEAR ALGEBRA:

Vector spaces – norms – Inner Products – Eigenvalues using QR transformations – QR factorization – generalized eigenvectors – Canonical forms – singular value decomposition and applications – pseudo inverse – least square approximations.

Unit II PROBABILITY AND RANDOM VARIABLES:

Probability – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

Unit III TWO DIMENSIONAL RANDOM VARIABLES:

Joint distributions – Marginal and conditional distributions – Functions of two-dimensional random variables – Regression curve – Correlation.

Unit IV SAMPLING DISTRIBUTIONS:

Type I and Type II errors – Small and Large samples – TESTING OF HYPOTHESIS: Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

Unit V MULTIVARIATE ANALYSIS:

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables**.**

Course Outcomes:

At the end of the course, students will be able to

CO1: Apply the concepts of Linear Algebra to solve practical problems.
CO2: Use the ideas of probability and random variables in solving engineering problems.
CO3: Explain the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
CO4: Use statistical tests in testing hypotheses on data.
CO5: Develop critical thinking based on empirical evidence and the scientific approach to knowledge development.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	1	3
CO2	2	2	1	2	1	2
CO3	2	3	2	1	2	3
CO4	3	2	3	2	1	2
CO5	2	3	1	2	1	3

References:

Jin Ho Kwak and Snngpyo Hong, Linear Algebra, Second Edition, Springer (2004).

Gilbert Strang, Introduction to linear algebra, 4th Edition, Academic Press.

Introduction of Probability Models, S. M. Ross, Academic Press, N.Y.

Fundamentals of Statistics, vol. I & II, A. Goon, M. Gupta and B. Dasgupta, World Press.

Higher Engineering Mathematics, B. S. Grewal, Khanna Publication, Delhi.

Probability and Statistics for Engineers, (Fourth Edition), I. R. Miller, J.E. Freund and R. Johnson, PHI.

IV. MANDATORY COURSE

RM24K11	**RESEARCH METHODOLOGY AND IPR**	**3 Credits**

Refer to the syllabus of the MOOC course

V. INDUSTRY ORIENTED COURSE

AM24G11	**FRAMEWORK FOR ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING WITH PYTHON**	**4 Credits**

Course Description:

This course offers a comprehensive introduction to Python programming and its applications in data handling, analysis, and visualization, preparing students for data-driven problem-solving.

Course Content:

UNIT I: PYTHON BASICS

IDE – Use of Functions - Collaborative version control system – git - Condition Statements - if then else - Nested conditionals - Loops - For -While - do while - List - Nested lists - slicing operation - Tuples - Dictionary - creation of python modules.

UNIT II: FILE HANDLING AND ARRAYS

Files processing - NumPy - Array Indexing - Array Slicing - Reshaping - Concatenation - Splitting - Aggregation - Broadcasting - Sorting - Vectorizing - Matrix operations.

UNIT III: DATA PROCESSING

Pandas - Series object - Use of Data frames - importing and exporting data to csv/ other formats - Data indexing and selection - Handling missing data - Replacing data items - Combining datasets - Pivot Tables - working with time series.

UNIT IV: DATA VISUALIZATION

Importing matplotlib and seaborn libraries - setting styles - simple line plots - Scatter plots - visualizing errors - density and contour plots - histograms - legend - colorbars - subplots - three- dimensional plotting.

UNIT V: STATISTICAL LEARNING

Scikit-learn – working with predefined datasets – classification with multiple algorithms – training - testing ratio - fitting with different parameters – normalization – cross validation

Course Outcomes:

At the end of this course, the students should be able to:

CO1: Develop and execute programs with loops and other data structures.

CO2: Work with files and arrays using numpy.

CO3: Work with data using Pandas.

CO4: Write programs for visualization using matplotlib and seaborn.

CO5: Develop separate functions for statistical learning.

CO6: Develop computer applications for data science/ machine learning projects..

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	2	2
CO5	1	2	1	3	2	3
CO6	1	3	2	3	3	3

References:

1. Eric Matthes, Python Crash Course, 2nd Edition, No Starch Press, 2019
2. Jake Vander Plas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media, Inc, 2016

3. Wes McKinney, Python for Data Analysis, 3rd Edition, O' Reilly, 2022
4. Bobby Iliev, Introduction to Git and Github, MIT License, https://github.com /bobbyiliev/introduction-to-git-and-githubebook/raw/main/ebook/en/export/introduction-to-git-and-github-dark.pdf, 2021.
5. https://scikit-learn.org/stable/tutorial/statistical_inference/index.html

AM24G12	FULL STACK WEB APPLICATION DEVELOPMENT	4 Credits

Course Description:

This course covers the development of full-stack web applications using modern technologies like TypeScript, Angular, Node.js, Express.js, and MongoDB. It begins with the fundamentals of server-side, client-side, and single-page applications, followed by an in-depth exploration of TypeScript, covering data types, functions, OOP principles, and more. The course then focuses on Angular for building dynamic web applications, including routing, forms, and HTTP operations. Next, students will learn Node.js, with a focus on asynchronous programming, file handling, and events. Express.js is introduced for building robust server-side applications, covering routing, middleware, and RESTful services. Finally, MongoDB is explored for database operations, including CRUD, indexing, and the aggregation framework.

Course Content:

Unit I: FUNDAMENTALS & TYPESCRIPT LANGUAGE

Server-Side Web Applications. Client-Side Web Applications. Single Page Application. About TypeScript. Creating TypeScript Projects. TypeScript Data Types. Variables. Expression and Operators. Functions. OOP in Typescript. Interfaces. Generics. Modules. Enums. Decorators. Enums. Iterators. Generators.

Unit II: ANGULAR

About Angular. Angular CLI. Creating an Angular Project. Components. Components Interaction. Dynamic Components. Angular Elements. Angular Forms. Template Driven Forms. Property, Style, Class and Event Binding. Two way Bindings. Reactive Forms. Form Group. Form Controls. About Angular Router. Router Configuration. Router State. Navigation Pages. Router Link. Query Parameters. URL

matching. Matching Strategies. Services. Dependency Injection. HttpClient. Read Data from the Server. CRUD Operations. Http Header Operations. Intercepting requests and responses.

Unit III: NODE.JS

About Node.js. Configuring Node.js environment. Node Package Manager NPM. Modules. Asynchronous Programming. Call Stack and Event Loop. Callback functions. Callback errors. Abstracting callbacks. Chaining callbacks. File System. Synchronous vs. asynchronous I/O. Path and directory operations. File Handle. File Synchronous API. File Asynchronous API. File Callback API. Timers. Scheduling Timers. Timers Promises API. Node.js Events. Event Emitter. Event Target and Event API. Buffers. Buffers and TypedArrays. Buffers and iteration. Using buffers for binary data. Flowing vs. non-flowing streams. JSON.

Unit IV: EXPRESS.JS

Express.js. How Express.js Works. Configuring Express.js App Settings. Defining Routes. Starting the App. Express.js Application Structure. Configuration, Settings. Middleware. body-parser. cookie-parser. express-session. response-time. Template Engine. Jade. EJS. Parameters. Routing. router.route(path). Router Class. Request Object. Response Object. Error Handling. RESTful.

Unit V: MONGODB

Introduction to MongoDB. Documents. Collections. Subcollections. Database. Data Types. Dates. Arrays. Embedded Documents. CRUD Operations. Batch Insert. Insert Validation. Querying The Documents. Cursors. Indexing. Unique Indexes. Sparse Indexes. Special Index and Collection Types. Full-Text Indexes. Geospatial Indexing. Aggregation framework.

Course Outcomes:

At the end of this course, the students should be able to:

CO1: Develop basic programming skills using Javascript

CO2: Implement a front-end web application using Angular.

CO3: Will be able to create modules to organise the server

CO4: Build RESTful APIs with Node, Express and MongoDB with confidence.

CO5: Will learn to Store complex, relational data in MongoDB using Mongoose.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	3	1	2	1	3

References:

1. Adam Freeman, Essential TypeScript, Apress, 2019
2. Mark Clow, Angular Projects, Apress, 2018
3. Alex R. Young, Marc Harter,Node.js in Practice, Manning Publication, 2014
4. Pro Express.js, Azat Mardan, Apress, 2015
5. MongoDB in Action, Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, Tim
6. Hawkins, Manning Publication, Second edition, 2016

AM24G13	VISUALIZATION METHODS AND TECHNIQUES	4 Credits

Course Description:

This course explores data “visualization techniques” and their applications. It covers key concepts like explorative and confirmative analysis, visual representation of multivariate data, and interaction techniques. Students will learn to work with spatial, geospatial, and time-oriented data using tools like Tableau and R. The course also introduces advanced design techniques for effective visualization, focusing on evaluation, case studies, and interactive applications.

Course Content:

Unit I: INTRODUCTION

Presentation-Explorative Analysis-Confirmative Analysis-Mental Model-Scientific Visualization-Reference Model-Designing a Visual Application-Linear Data Representation – Perception-Issues.

Unit II: VISUAL REPRESENTATION

Information Visualization Process - Representation Techniques - Human Factor and Interaction- Relation and connection-Multivariate Analysis – Trees – Graphs -Network and Hierarchies - World Wide Web Manipulable and Transformable Representation.

Unit III: MULTIMODAL PRESENTATION

Human Vision – Presentation in Space- Temporal Consideration- Space and Time – Techniques for Spatial Data, Geospatial Data, Time-oriented Data- Text Document- Data Analysis using Tableau and R language.

Unit IV: INTERACTION TYPES

Interaction Concepts and Techniques – Problem of Information Overload – Interaction Types- Human Computer Interaction-Norman's Action Cycle-Interaction for: Information Visualization – Navigation – Models – Involuntary - Interactive Medical Application- Tactile Maps for Visually Challenged People.

Unit V: ADVANCE DESIGN TECHNIQUES

Designing Effective Visualization, Comparing and Evaluating- Research Directions –Systems-Personal view –Attitude-Idea Generation – Convergence – Sketching- Evaluation Criteria – Analytic and Empirical Method – Case Study – Interactive Calendars –Selecting One from Many- Animation Design for Simulation.

Course Outcomes:

At the end of the course the student will be able to

CO1: Understand the concepts and techniques used in Visualization Techniques.

CO2: Implement different techniques of information representation.

CO3: Implement various presentations of information.

CO4: Apply different interaction types used to present information.

CO5: Design and implement effective Visualization

CO6: Create and evaluate interactive data Visualization real-time problem.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	1
CO2	3	2	3	2	2	1
CO3	3	1	3	2	2	1

CO4	3	2	3	2	2	1
CO5	3	2	3	2	2	2
CO6	3	1	2	3	3	1

References:

1. O.Ward, Georges Grinstein and Daniel Keim," Interactive Data VisualizationFoundations and Applications", Second Edition, A K Peters,2021.

2. Robert Spence, "Information Visualization An Introduction", Third Edition, Pearson Education, 2014.

3. 3. Colin Ware, "Information Visualization Perception for Design", Third Edition, Morgan Kaufmann Publishers, 2012.

4. Jason Gregory, "Game Engine Architecture", Third Edition, A K Press, 2015.

5. RiccardoMazza, "Introduction to Information Visualization", Springer.2009

6. JoergOsarek, "Virtual Reality Analytics", Gordon's Arcade, 2016.

VI. PROFESSIONAL ELECTIVE COURSES

Cluster A: ARTIFICIAL INTELLIGENCE

AM24A11	INFORMATION RETRIVAL	3 Credits

Course Description:

This course offers an in-depth exploration of Information Retrieval (IR), starting with its goals, history, and the influence of the web. It covers key retrieval models like Boolean and Vector Space, along with TF-IDF weighting and cosine similarity for ranking and analysing text. Core concepts include text preprocessing (tokenizing, stemming, stop-word removal), and indexing through inverted indices and sparse vectors. Further topics address text representation, query languages, relevance feedback, and query expansion, as well as classification methods like Naive Bayes and Support Vector Machines (SVM). Advanced subjects include web crawling, link analysis, PageRank, and recommender systems, ending with performance evaluations using precision, recall, and F-measure metrics.

Course Content:

Unit-I: INTRODUCTION TO INFORMATION RETRIEVAL

Goals and History of IR – The Impact of the Web on IR – Basic IR Models Boolean and Vector Space Retrieval Models – Ranked Retrieval – Text Metrics – TF-IDF (term frequency/inverse document

frequency) Weighting – Cosine Similarity - Pre-processing: Simple tokenizing, Stop-word removal, and stemming, Basic Searching and Indexing: inverted indices and files, efficient processing with sparse vectors.

Unit-II: DC MACHINES

Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt DC motors – electrical and mechanical time constants - Time domain block diagrams –transfer function of DC motor-responses – digital computer simulation of permanent magnet and shunt DC machines.

Unit-III: CATEGORIZATION AND CLUSTERING

Text classification - Naive Bayes – Decision Trees and Nearest Neighbor- Vector space classification - Support vector machines, Expectation Maximization (EM) - Flat clustering, Hierarchical clustering, Matrix decompositions and latent semantic indexing - Applications to Information Filtering – Organization and Relevance Feedback.

Unit-IV: INFORMATION EXTRACTION AND INTEGRATION

Search Engines, Spidering, Web Crawling, Meta-crawlers, Directed spidering, link analysis, Static ranking: Page Rank HITS, shopping agents, Query log analysis, Adversarial IR; Extracting data from text, XML, Ontologies, Thesauri, Semantic Web, collecting and integrating specialized information on the web.

Unit-V: RECOMMENDER SYSTEMS AND IR EVALUATION

Recommender Systems – Collaborative Filtering – Content Based Recommendation of Documents and Products – Information Extraction and Integration – Extracting Data from Text – XML – Semantic Web – Collecting and Integrating Specialized Information on the Web. Experimental Evaluation of IR Performance Metrics - Recall, Precision and F Measure – Evaluations on Benchmark Text Collections.

Course Outcomes:

At the end of the course, students will be able to

CO1: Build an Information Retrieval system using the available tools.

CO2: Identify and design the various components of an Information Retrieval system.

CO3: Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval.

CO4: Analyse the Web content structure.

CO5: Analyse the approaches used for recommendation systems.

CO6 Design an efficient search engine.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	1
CO2	1	2	2	2	2	1
CO3	3	2	2	2	2	2
CO4	1	2	2	2	1	2
CO5	2	2	2	2	2	2
CO6	1	2	2	2	2	2

References:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, "Introduction to Information Retrieval", Cambridge University Press, 2008.
2. F. Ricci, L. Rokach, B. Shapira, P. B. Kantor, "Recommender Systems Handbook",Springer, 2011.
3. Peter Brusilovsky, "The Adaptive Web Methods and Strategies of Web Personalization",
4. Springer, 2007.
5. Manu Konchady, "Building Search Applications: Lucene, LingPipe, and Gate",Mustru Publishing 2008.

AM24A12	NATURAL LANGUAGE PROCESSING	3 Credits

Course Description:

This course provides a comprehensive study of Natural Language Processing (NLP), starting with its foundational components, including linguistics, probability, and morphology, along with techniques like tokenization and finite state automata. It explores statistical NLP and sequence labelling, covering N-grams, language models, Naive Bayes classification, and modern methods like Word2Vec and part-of-speech tagging. The course delves into contextual embedding, focusing on parsing techniques such as Context-Free Grammars, CKY Parsing, and dependency parsing. Advanced topics include computational semantics, with a focus on Word Sense Disambiguation, Semantic Role Labelling, and information extraction. The course concludes with discourse analysis and speech processing, exploring discourse structure,

question answering systems, chatbots, and dialogue systems using frame-based and dialogue-state architectures.

Course Content:

Unit I: INTRODUCTION

Natural Language Processing – Components - Basics of Linguistics and Probability and Statistics – Words-Tokenization-Morphology-Finite State Automata.

Unit II: STATISTICAL NLP AND SEQUENCE LABELLING

N-grams and Language models –Smoothing -Text classification- Naïve Bayes classifier – Evaluation - Vector Semantics – TF-IDF - Word2Vec- Evaluating Vector Models -Sequence Labeling – Part of Speech – Part of Speech Tagging -Named Entities –Named Entity Tagging.

Unit III: CONTEXTUAL EMBEDDING

Constituency –Context Free Grammar –Lexicalized Grammars- CKY Parsing – Earley's algorithm Evaluating Parsers -Partial Parsing – Dependency Relations- Dependency Parsing -Transition Based - Graph Based.

Unit IV: COMPUTATIONAL SEMANTICS

Word Senses and WordNet – Word Sense Disambiguation – Semantic Role Labelling – Proposition Bank- FrameNet- Selection Restrictions - Information Extraction - Template Filling.

Unit V: DISCOURSE ANALYSIS AND SPEECH PROCESSING

Discourse Coherence – Discourse Structure Parsing – Centering and Entity Based Coherence – Question Answering –Factoid Question Answering – Classical QA Models – Chatbots and Dialogue systems – Frame-based Dialogue Systems – Dialogue - State Architecture.

Course Outcomes:

At the end of the course, students will be able to

CO1: Understand basics of linguistics, probability and statistics associated with NLP.

CO2: Implement a Part-of-Speech Tagger.

CO3: Design and implement a sequence labeling problem for a given domain.

CO4: Implement semantic processing tasks and simple document indexing and searching system using the concepts of NLP.

CO5: Implement a simple chatbot using dialogue system concepts..

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	2	2	3	2	2	2

CO3	2	1	3	2	1	2
CO4	3	2	3	2	1	2
CO5	3	3	3	3	3	3

References:

1. Daniel Jurafsky and James H.Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition" (Prentice Hall Series in Artificial Intelligence), 2020
2. Jacob Eisenstein. "Natural Language Processing ", MIT Press, 2019
3. Samuel Burns "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK, 2019
4. Christopher Manning, "Foundations of Statistical Natural Language Processing", MIT Press, 2009.
5. Nitin Indurkhya,Fred J. Damerau, "Handbook of Natural Language Processing", Second edition, Chapman & Hall/CRC: Machine Learning & Pattern Recognition, Hardcover,2010
6. Deepti Chopra, Nisheeth Joshi, "Mastering Natural Language Processing with Python", Packt Publishing Limited, 2016
7. Mohamed Zakaria Kurdi "Natural Language Processing and Computational Linguistics: Speech, Morphology and Syntax (Cognitive Science)", ISTE Ltd., 2016
8. Atefeh Farzindar,Diana Inkpen, "Natural Language Processing for Social Media (Synthesis Lectures on Human Language Technologies)", Morgan and Claypool Life Sciences, 2015
9. .

AM24A13	ARTIFICIAL NEURAL NETWORKS	3 Credits

Course Description:

This course covers the basics of Artificial Neural Networks (ANNs), including neural computation, biological and artificial neuron models, and learning rules. It explores multilayer feedforward networks, Hopfield networks, and associative memories. Applications include character recognition, robot kinematics, medical diagnosis, and self-organizing maps.

Course Content:

Unit-I: ARTIFICIAL NEURAL NETWORK

Neural computation-History of Neural Systems Development – Fundamental Concepts and Models of Artificial Neural Systems: Biological Neurons and Their Artificial Models – Models of Artificial Neural

Networks – Neural Processing – Learning and Adaptation – Neural Network Learning Rules – Single Layer Perception Classifiers.

Unit-II: MULTILAYER FEEDFORWARD NETWORKS

Linearly Non-separable Pattern Classification - Delta Learning Rule for Multi-perceptron Layer - Generalized Delta Learning Rule - Feedforward Recall and Error Back-Propagation Training - Learning Factors - Classifying and Expert Layered Networks - Functional Link Networks.

Unit-III: SINGLE-LAYER FEEDBACK NETWORKS

Basic Concepts of Dynamical Systems - Mathematical Foundations of Discrete-Time Hopfield Networks - Mathematical Foundations of Gradient-Type Hopfield Networks - Transient Response of Continuous-Time Networks - Relaxation Modelling in Single-Layer Feedback Networks.

Unit-IV: ASSOCIATIVE MEMORIES

Basic Concepts - Linear Associator - Basic Concepts of Recurrent Auto associative Memory - Performance Analysis of Recurrent Auto associative Memory - Bidirectional Associative Memory - Associative Memory of Spatio-temporal Patterns.

Unit-V: APPLICATIONS OF NEURAL ALGORITHMS AND SYSTEMS

Linear Programming Modelling Network - Character Recognition Networks - Neural Networks Control Applications - Networks for Robot Kinematics - Connectionist Expert Systems for Medical Diagnosis - Self-organizing Semantic Maps– Interactive Calendars –Selecting one from many- Animation Design for Simulation.

Course Outcomes:

On completion of the course, the student is expected to be able to

CO1: Understand the fundamental concept behind neural network

CO2: Implement the feed forward network

CO3: Understand the working of feedback neural network

CO4: Explore the memory architecture using neural networks.

CO5: Design and develop applications using neural networks

CO6: Explore the recent advances in neural networks.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6

CO1	3	1	3	2	1	2
CO2	2	2	3	2	2	2
CO3	2	1	3	2	1	2
CO4	3	2	3	2	1	2
CO5	3	1	3	2	1	2
CO6	3	2	1	2	1	2

References:

1. Jacek M.Zuarda, "Introduction to Artificial Neural Networks", West Publishing Company.1994
2. Simon Haykin, Neural Networks & Learning Machines, Third Edition, Pearson, 2009

AM24A14	MIXED REALITY TECHNIQUES	3 Credits

Course Description:

This course offers an in-depth exploration of Mixed Reality (MR), covering its foundational aspects and applications. It begins with an introduction to Virtual Reality (VR), Augmented Reality (AR), and MR, including their history, use cases, and hardware. Key topics include MR design principles, hardware devices, optical see-through displays, and computer vision for MR. The course then delves into interaction design, focusing on tangible interaction, auditory-induced presence, and mixed interaction techniques. It covers MR systems, emphasizing human-robot interaction (HRI), computational cognitive modeling, and usability evaluation of virtual environments. Finally, it explores diverse MR applications in fields such as healthcare, teleoperation, psychological experimentation, sports, and early-stage creative design, including MR companion robots.

Course Content:

Unit I: INTRODUCTION TO MIXED REALITY

Introduction to Virtual Reality (VR) - Augmented Reality (AR) -Mixed Reality (MR)– History – MR Use Cases & Designing for MR Platforms – Mixing Virtual with Real - MR Hardware and Devices – The Input – The Output – Optical See-Through Displays – Eye Tracking- Computer Vision for MR.

Unit II: INTERACTION DESIGN IN MIXED REALITY

Integrating Framework for MR –Embedded MR Environment - Tangible Interaction – Auditory-

Induced Presence – Exertion in MR Systems – Mixed Interaction in MR.

Unit III: MIXED REALITY SYSTEMS

Outdoor MR Systems – Multimodal Excitatory Interfaces – Tracking in Mixed Reality – Authoring Immersive MR – Collaborative AR – Software Engineering Method for MR.

Unit IV: MIXED REALITY AND HUMAN-ROBOT INTERACTION

Mixed Reality for Robots – User-centered HRI – Mental Transformation in HRI – Computational Cognitive Modeling – Evaluating the usability of the virtual environment – Security Robot.

Unit V: APPLICATIONS OF MIXED REALITY

MR in healthcare and medical simulations – Teleoperation interface for MR Robot - MR in psychological experimentation – MR in Sports – MR Prototypes to support early creative design – MR Companion Robots.

Course Outcomes:

At the end of the course, students will be able to

CO1: Demonstrate knowledge and understanding of VR, AR, and MR concepts, technologies, and applications.

CO2: Apply design principles and considerations specific to Mixed Reality platforms.

CO3: Understand interaction design principles in Mixed Reality.

CO4: Apply software design and implementation skills for Mixed Reality systems.

CO5: Demonstrate knowledge of the intersection of Mixed Reality and Human-Robot Interaction (HRI)

CO6: Analyze and evaluate the integration of Mixed Reality technologies and principles into real-world applications.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1	1	2
CO2	3		3	2	2	2
CO3	2	1	3	1	3	2
CO4	3	2	3	2	3	2
CO5	1		3	2	3	2

CO6	3	2	3	3	3	2

References:

1. O'Connell, Kharis, “Designing for Mixed Reality”, O'Reilly Media, Inc, 2016.
2. Dubois E, Gray P, Nigay L, “The engineering of mixed reality systems” Springer Science & Business Media, 2009.
3. Wang, Xiangyu, “Mixed reality and human-robot interaction”. Vol. 47. Springer Science & Business Media, 2011.
4. Benyon, D, “Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design”. Third Edition, Pearson Education Limited, 2013

Cluster B: WEB APPLICATION AND DEVELOPMENT

AM24B11	WEB SERVICES AND API DESIGN	3 Credits

Course Description:

This course provides a comprehensive overview of Web Services, focusing on various architectures and implementation techniques. It begins with an introduction to Web Services and Service-Oriented Architecture (SOA), covering the Web Services Technology Stack and different architectural views, including logical, deployment, and process perspectives. The course then delves into the building blocks of web services, introducing SOAP with its syntax, message handling, and implementations, as well as WSDL and UDDI for service description and discovery. It explores Restful Web Services, covering HTTP methods, the Programmable Web, and client implementation techniques using XML and JSON parsers. The course continues with practical implementation of Restful Web Services, focusing on Amazon S3 design principles, Spring Web Services, and Spring MVC components. Finally, it addresses Resource-Oriented Architecture, including principles of resource design, statelessness, and creating read-only services, with a focus on URIs, representations, and linking resources.

Course Content:

Unit I: INTRODUCTION TO WEB SERVICE

Overview – Web Service -Architecture – Service-Oriented Architecture (SOA), Architecting Web Services: Web Services Technology Stack, Logical Architectural View, Deployment Architectural View, and Process Architectural View**.**

Unit II: WEB SERVICE BUILDING BLOCKS

Introduction to SOAP: SOAP Syntax- Sending SOAP Messages - SOAP Implementations - Introduction to WSDL: WSDL Syntax - SOAP Binding - WSDL Implementations - Introduction to UDDI: The UDDI API - Implementations - The Future of UDDI.

Unit III: RESTFUL WEB SERVICES

Programmable Web - HTTP: Documents in Envelopes - Method Information - Scoping Information - The Competing Architectures - Technologies on the Programmable Web -Leftover Terminology - Writing Web Service Clients: The Sample Application - Making the Request: HTTP Libraries - Processing the Response: XML Parsers - JSON Parsers: Handling Serialized Data - Clients Made

Easy with WADL.

Unit IV: IMPLEMENTATION OF RESTFUL WEB SERVICES

Introducing The Simple Storage Service - Object-Oriented Design Of S3 - Resources – HTTP Response Codes Resource- Uris - Addressability - Statelessness - Representations - Links And Connectedness - The Uniform Interface – Spring Web Services – Spring MVC Components - Spring Web Flow - A Service Implementation Using Spring Data REST.

Unit V: RESOURCE ORIENTED ARCHITECTURE

Resource- URIs - Addressability - Statelessness - Representations - Links and Connectedness - The Uniform Interface- Designing Read-Only Resource-Oriented Services : Resource Design - Turning Requirements Into Read-Only Resources - Figure Out the Data Set- Split the Data Set into Resources- Name the Resources - Design Representation- Link the Resources to Each Other- The HTTP Response.

Course Outcomes:

On completion of the course, the student is expected to be

CO1: Explain how to write XML documents.

CO2: Apply the web service building blocks such as SOAP, WSDL and UDDI

CO3: Describe the RESTful web services.

CO4: Implement the RESTful web service with Spring Boot MVC

CO5: Discuss Resource-oriented Architecture.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2

CO2	2	2	3	2	2	2
CO3	2	1	3	2	1	2
CO4	3	2	3	2	1	2
CO5	3	3	3	3	3	3

References:

1. Leonard Richardson and Sam Ruby, RESTful Web Services, O'Reilly Media, 2007
2. McGovern, et al., "Java Web Services Architecture", Morgan Kaufmann Publishers,2005.
3. Lindsay Bassett, Introduction to JavaScript Object Notation, O'Reilly Media, 2015
4. Craig Walls, "Spring in Action, Fifth Edition", Manning Publications, 2018
5. Raja CSP Raman, Ludovic Dewailly, "Building A RESTful Web Service with Spring 5",Packt Publishing, 2018.
6. Bogunuva Mohanram Balachandar, "Restful Java Web Services, Third Edition: A pragmaticguide to designing and building RESTful APIs using Java", Ingram short title, 3rd Edition,2017.
7. Mario-Leander Reimer, "Building RESTful Web Services with Java EE 8: Create modern RESTful web services with the Java EE 8 API", Packt publishing, 2018

AM24B12	SOFTWARE ENGINEERING AND ARCHITECTURAL PATTERN	3 Credits

Course Description:

This course covers software engineering processes, including Agile models like Scrum and DevOps, and various modelling techniques. It explores software design concepts, system dependability, security, and reliability engineering. Topics also include service-oriented architecture, real-time systems, and embedded design. The course concludes with software testing strategies and configuration management for web and mobile apps.

Course Content:

Unit I: SOFTWARE PROCESS & MODELLING

Prescriptive Process Models – Agility and Process – Scrum – XP – Kanban – DevOps – Prototype Construction – Prototype Evaluation – Prototype Evolution – Modelling – Principles – Requirements Engineering – Scenario-based Modelling – Class-based Modelling – Functional Modelling – Behavioural Modelling.

Unit II: SOFTWARE DESIGN

Design Concepts – Design Model – Software Architecture – Architectural Styles – Architectural Design – Component-Level Design – User Experience Design – Design for Mobility – Pattern- Based Design.

Unit III: SYSTEM DEPENDABILITY AND SECURITY

Dependable Systems – Dependability Properties – Sociotechnical Systems – Redundancy and Diversity – Dependable Processes – Formal Methods and Dependability – Reliability Engineering – Availability and Reliability – Reliability Requirements – Fault-tolerant Architectures – Programming for Reliability – Reliability Measurement – Safety Engineering – Safety-critical Systems – Safety Requirements – Safety Engineering Processes – Safety Cases – Security Engineering – Security and Dependability – Safety and Organizations – Security Requirements – Secure System Design – Security Testing and Assurance – Resilience Engineering – Cybersecurity – Sociotechnical Resilience – Resilient Systems Design.

Unit IV: SERVICE-ORIENTED SOFTWARE ENGINEERING, SYSTEMS ENGINEERING AND REAL-TIME SOFTWARE ENGINEERING

Service-oriented Architecture – RESTful Services – Service Engineering – Service Composition – Systems Engineering – Sociotechnical Systems – Conceptual Design – System Procurement – System Development – System Operation and Evolution – Real-time Software Engineering – Embedded System Design – Architectural Patterns for Real-time Software – Timing Analysis – Real-time Operating Systems.

Unit V: SOFTWARE TESTING AND SOFTWARE CONFIGURATION MANAGEMENT

Software Testing Strategy – Unit Testing – Integration Testing – Validation Testing – System Testing – Debugging – White-Box Testing – Basis Path Testing – Control Structure Testing – Black-Box Testing – Software Configuration Management (SCM) – SCM Repository – SCM Process – Configuration Management for Web and Mobile Apps.

Course Outcomes:

At the end of this course, the students will have the ability in

CO1: Identify appropriate process models based on the Project requirements

CO2: Understand the importance of having a good Software Architecture.

CO3: Understand the five important dimensions of dependability, namely, availability, reliability, safety, security, and resilience.

CO4: Understand the basic notions of a web service, web service standards, and service-oriented architecture.

CO5: Be familiar with various levels of Software testing.

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1		
CO2	2	2	3	1	2	3
CO3	2	2	3	2	2	2
CO4	2	2	3	1	2	1
CO5	3	3	3	3	3	3

References

1. Software Engineering: A Practitioner's Approach, 9th Edition. Roger Pressman and Bruce Maxim, McGraw-Hill 2019.
2. Software Engineering, 10th Edition, Ian Somerville, Pearson Education Asia 2016.
3. Software Architecture In Practice, 3rd Edition, Len Bass, Paul Clements and Rick Kazman, Pearson India 2018
4. An integrated approach to Software Engineering, 3rd Edition, Pankaj Jalote, Narosa Publishing House, 2018
5. Fundamentals of Software Engineering, 5th Edition, Rajib Mall, PHI Learning Private Ltd, 2018.

AM24B13	CLOUD COMPUTING FOR ML APPLICATIONS	3 Credits

Course Description:

This course explores Cloud Computing and its intersection with Machine Learning (ML) and Edge Computing. It starts with an introduction to core concepts, including Cloud Computing, Edge

Computing, and Cloud-Edge integration, and examines various use cases. It then covers Machine Learning and Deep Learning models in the cloud, focusing on defining, training, and deploying these models using serverless computing and containers. The course explores Functions-as-a-Service (FaaS) and event-driven programming, including Machine Learning as a Service (MLaaS), its benefits, key functionality, and implementation phases of Machine Learning Operations (MLOps). Advanced topics include Edge Machine Learning, addressing challenges and hardware options like VPUs, GPUs, and TPUs. Finally, the course looks at recent trends, including Cloud APIs for computer vision, scalable inference serving, and embedded ML at the edge with techniques such as shallow RNNs and ProtoNN, emphasizing resource-efficient ML solutions.

Course Content:

Unit I: CLOUD COMPUTING FUNDAMENTALS

Introduction to Cloud computing, Edge computing, Edge intelligence, Cloud Edge computing, Use cases.

Unit II: MACHINE LEARNING AND DEEP LEARNING MODELS IN THE CLOUD:

Defining Structure and Training Machine Learning Models in cloud, Serverless Machine Learning, using containers with Machine Learning Models, Benefits of Serverless Computing for Machine Learning.

Unit III: FUNCTIONS-AS-A-SERVICE AND EVENT-DRIVEN PROGRAMMING IN CLOUD:

Software-as-a-Service, Machine Learning as a service (MLaaS), MLaaS functionality, Benefits of MLaaS, MLaaS service providers, Machine Learning Operations (MLOps), Key phases in MLOps implementation.

Unit IV: EDGE MACHINE LEARNING:

Machine learning and edge bringing AI to IoT, Challenges in machine learning and edge computing integration, Edge devices and ML frameworks, Hardware Inference Model in Edge Machine Learning – VPU, GPU, TPU.

Unit V: RECENT TRENDS IN CLOUD AND EDGE COMPUTING FOR MACHINE LEARNING:

Cloud APIs for computer vision, Scalable inference serving on cloud, Embedded ML at Edge – Shallow RNN, ProtoNN, Resource-efficient Machine learning.

Course Outcomes:

At the end of the course, students will be able to

CO1: Demonstrate the application of cloud and edge computing in Machine learning applications

CO2: Analyse the various services and architecture of cloud and edge computing

CO3: Apply Machine Learning algorithms using cloud and edge computing

CO4: Relate current research papers on cloud and edge computing to understand the issues raised by current research.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2		
CO2	2	2	3	2	1	1
CO3	2	1	3	2	1	1
CO4	3	2	2	1	2	3

References:

1. John Biggs, Vicente Herrera García, Building Intelligent Cloud Applications, O'Reilly publisher, 2019
2. Daniel Situnayake, Jenny Plunkett, AI at the Edge, O'Reilly publisher, 2022
3. Anirudh Koul, Siddha Ganju and Meher Kasam, Practical Deep Learning for Cloud, Mobile, and Edge, O'Reilly Publication, 2020
4. Mark Treveil, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim
5. Zentici, Adrien Lavoillotte, Makoto Miyazaki, Lynn Heidmann, Introducing MLOps, O'Reilly, 2020
6. Kai Hwang, Cloud Computing for Machine Learning and Cognitive Applications, MIT press, 2017
7. Web resources: https://github.com/bisonai/awesome-edge-machinelearning/
8. tree/master/Papers/ML_Algorithms_For_Edge

Cluster C: SECURITY PRACTICES

AM24C11	DATA PRIVACY	3 Credits

Course Description:

Data Privacy course explores the principles, laws, and technologies related to data privacy in the digital age. Students will learn about the challenges and best practices in protecting personal data, compliance with privacy regulations, and the ethical implications of data collection and usage.

Course Content:

Unit I: INTRODUCTION

Introduction to Data Privacy - Overview of data privacy and its significance - Key terms and concepts: personal data, consent, data subjects - The evolution of data privacy in the digital age- Overview of major data privacy laws.

Unit II: DATA PROTECTION PRINCIPLES

Core principles of data protection: legality, purpose limitation, data minimization - Understanding individual rights - Data processing agreements and third-party risks - Data Breaches and Incident Response - Common causes of data breaches and their impact - Incident response planning and best practices - Case studies of notable data breaches.

Unit III: PRIVACY BY DESIGN AND DEFAULT

Implementing privacy by design in systems and processes - Role of data protection officers (DPOs) in organizations - Tools and frameworks for privacy risk assessments - Emerging Technologies and Privacy Challenges - Impact of AI, big data, and IoT on data privacy- Privacy implications of machine learning algorithms.

Unit IV: ETHICAL CONSIDERATIONS IN DATA PRIVACY

Understanding the ethical implications of data collection and usage - The role of trust and transparency in data practices - Discussions on surveillance and privacy rights- Data Privacy in Business Practices - Strategies for building a culture of data privacy within organizations- Best practices for data governance and compliance.

Unit V: GLOBAL TRENDS AND FUTURE DIRECTIONS

Current trends in data privacy legislation and enforcement - Future challenges and opportunities in data privacy - Group project: Develop a data privacy compliance framework for a hypothetical organization.

Course Outcome:

At the end of this course, the students will have the ability to

CO1: Understand the key concepts and principles of data privacy.

CO3: Analyze the legal frameworks governing data privacy globally.

CO3: Evaluate the impact of data privacy regulations on businesses and individuals.

CO4: Develop strategies for implementing effective data privacy practices..

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	2	2	3	2	2	2
CO3	2	1	3	2	1	2
CO4	3	2	2	2	1	3

References:

1. "Data Privacy: Law and Practice" by Paul M. Schwartz and Daniel J. Solove
2. "Privacy and Civil Liberties Oversight Board Reports"

AM**24C12**	**BLOCKCHAIN TECHNOLOGIES**	**3 Credits**

Course Description:

Blockchain Technologies course provides an in-depth exploration of blockchain technology, its underlying principles, and its applications across various industries. Students will learn about the architecture of blockchain systems, consensus algorithms, smart contracts, and the potential impact of blockchain on business and society.

Course Content:

Unit I: INTRODUCTION TO BLOCKCHAIN

History of Blockchain – Blockchain Architecture - Distributed Ledger Technology (DLT); Blocks and Chain Structure; Types of Blockchain – Consensus – Consensus algorithms- Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization.

Unit II: BITCOIN AND CRYPTOCURRENCIES

History and Origins of Bitcoin; Bitcoin Technology and Architecture - Transactions and Scripting Language- Bitcoin Wallets; Bitcoin Mining - Bitcoin Transactions and Network; Alternative Coins - Bitcoin Limitations - Name Coin – Prime Coin – Zcash –Bitcoin Smart Contracts – Ricardian Contracts.

Unit III: ETHEREUM

Ethereum and its features; Ethereum Architecture: Ethereum Virtual Machine -The Ethereum Network – Runtime Byte Code, Blocks and Blockchain - Fee Schedule– Ethereum Programming Languages - Smart Contracts Development - Ethereum Scaling Solutions - Ethereum DApps and Use Cases - Ethereum Community and Ecosystem.

Unit IV: WEB3 AND HYPERLEDGER

Web3 – Web3 concepts and Architecture- Benefits and Features of Web3- Web3 Development Tools and Frameworks –Hyperledger Projects and Frameworks - Hyperledger Fabric - Hyperledger Sawtooth - Hyperledger Indy - Hyperledger Iroha - Hyperledger Besu- Hyperledger Tools.

Unit V: ALTERNATIVE BLOCKCHAINS AND NEXT EMERGING TRENDS

Kadena – Ripple- Rootstock – Quorum – Tendermint Interoperability and Cross-Chain Communication - Scalability – Privacy – Tokenization and Digital Assets - Cryptocurrency Regulations and Legal Frameworks - Cryptocurrency Use Cases-Notable Projects – Miscellaneous tools.

Course Outcome:

After successful completion of this course, the students will be able to

CO1: Understand the technology components of Blockchain and how it works behind-the scenes.
CO2: Aware of different approaches to developing decentralized applications.
CO3: Establish deep understanding of the Ethereum model, its consensus model, code execution.
CO4: Understand the architectural components of a Hyperledger and its development framework.
CO5: Know the Alternative blockchains and emerging trends in blockchain.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	2	2	3	2	2	2
CO3	2	1	3	2	1	2
CO4	3	3	1	2	3	3
CO5	3	3	1	2	3	3

References:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing,2018.
2. Arshdeep Bahga, Vijay Madisetti, “Blockchain Applications: A Hands-On Approach”, VPT, 2017.
3. Andreas Antonopoulos, Satoshi Nakamoto, “Mastering Bitcoin”, O’Reilly Publishing, 2014.
4. Roger Wattenhofer, “The Science of the Blockchain” CreateSpace Independent Publishing Platform, 2016.
5. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Princeton University Press, 2016.
6. Alex Leverington, “Ethereum Programming”, Packt Publishing.

AM24C13	DIGITAL FORENSICS	3 Credits

Course Description:

The Digital Forensics course provides an in-depth understanding of digital forensics principles, practices, and tools used in the investigation of cybercrimes. Students will learn how to collect, analyze, and present digital evidence in a manner that is legally admissible in court. The course will cover various types of digital devices and environments, including computers, mobile devices, and networks.

Course Content:

Unit I: COMPUTER FORENSICS AND INVESTIGATION

Understanding computer forensics, Preparing for Computer Investigations, Corporate High-Tech Investigation. Data Acquisition and Recovery: Storage formats, Using acquisition tools, Data Recovery: RAID Data acquisition.

Unit II: PROCESSING CRIME AND INCIDENT SCENE

Identifying and collecting evidence, Preparation for search, Seizing and Storing Digital evidence.

Unit III: COMPUTER FORENSICS TOOLS (ENCASE) AND WINDOWS OPERATING SYSTEM

Understanding file structure and file system, NTFS disks, Disk Encryption and Registry Manipulation. Computer Forensics software and hardware tools.

Unit IV: COMPUTER FORENSICS ANALYSIS AND VALIDATION

Data collection and analysis, validation of forensics data, addressing – data hiding technique.

Unit V: EMAIL INVESTIGATION AND MOBILE DEVICE FORENSICS

Investigation e-mail crimes and Violations, Using specialized E-mail forensics tools. Understanding mobile device forensics and Acquisition procedures. Role of Digital Forensics in Real time applications: PRO Discover Basic, Volatility, Sleuth Kit.

Course Outcome:

At the end of this course, the students will have the ability to

CO1: Learn the fundamentals of digital forensics technology along with different systems and services

CO2: Recover and seize data from a crime scene without damage, using legal procedures and standards.

CO3: Exhibit knowledge in forensic data acquisition and analysis and investigate artifacts in different operating systems.

CO4: Apply forensics tools and concepts on modern frameworks such as network, email, smart phones, cloud and social media.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	2	2	3	2	2	2
CO3	2	1	3	2	1	2
CO4	3	2	2	3	1	2

References:

1. Bill Nelson, Amelia Philips, Christopher Steuart, Guide to Computer Forensics and Investigations, Fourth Edition, Cengage Learning, 2016.
2. David Lilburn Watson, Andrew Jones, Digital Forensics Processing and Procedures, Syngress, 2013.
3. Cory Altheide, Harlan Carvey, Digital Forensics with Open Source Tools, British LibraryCataloguing-in-Publication Data, 2011
4. Greg Gogolin,Digital Forensics Explained,CRC Press, 2013

AM24C14	WEB APPLICATION SECURITY	3 Credits

Course Description:

This course covers the fundamentals of securing web applications and protecting them from various types of attacks and vulnerabilities. It introduces students to the common threats, security mechanisms, and secure coding practices required to build robust and secure web-based systems. The course emphasizes practical aspects through hands-on labs, penetration testing tools, and real-world case studies, ensuring that students can apply security principles to web applications.

Course Content:

Unit I FUNDAMENTALS OF WEB APPLICATION SECURITY:

The history of Software Security-Recognizing Web Application Security Threats, Web Application Security, Authentication and Authorization, Secure Socket layer, Transport layer Security, Session Management-Input Validation.

Unit II SECURE DEVELOPMENT AND DEPLOYMENT:

Web Applications Security – Security Testing, Security Incident Response Planning, The Microsoft Security Development Lifecycle (SDL), OWASP Comprehensive Lightweight Application Security Process (CLASP), The Software Assurance Maturity Model (SAMM)

Unit III API SECURITY:

API security fundamentals - session cookies - token-based authentication - Securing APIs in various architectures - including microservices and service meshes.

Unit IV VULNERABILITY ASSESSMENT AND PENETRATION TESTING:

Vulnerability Assessment Lifecycle, Vulnerability Assessment Tools: Cloud-based vulnerability scanners, Host-based vulnerability scanners, Network-based vulnerability scanners, Databasebased vulnerability scanners, Types of Penetration Tests: External Testing, Web Application Testing, Internal Penetration Testing, SSID or Wireless Testing, Mobile Application Testing.

Unit V HACKING TECHNIQUES AND TOOLS:

Social Engineering, Injection, Cross-Site Scripting (XSS), Broken Authentication and Session Management, Cross-Site Request Forgery, Security Misconfiguration, Insecure Cryptographic

Storage, Failure to Restrict URL Access, Tools: Comodo, OpenVAS, Nexpose, Nikto, Burp Suite, etc.

Course Outcomes:

At the end of the course, students will be able to

CO1: Understand common web application vulnerabilities such as SQL injection, Cross-Site Scripting (XSS), and Cross-Site Request Forgery (CSRF).

CO2: Explore authentication, authorization, and session management techniques.

CO3: Study encryption and secure communication protocols.

CO4: Learn secure coding practices to mitigate risks.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	2	2	3	2	2	2
CO3	2	1	3	2	1	2
CO4	3	2	3	2	1	3

References:

1. Andrew Hoffman, Web Application Security: Exploitation and Countermeasures for Modern Web Applications, First Edition, 2020, O'Reilly Media, Inc.
2. Bryan Sullivan, Vincent Liu, Web Application Security: A Beginners Guide, 2012, The McGraw-Hill Companies.
3. Neil Madden, API Security in Action, 2020, Manning Publications Co.,

Cluster D: DATA SCIENCE

AM24D11	REINFORCEMENT LEARNING	3 Credits

Course Description:

This course offers a comprehensive introduction to Reinforcement Learning (RL), covering both foundational concepts and advanced techniques. Students will explore the elements of RL, the agent-environment interaction, and tackle the multi-armed bandit problem. The course delves into the Markov Decision Process (MDP), dynamic programming, and Bellman equations, followed by Monte Carlo

methods for prediction and control, and Temporal Difference (TD) learning techniques such as SARSA and Q-learning. Advanced topics include Deep Q Networks (DQN) and its variants like Double DQN and Dueling DQN. The course concludes with a study of policy gradient methods and cutting-edge algorithms such as A2C, A3C, TRPO, and Proximal Policy Optimization (PPO), equipped with the tools to implement and scale RL solutions for complex, real-world problems.

Course Content:

Unit I: INTRODUCTION TO REINFORCEMENT LEARNING

Introduction To Reinforcement Learning–Elements of Reinforcement Learning–Limitations and Scope – History of Reinforcement Learning– The Agent-Environment Interface - An-Armed Bandit Problem.

Unit II: MARKOV DECISION PROCESS AND DYNAMIC PROGRAMMING

Markov Decision Process – Action Space – Policy – Episode – Return and Discount Factor - The Markov Property – Markov Decision Processes – Bellman Equation – Dynamic Programming –Value Iteration and Policy Iteration.

Unit III: MONTE CARLO METHODS AND TEMPORAL METHODS

Understanding Monte Carlo Method – Prediction and Control Tasks – Monte Carlo Prediction –First and Every Visit – Monte Carlo Control – Understanding Temporal Difference Learning – TD Prediction – On-Policy TD Control – SARSA – Off-Policy TD Control – Q-Learning.

Unit IV: DEEP Q NETWORKS AND ITS VARIANTS

DQN – replay Buffer – Loss functions – Target Function – Architecture of DQN – Double DQN DQN with prioritized Experience replay – Dueling DQN – Deep Recurrent Method.

Unit V: FUNCTION APPROXIMATION

Getting Started with Policy Gradient Methods – Policy Gradient Intuition – Variance Reduction Methods – Actor – Citic Methods – A2C, A3C , A3C – Deep Gradient Policy Gradient – Twin Delayed DDPG – Trust Region Policy Approximation – TRPO -Proximal Policy Optimization.

Course Outcomes:

At the end of the course, students will be able to

CO1: Understand different terminologies of RL and Concepts of Probability.

CO2: Illustrate Markov Decision Process and Bellman Equation for learning.

CO3: Apply dynamic programming techniques on Markov decision process and Monte Carlo methods.

CO4: Implement Time difference learning for real world problems.

CO5: Apply Approximation methods of learning and Q-Learning Technique.

CO6: Understand the need for function approximation algorithms.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	3	2	1
CO2	1	2	3	3	1	1
CO3	3	2	1	3	1	1
CO4	2	1	1	2	3	3
CO5	1	2	2	1	3	2
CO6	3	1	1	2	1	1

References:

1. Richard S.Sutton and Andrew G.Barto, “Reinforcement learning: An introduction”, Second Edition, MIT Press, 2019.
2. Sudharsan Ravichandiran, “Deep Reinforcement Learning with Python”, Second Edition, Packet Publishing, 2020.
3. Kevin P Murphy, “Machine Learning: A Probabilistic Perspective”, Second Edition, MIT Press, 2022.
4. Csaba Szepesvari, “Algorithms for Reinforcement Learning (Synthesis Lectures on Artificial Intelligence & Machine Learning)”, Morgan & Claypool Publishers, 2010.
5. Laura Graesser and Wah Loon Keng, “Foundations of Deep Reinforcement learning: theory and Practice in Python”, Pearson, 2022.

AM24D12	IMAGE PROCESSING AND COMPUTER VISION	3 Credits

Course Description:

This course covers the fundamentals of image processing, including human vision, digital imaging systems, and color models. It explores image enhancement techniques such as Fourier and wavelet transforms, grey level transformations, and spatial filtering. The course also focuses on image restoration, noise modelling, and boundary detection using morphological operations and edge detection. Image segmentation and feature extraction methods, including SIFT, SURF, and PCA, are covered. Finally, students will learn about image classifiers, supervised learning methods (like SVM), unsupervised learning (like K-means clustering), and deep learning-based image classification.

Course Content:

Unit I: FUNDAMENTALS OF IMAGE PROCESSING

Introduction – Applications of Image Processing – Steps in Image Processing Applications – Human vision and color perception- Digital Imaging System – Imaging sensors-Sampling and Quantization – Pixel Connectivity – Distance Measures – Colour Fundamentals and Models – File Formats – Image Operations.

Unit II: IMAGE ENHANCEMENT AND TRANSFORMS

Image Transforms: Discrete Fourier Transform – Fast Fourier Transform – – Wavelet Transforms -Image Enhancement in Spatial and Frequency Domain – Grey Level Transformations – Histogram Processing – Spatial Filtering – Smoothing and Sharpening – Frequency Domain: Filtering in Frequency Domain.

Unit III: RESTORATION AND BOUNDARY DETECTION

Image Restoration – Image Degradation Model – Noise Modeling – Blur – Order Statistic Filters – Image Restoration - Morphological Operations- Dilation-Erosion-Opening-Closing- Edge Detection-Corner Detection - Detection of Discontinuities Edge Linking and Boundary Detection.

Unit IV: IMAGE SEGMENTATION AND FEATURE EXTRACTION

Image Segmentation — Thresholding – Region based Segmentation – Image Features and Extraction – Image Features – Types of Features – Feature extraction – SIFT, SURF– Feature reduction algorithms-PCA.

Unit V: IMAGE CLASSIFIER AND APPLICATIONS

Image Classifiers – Supervised Learning – Maximum Likely Hood-Minimum Distance – Parallopiped-Support Vector Machines, Image Clustering – Unsupervised Learning – K-means Hierarchical and Partition Based Clustering Algorithms –ANN – Deep Learning Image Classifier.

Course Outcomes:

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

CO1: Implement basic image processing operations.

CO2: Apply and develop new techniques in the areas of image enhancement and frequency transforms.

CO3: To restore images from noise and to extract edges and boundaries.

CO4: Understand the image segmentation algorithms and Extract features from images.

CO5: Apply classifiers and clustering algorithms for image classification and clustering.

CO6: Design and develop an image processing application that uses different concepts of image processing.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2	1	2
CO2	2		3	2	2	2
CO3	2		3	2	1	2
CO4	3		3	2	1	2
CO5	3		2	2	3	3
CO6	3	1	3	3	2	1

References:

1. Rafael Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018
2. S. Sridhar, “Digital Image Processing”, Second Edition, Oxford University Press, 2016.
3. Forsyth and Ponce, “Computer Vision – A Modern Approach”, Second Edition, Prentice Hall, 2011.
4. Anil K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall Information , 2011 5. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing Analysis and Machine Vision”, Fourth Edition, Cengage India, 2017.

AM24D13	RECOMMENDER SYSTEMS	3 Credits

Course Description:

This course provides a thorough examination of Recommender Systems, starting with foundational concepts such as taxonomy, data mining methods, and the various functions and applications of these systems. It addresses collaborative filtering techniques, including user-based and item-based approaches, their comparisons, and the challenges, including attacks on collaborative systems. The course then explores content-based recommendation, focusing on system architecture, item profiles, feature extraction, and user profile learning. It continues with knowledge-based recommendation, covering constraint-based and case-based recommenders, and different hybridization approaches. Finally, the course covers methods for evaluating recommender systems, including evaluation designs, use of historical datasets, and community-based search, social tagging, and trust in recommendations.

Course Content:

UNIT I INTRODUCTION

Basic taxonomy of recommender systems - Data mining methods for recommender systems - Recommender system functions - Understanding ratings - Applications of recommendation systems - Issues with recommender system.

UNIT II COLLABORATIVE FILTERING

Nearest-neighbor collaborative filtering (CF). User-based and item-based CF, comparison, Components of neighborhood methods Hybrid recommender systems. Attacks on collaborative recommender systems.

UNIT III CONTENT-BASED RECOMMENDATION

High-level architecture of content-based systems - Advantages and drawbacks of content- based filtering, Item profiles - Discovering features of documents - Obtaining item features from tags - Representing item profiles - Methods for learning user profiles - Similarity based retrieval - Classification algorithms.

UNIT IV KNOWLEDGE- BASED RECOMMENDATION

Knowledge representation and reasoning – Constraint-based recommenders – Case-based recommenders - Hybrid approaches: Opportunities for hybridization - Monolithic hybridization design - Parallelized hybridization design - Pipelined hybridization design.

UNIT V EVALUATING RECOMMENDER SYSTEMS

Introduction - Evaluation designs - Evaluation on historical datasets - Community-Based Web Search - Social Tagging Recommenders Systems - Trust and Recommendations**.**

Course Outcomes:

At the end of the course, students will be able to

CO1: Develop an understanding of recommender systems and data mining techniques used.

CO2: Apply collaborative filtering techniques and addressing attacks on collaborative recommender systems.

CO3: Design content-based recommender systems using similarity retrieval or classification algorithms.

CO4: Employ knowledge representation and reasoning in recommender systems and opportunities for hybridization.

CO5: Evaluate and improve recommender systems for real-time application.

CO6: Develop state-of-the-art recommender systems**.**

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	1	3	
CO2	2		3	1	2	
CO3	3		3	2	2	
CO4	3	2	3	2	2	2
CO5	3	1	2	2	2	1
CO6	3	2		3	3	

References:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press(2011), 1st ed. 2.

2. C.C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.

3. F. Ricci, L Rokach, B. Shapira and P.B. Kantor, Recommender systems handbook, Springer 2010.

4. Schutze, Hinrich, Christopher D. Manning, and Prabhakar Raghavan. Introduction to information retrieval. Cambridge University Press, 2008.

5. Leskovec, Jure, Anand Rajaraman, and Jeffrey David Ullman. Mining of massive data sets. Second Edition, Dreamtech Press, 2016.

6. T.V.Geetha and S.Sendhilkumar, Machine Learning: Concepts,Techniques and Applications, First Edition, CRC Press, Taylor and Franics, 2023

AM24D14	COMPUTATIONAL OPTIMIZATION	3 Credits

Course Description:

This course focuses on the theory and application of optimization techniques, equipping students with both classical and modern methods for solving complex optimization problems. It covers a wide range of topics, including linear programming, dynamic programming, classical optimization techniques, and modern methods such as genetic algorithms and fuzzy systems. The course also delves into integer programming and practical applications of optimization in design and manufacturing systems. By integrating both theoretical and numerical methods, students will gain the ability to formulate and solve optimization problems in real-world engineering contexts.

Course Content:

Unit I: LINER PROGRAMMING (L.P)

Revised Simplex Method, Duel simplex Method, Sensitivity Analysis DYNAMIC PROGRAMMING (D.P): Multistage decision processes. Concepts of sub optimization, Recursive Relation-calculus method, tabular method, LP as a case of D.P.

Unit II: CLASSICAL OPTIMIZATION TECHNIQUES

Single variable optimization without constraints, Multi variable optimization without constraints, multivariable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions. NUMERICAL METHODS FOR OPTIMIZATION: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method.

Unit III: MODERN METHODS OF OPTIMIZATION: GENETIC ALGORITHM (GA)

Differences and similarities between conventional and evolutionary algorithms, working principle, Genetic Operators- reproduction, crossover, mutation GENETIC PROGRAMMING (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, Random population generation. Fuzzy Systems: Fuzzy set Theory, Optimization of Fuzzy systems.

Unit IV: INTEGER PROGRAMMING

Graphical Representation, Gomory's Cutting Plane Method, Balas' Algorithm for Zero–One Programming, Branch-and-Bound Method.

Unit V: APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS

Formulation of model- optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Course Outcomes:

At the end of the course student will be able to

CO 1: Apply linear programming techniques such as Revised and Dual Simplex Methods.

CO 2 Implement dynamic programming for multistage decision-making processes.

CO 3: Use classical optimization techniques with and without constraints, including Lagrange multipliers.

CO 4: Apply numerical optimization methods like Nelder Mead's Simplex, Steepest Descent, and Newton's method.

CO 5: Utilize modern optimization methods, including Genetic Algorithms (GA) and Genetic Programming (GP).

CO 6: Solve optimization problems in design and manufacturing systems, such as optimizing mechanisms and machining processes

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	2	2
CO2	2	3	3	2	2	2
CO3	3	2	3	2	2	2

CO4	3	3	3	2	2	2
CO5	3	3	3	3	3	2
CO6	3		2	3	3	

References:

1. Singiresu S. Rao, S. S. Rao, Engineering Optimization: Theory and Practice, 2009.
2. B Gupta ,Optimization Techniques in Operation Research, I.K.International House Pvt.Ltd 2007.
3. Godfrey C. Onwubolu, B. V. Babu,New Optimization Techniques in Engineering, 2004
4. Cesar Lopez,MATLAB Optimization Techniques,2014 Sherali, H.D., Shetty, C.M.,Optimization with Disjunctive Constraints,Springer,2016(e-book)

Cluster E: DATA ANALYTICS

AM24E11	SOCIAL NETWORK ANALYSIS	3 Credits

Course Description:

Social Network Analysis refers to the study conducted with an awareness of social networks, including connections with other analysts in the field. It involves examining relationships between individuals or groups to understand patterns and dynamics within social structures.

Course Content:

UNIT – I INTRODUCTION:

Social Network Analysis: Definition and Features – The Development of Social Network Analysis – Basic Graph Theoretical Concepts of Social Network Analysis – Ties, Density, Path, Length, 32 Distance, Betweenness, Centrality, Clique – Electronic Sources for Network Analysis – Electronic Discussion Networks, Blogs and Online Communities, Web-based Networks –Applications of Social Network Analysis.

UNIT-II SOCIAL NETWORK PROFILES:

Introduction to Social Networks Profiles – Types of Commercial Social Network Profiles(CSNP) – Quantitative and Qualitative Analysis of CSNP – Analysis of Social Networks Extracted from Log Files– Data Mining Methods Related to SNA and Log Mining–Clustering Techniques–Case Study.

UNIT – III SEMANTICS OF SOCIAL NETWORKS:

Introduction to Ontology based Knowledge Representation – Ontology Languages for the Semantic Web–RDF and OWL–Modeling Social Network Data – Network Data Representation, Ontological Representation of Social Individuals and Relationships–Aggregating and Reasoning with Social Network Data – Advanced Representations.

UNIT – IV SOCIAL NETWORK MINING:

Detecting and Discovering Communities in Social Network: Evaluating Communities–Methods for Community Detection – Trust factor- Applications of Community Mining Algorithms –Ethical Practices in Social Network Mining – Understanding and Predicting Human Behavior for Social Communities– Decentralized Online Social Networks–Multi-Relational Characterization of Dynamic Social Network Communities – Inferential Methods in Social Network Analysis.

UNIT – V VISUALIZATION AND APPLICATIONS OF SOCIAL NETWORKS:

Visualization of Social Networks Node-Edge Diagrams – Random Layout – Force-Directed Layout – Tree Layout – Matrix Representations –Matrix and Node-Link Diagrams – Hybrid Representations – Visualizing Online Social Networks – Applications – Covert Networks – Community Welfare – Collaboration Networks – Co-Citation Networks – Data Privacy in Social Networks.

Course outcomes:

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

CO1: Understand basic principles behind network analysis algorithms and develop practical skills in network analysis.
CO2: Model and represent knowledge for social semantic Web.
CO3: Apply datamining techniques on social networks.
CO4: Use extraction and mining tools for analyzing Social networks.
CO5: Develop secure social network applications.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	2	2
C05	3	3	2	2	3	3

References:

1. Peter Mika, “Social Networks and the SemanticWeb”,Springer, 2007.
2. BorkoFurht,“Handbook of Social Network Technologies and Applications”, Springer,2010
3. Song Yang, Franziska B.Keller, Lu Zheng, “Social Network Analysis: Methods and Examples”,Sage Publication,2016
4. GuandongXu,Yanchun Zhang, LinLi, “Web Mining and Social Networking Techniques and Applications”,Springer,2011.
5. MaxChevalier, Christine Julien, Chantal Soulé- Dupuy,“Collaborative and Social Information Retrieval and Access: Techniques for Improved User Modelling”, 33 IGIGlobal,2009.
6. John G. Breslin, Alexandre Passant, Stefan Decker, “The Social Semantic Web”,Springer,2009.
7. John Scott, Peter J. Carrington, “The SAGE Handbook of Social Network Analysis”,SagePublication, 2011.

AM24E12	BUSINESS DATA ANALYTICS	3 Credits

Course Description:

Business Data Analytics course provides an in-depth understanding of data analytics in business contexts, emphasizing analytical methods and tools used to extract insights from data for strategic decision-making.

Course Content:

UNIT I INTRODUCTION TO BUSINESS DATA ANALYTICS:

Overview of analytics in business - Types of data: structured vs. unstructured - Data lifecycle and management - Data Collection and Preparation - Data sources: internal and external - Data cleaning and preprocessing techniques - Introduction to data wrangling tools (Pandas, Excel).

UNIT II STATISTICAL METHODS FOR ANALYTICS:

Descriptive and inferential statistics - Hypothesis testing and confidence intervals - Correlation and regression analysis - Data Visualization Techniques - Principles of effective visualization - Tools for visualization (Tableau, Power BI, Matplotlib).

UNIT III INTRODUCTION TO MACHINE LEARNING:

Overview of machine learning in business - Supervised vs. unsupervised learning - Common algorithms: regression, classification, clustering - Predictive Analytics - Time series analysis - Forecasting methods- Applications in business (sales forecasting, demand planning).

UNIT IV PRESCRIPTIVE ANALYTICS:

Optimization techniques - Decision-making models - Case studies in supply chain and logistics- Big Data Technologies - Introduction to big data and its challenges - Tools and frameworks - Data storage and retrieval methods**.**

UNIT V ETHICS AND DATA PRIVACY:

Understanding data privacy regulations - Ethical considerations in data analytics - Best practices for responsible data use - Real-World Applications and Case Studies - Case studies from various industries**.**

Course outcomes:

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

CO1: Understand the fundamentals of business data analytics.
CO2: Learn statistical techniques and data visualization methods.
CO3: Apply machine learning algorithms to business problems.
CO4: Develop skills in using analytical tools and software.
CO5: Interpret and communicate analytical results effectively.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	3	2	2	3	3

References:

1. "Business Analytics: Data Analysis and Decision Making" by Albright & Winston
2. "Data Science for Business" by Provost & Fawcett
3. Online resources: Coursera, edX courses related to data analytics

AM24E13	**DATA MINING TECHNIQUES**	**3 Credits**

Course Description:

The Data Mining Techniques course offers a comprehensive exploration of methodologies used to extract valuable insights from large datasets. Students will learn foundational concepts, including data preprocessing, clustering, classification, association rule mining, and anomaly detection. The course emphasizes practical applications of these techniques using tools such as Python and R, alongside real-world case studies across various industries. By the end of the course, students will be equipped with the skills to identify patterns and trends in data, facilitating informed decision-making in business and technology contexts.

Course Content:

UNIT I DATA MINING CONCEPTS:

Introduction to Data Mining – Data Mining Functionalities – Classification of Data Mining Systems, Data Mining Task Primitives-Integration of Data Mining With Database- Major Issues in Data Mining.

UNIT II FREQUENT PATTERN MINING:

Basic Concepts – Market Basket Analysis - Efficient and Scalable Frequent Item Set Mining Methods – The Apriori Algorithm – Frequent Pattern Growth Algorithm-Various Kinds of Association Rules-Association Mining to Correlation Analysis.

UNIT III CLASSIFICATION AND PREDICTION:

Classification - Issues Regarding Classification and Prediction -Decision Tree Induction- Bayesian Classification - Rule-Based - Accuracy and Error Measures.

UNIT IV CLUSTER ANALYSIS:

Types of Data in Cluster Analysis - Major Clustering Methods- The K-Means Method. Similarity and Distance Measures- Hierarchical Algorithms- Partitioning Algorithms- Clustering Large M.Tech-SE Page 93 Databases- Clustering with Categorical Attributes.

UNIT V OUTLIER ANALYSIS:

Outlier Analysis- Distance-Based Outlier Detection- Density-based Local Outlier Detection - Contemporary issues: Applications of data mining techniques in industry.

Course outcomes:

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

CO1: Understand the basics of data techniques and their applications real world scenarios.

CO2: Apply frequent pattern analysis in business analytics

CO3: Design appropriate classification techniques and association rule generation.

CO4: Comprehend clustering techniques and discover the knowledge imbibed in the high dimensional system.

CO5: Comprehend and use the specific clustering approaches.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	2	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	2	2	2	2	3

References:

1. J. Han and M. Kamber. Data Mining: Concepts and Techniques- 3rd Edition. Morgan Kaufman. 2011.
2. Pang-Ning Tan , Michael Steinbach and Vipin Kumar. Introduction to Data Mining, Pearson, 2014.
3. M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.

AM24E14	PREDICTIVE ANALYTICS	3 Credits

Course Description:

This course delves into the methodologies and tools used for predictive modeling and forecasting. It emphasizes practical applications and the use of various algorithms to analyze historical data and predict future outcomes.

Course Content:

UNIT – I INTRODUCTION TO PREDICTIVE ANALYTICS

Overview of predictive analytics and its importance - Types of predictive models: classification vs. regression - Data types and structures - Data Preprocessing and Exploration - Data cleaning and preparation techniques - Exploratory Data Analysis (EDA) methods - Feature engineering and selection.

UNIT – II REGRESSION ANALYSIS

Simple and multiple linear regression - Assumptions and diagnostics of regression models - Time Series Forecasting - Components of time series data - Techniques for forecasting: ARIMA, Exponential Smoothing - Seasonality and trend analysis.

UNIT – III CLASSIFICATION TECHNIQUES

Overview of classification algorithms - Logistic Regression- Decision Trees – SVM - Performance metrics: accuracy, precision, recall, F1-score - Model tuning and validation techniques - Advanced Machine Learning Algorithms - Ensemble methods: Random Forests, Gradient Boosting.

UNIT – IV MODEL EVALUATION AND SELECTION

Cross-validation techniques - Bias-variance trade-off - ROC curves and AUC for model assessment.

UNIT – V PREDICTIVE ANALYTICS IN BUSINESS

Case studies in marketing, finance, and operations- Implementing predictive analytics projects - Ethical considerations in predictive modelling - Tools and Software for Predictive Analytics - Overview of tools: Python libraries -Scikit-learn -TensorFlow.

Course outcomes:

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

CO1: Understand the fundamental concepts of predictive analytics.

CO2: Learn statistical and machine learning techniques for prediction.

CO3: Develop skills in data preprocessing, feature selection, and model evaluation.

CO4: Apply predictive models to real-world scenarios across different industries.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	1	2

References:

1. "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel
2. "Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst" by Dean Abbott

Cluster E: IoT & ROBOTICS

AM24F11	BUILDING IoT SYSTEMS	3 Credits

Course Description:

Building IoT Systems course provides an in-depth exploration of the principles and technologies involved in designing and building Internet of Things (IoT) systems. Students will learn about the entire IoT ecosystem, from hardware components to cloud integration and data analysis.

Course Content:

Unit I: EVOLUTION OF THE INTERNET

Things/Real World Objects – Smart Objects – Technology Enablers of Iot – Device Layer – Role of WSNs In IoT - Edge/Fog Layer – Role of Cloud In IoT – Possible IoT Reference Models - M2M Communication – Domain Specific IoTs – Complexity and Levels of IoT Based Systems – IoTand Industry 4.0.

Unit II: DEVICE LAYER

Microprocessors Vs. Microcontrollers – Open-Source Movement in Hardware – Engineering Vs Prototyping – Software Development Lifecycle for Embedded Systems – Arduino IDE – Programming and Developing Sketches – Arduino Rest Apis – Raspberry PI– Interfaces – Python Packages of Interests for IoT – Emerging Microcontrollers and Platforms for Building IoT Systems.

Unit III: DEVELOPING IOT SYSTEMS

Requirements and Process Specifications – Domain Model and Information Model – Service and Level Specifications – Functional View and Operational View – Device-Component Integration – Application Development – Models of Communication – HTTP, Coap, MQTT and Websocket Protocols – SDN and NFV for IoT.

Unit IV: CLOUD OFFERINGS AND ANALYTICS

Cloud Storage Models and Communication API – WAMP Autobahn – Xively Cloud – Python Web Application Framework – Django–IBM Watson – AWS for IoT - Map Reduce Programming Model, Job Execution and Work Flow, Cluster Setup – Lambda Architecture – Apache Hadoop – REST Based and Websocket Based Approaches in Apache Storm.

Unit V: IoT MANAGEMENT & CASE STUDIES

IoT Systems Management – SNMP – NETCONF – YANG – Case Studies: Home Automation, Smart Cities, Weather Monitoring System, Forest Fire Monitoring, Air Pollution Monitoring – Smart Irrigation.

Course outcomes:

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

CO1: Understand the evolution of the Internet and the impact of IoT in the society.

CO2: Design portable IoT devices using Arduino IDE/ Raspberry Pi with Python.

CO3: Apply appropriate protocols in various parts of IoT based systems.

CO4: Use cloud offerings and big data tools in IoT based systems.

CO5: Implement Map-Reduce based programs using Apache frameworks.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	2	2
CO5	3	3	2	2	3	3

References :

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A Hands-On Approach”, Universities Press, 2015.
2. Manoel Carlos Ramon, “Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014.
3. David Hanes, Gonzalo Salguerio, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for Internet of

Things", Cisco Press, 2017.

4. Perry Lea, "Internet of Things for Architects", PACKT, 2018.
5. Andy King, "Programming the Internet of Things: An Introduction to Building Integrated, Device to Cloud IoT solutions", O'REILLY', 2021

AM24F12	BIO-INSPIRED LEARNING ALGORITHMS	3 Credits

Course Description:

Bio-Inspired Learning Algorithms course explores bio-inspired algorithms and their application in machine learning and optimization. Students will study algorithms modeled after natural processes, such as genetic algorithms, swarm intelligence, and neural networks, and how these techniques can solve complex problems in various domains.

Course Content:

Unit I: ARTIFICIAL NEURAL NETWORKS

Pattern classification – Single and Multilayer perceptrons – Backpropagation – Pattern Association – Hebbian learning – Hopfield networks – Bidirectional Associative Memory Networks – Competitive learning – Kohenen's Self Organizing Maps.

Unit II: GENETIC ALGORITHMS

Representation – Reproduction – Crossover and Mutation Operators – Crossover and Mutation rates – Selection mechanisms – Fitness proportionate – ranking and tournament selection – Building Block – Hypothesis and Schema Theorem.

Unit III: SWARM INTELLIGENCE

Stigmergy – Competition and Cooperation – Particle Swarm Optimization – Anatomy of a particle – Velocity and Position updation– PSO topologies – Control parameters –Ant Colony Optimization – Pheromone updation and evaporation.

Unit IV: ARTIFICIAL NEURAL NETWORKS

Biological inspiration behind neural networks - Basic concepts: neurons, activation functions, and architectures - Deep learning overview and its relevance - Fuzzy Logic and Neuro-Fuzzy Systems - Introduction to fuzzy logic principles - Fuzzy inference systems and their applications.

Unit V: BIO-INSPIRED TECHNIQUES

Overview of bio-inspired algorithms - bee algorithms- firefly algorithms- Comparison and evaluation of algorithm performance - ase studies in various domains- Optimization Techniques - Applying bio-inspired algorithms for optimization problems - Analyzing case studies in fields such as robotics, finance, and healthcare.

Course outcomes:

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

CO1: Understand the principles and mechanisms of bio-inspired algorithms.

CO2: Analyze the strengths and limitations of different algorithms.

CO3: Apply bio-inspired techniques to real-world problems.

CO4: Gain hands-on experience through projects and simulations.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	3	2	3	2	2	2
CO3	2	1	3	2	2	2
CO4	3	2	3	2	1	2

References :

1. Goldberg, , ” Genetic algorithms in search optimization and machine learning”, Addison Wesley, 1999
2. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.
3. "Genetic Algorithms in Search, Optimization, and Machine Learning" by David E. Goldberg
4. "Swarm Intelligence: From Natural to Artificial Systems" by Eric Bonabeau, Marco Dorigo, and Guy Theraulaz

AM24F13	ETHICS OF AI AND ROBOTICS	3 Credits

Course Description:

Ethics of AI and Robotics course explores the ethical implications of artificial intelligence and robotics technologies, focusing on the societal, legal, and moral challenges they present. Students will engage

with philosophical frameworks and case studies to critically analyze the impact of AI and robotics on individuals and society.

Course Content:

Unit I: INTRODUCTION

Definition of morality and ethics in AI-Impact on society-Impact on human psychology-Impact on the legal system-Impact on the environment and the planet-Impact on trust.

Unit II: ETHICAL INITIATIVES IN AI

International ethical initiatives-Ethical harms and concerns-Case study: healthcare robots, Autonomous Vehicles , Warfare and weaponization.

Unit III: AI STANDARDS AND REGULATION

Model Process for Addressing Ethical Concerns During System Design - Transparency of Autonomous Systems-Data Privacy Process- Algorithmic Bias Considerations - Ontological Standard for Ethically Driven Robotics and Automation Systems.

Unit IV: ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS

Robot-Roboethics- Ethics and Morality- Moral Theories-Ethics in Science and Technology - Ethical Issues in an ICT Society- Harmonization of Principles- Ethics and Professional Responsibility Roboethics Taxonomy.

Unit V: AI AND ETHICS- CHALLENGES AND OPPORTUNITIES

Challenges - Opportunities- ethical issues in artificial intelligence- Societal Issues Concerning the Application of Artificial Intelligence in Medicine- decision-making role in industries-National and International Strategies on AI.

Course outcomes:

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

CO1: Understand key ethical theories and their application to AI and robotics.

CO2: Analyze ethical dilemmas and societal implications related to AI technologies.

CO3: Evaluate current policies, regulations, and guidelines affecting AI and robotics.

CO4: Develop frameworks for responsible design and deployment of AI systems.

Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	1	2
CO2	3	2	2	2	3	2
CO3	2	1	3	2	1	2
CO4	3	2	3	2	1	2

References :

1. Y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp and Alan Winfield ,The ethics of artificial intelligence: Issues and initiatives, EPRS | European Parliamentary Research Service Scientific Foresight Unit (STOA) PE 634.452 – March 2020
2. Patrick Lin, Keith Abney, George A Bekey, Robot Ethics: The Ethical and Social Implications of Robotics, the MIT Press- January 2014.
3. "AI Ethics" by Mark Coeckelbergh

VII. AUDIT COURSE: (0 credit)

Refer to Swayam – MOOC Syllabus

VIII. OPEN ELECTIVE: (3 credits)

Refer SWAYAM – MOOC Syllabus.

IX. INTERNSHIP PROGRAMME: (4 credits)

Refer to PG Regulations 2024.

X. PROJECT DISSERTATION:

i. Project Phase I (12 credits)

ii. Project Phase II (16 credits)

Refer to PG Regulations 2024.