SEMESTER V

MAJOR SUBJECTS

COURSE TITLE: Evolutionary Computing

Course Code:	IMDAMJEC0524					Examination Scheme	
Total number of Lecture Hours: 56						External	80
						Internal	20
Lecture(L):	4	Practicals (P):	0	Tutorial(T):	0	Total Credits	4

Course Objectives

1. Implement and analyze a family of evolutionary algorithms, including genetic algorithms and evolutionary strategies.
2. Understand the implementation issues of evolutionary algorithms.
3. Compare and contrast the performance of different evolutionary algorithms in a statistically meaningful way.
4. Apply genetic and other evolutionary algorithms to a variety of practical problems.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Evolutionary Computing	14 Hrs
Overview of Evolutionary Computing- Evolutionary Algorithms, Evolutionary Search Techniques, Principles of Genetic Algorithms, Encoding schemes and Representation. Selection, Crossover, and Mutation Operators.	
UNIT 2: Evolutionary Strategies	14 Hrs
Evolutionary Strategies: Evolution in continuous variables. Transformations. Covariance Matrix Adaptation. Different Components of Evolutionary Algorithms- Framework, Populations, Selection operators, Genetic operators. Genetic Programming, Differential Evolution	
UNIT 3: Selection Methods	14 Hrs
Selection Mechanisms: Fitness proportionate, rank, tournament, Stochastic Universal Sampling and Boltzman selection methods. Niching methods. Spatial methods. Co-evolution: Multiple populations and single-population co-evolution. Tabu Search. Handling Constraints, Evolutionary Multi-objective optimization. Hyper-Heuristics.	
UNIT 4: Advanced Topics in Evolutionary Computing	14 Hrs
Ensemble Evolutionary Algorithm. Evolutionary Machine Learning. Swarm Intelligence Techniques: Particle Swarm Optimization, Ant Colony Optimization. Hybridization and Comparisons of Swarm Techniques, Applications of Evolutionary Algorithms in Different Domains and Real World Problems.	

To be effective from year-2024

Textbooks

1. Eiben, A. E., and J. E. Smith. "*Introduction to Evolutionary Computing*". 2nd ed., Springer, 2015.
2. Yang, Xin-She, and S. S. S. J. Deb. "*Nature-Inspired Optimization Algorithms*". 1st ed., Elsevier, 2021.
3. Michalewicz, Zbigniew, and Janusz M. Z. "*Evolutionary Computation 1: Basic Algorithms and Operators*". 2nd ed., Springer, 2019.

Reference Books

1. Bäck, Thomas, et al. "*Evolutionary Computation: A Unified Approach*". 1st ed., MIT Press, 2018.
2. Cantu-Paz, Eduardo. "*Genetic Algorithms in Search, Optimization, and Machine Learning*". 1st ed., Addison-Wesley, 2020.
3. Sivanandam, S. N., and S. N. Deepa. "*Introduction to Genetic Algorithms*". 2nd ed., Springer, 2019.

COURSEOUTCOMES(CO):

CO1: Explain the fundamental principles and mechanisms of evolutionary algorithms, including genetic algorithms, evolutionary strategies, and genetic programming.
CO2: Develop and implement evolutionary algorithms to solve complex optimization problems.
CO3: Analyze and evaluate the performance of evolutionary algorithms using metrics and comparative studies.
CO4: Apply evolutionary computing techniques to real-world problems, including multi-objective optimization and adaptive systems.
CO5: Communicate effectively the results of evolutionary computing experiments through reports and presentations.

LEVEL OF CO-PO MAPPING TABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	2	2	1	1	2	1	1	1	1	1	1	1
2	2	3	2	2	3	2	1	1	1	1	1	1
3	1	3	2	2	2	1	1	1	1	1	1	1
4	2	2	3	3	3	1	1	1	1	2	1	1
5	1	1	1	1	1	1	1	1	1	3	1	1

COURSE TITLE: Probability Theory

Course Code:		**IMDAMJPT0524**				**Examination Scheme**	
Total number of Lecture Hours:56						**External**	**80**
						Internal	**20**
Lecture(L):	**4**	**Practicals (P):**	**0**	**Tutorial(T):**	**0**	**Total Credits**	**4**

Course Objectives

- Understand the basic principles of probability theory and conditional probability.
- Study random variables and key probability distributions.
- Learn sampling distributions and hypothesis testing methods.
- Apply statistical significance tests.

Course Content	TEACHING HOURS
UNIT1:Fundamentals of Probability	-Hrs
Probability: Sample space and events – Probability – The axioms of probability – addition law of probability – Conditional probability – Bayes' theorem. **Counting Techniques:** Permutations and combinations, applications in probability, discrete probability: finite and countably infinite sample spaces, inclusion-exclusion principle.	14
UNIT2:Random Variables and Distributions	-Hrs
Random Variables: Discrete and Continuous, Probability Mass Function (PMF), Probability Density Function (PDF), and Cumulative Distribution Function (CDF)– Distribution - Binomial, poisson. Geometric and normal distribution.	14
UNIT3:SamplingDistributionsandHypothesisTesting	-Hrs
Sampling distribution: Populations and samples - Sampling distributions of mean (known and unknown) proportions, sums, and differences. Test of Hypothesis – Means and proportions – Hypothesis concerning one and two means – Type I and Type II errors. One tail, two-tail tests.	14
UNIT4:TestsofSignificanceandMarkovChains	-Hrs
Tests of significance: Test of significance forattributes: Test for number of successes, Test for proportion of successes & Test for difference between proportions. Student'st-test:Testthesignificanceofmean,difference between means of two samples (Independent & dependent sample), chi-square test and goodness of fit, ANOVA test.	14

Textbooks

1. A First Course in Probability by Sheldon Ross, 10th Edition (2020), Pearson Education.
2. Probability and Statistics by Ravichandran J., 3rd Edition (2020), Wiley India.
3. Introduction to Probability and Statistics by William Mendenhall, Robert J. Beaver, and Barbara M. Beaver, 15th Edition (2020), Cengage Learning.

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Reference Books

1. Schaum's Outline of Probability and Statistics by John Schiller, R. Alu Srinivasan, and Murray Spiegel, 5th Edition (2021), McGraw Hill Education.
2. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying Ye, 10th Edition (2021), Pearson Education.

COURSE OUTCOMES (CO):

CO1: Apply probability laws to real-world scenarios.
CO2: Analyze and use discrete and continuous probability distributions.
CO3: Perform hypothesis testing and interpret Type I and Type II errors.
CO4: Conduct significance tests and work with Markov Chain models.

LEVELOFCO-POMAPPINGTABLE

COs	POs											
	1	2	1	4	1	6	1	8	1	10	1	12
1	2	1	2	1	2	1	2	1	2	1	2	1
2	1	2	1	2	1	2	1	2	1	2	1	2
3	1	3	1	3	1	3	1	3	1	3	1	3
4	1	3	1	3	1	3	1	2	1	2	1	2

To be effective from year-2024

COURSE TITLE: Machine Learning

Course Code:	IMDAMJML0524				Examination Scheme	T	P
Total number of Lecture Hours: 42 Total number of Practical Hours: 28					External	80	-
					Internal	20	-
Lecture(L):	3	Practical(P):	1	Tutorial(T):	Total Credits	4	

Course Objectives:

- Equip students with a deep understanding of core machine learning techniques, including clustering, classification, with a focus on both theoretical concepts and practical implementations.
- Comprehend the basic principles of inductive learning and explore different categories of inductive learning algorithms.
- Learn to implement key inductive learning algorithms such as Decision Trees (ID3), AQ algorithm.
- Learn to implement and compare ensemble methods to single models, understanding the advantages of ensemble learning.
- Enable students to apply machine learning algorithms to analyze data, build predictive models, and evaluate their performance using appropriate metrics.

Course Content	TEACHING HOURS
UNIT 1:Inductive Learning	14 Hrs
Inductive learning algorithms. Categories of inductive learning algorithms. Rule extraction with inductive learning algorithms, Decision trees, ID3 algorithm. AQ algorithm, SAFARI algorithm Applications of Inductive Learning Machine Learning: Supervised, Unsupervised and Reinforcement Learning, Applications. **Introduction to Classification**: Overview, types of classification problems, binary vs. multi-class classification. Linear Regression, Logistic Regression.	
UNIT 2: Clustering Techniques	14 Hrs
Introduction to Clustering: Definition, types of clustering (hard vs. soft), applications, and importance. **K-Means and Variants**: K-means algorithm, choosing the number of clusters (elbow method), K-means++. **Hierarchical Clustering**: Agglomerative and divisive methods, dendrograms, linkage methods (single, complete, average), and practical applications. **Density-Based Clustering**: DBSCAN, and comparison with K-means and hierarchical methods.	

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UNIT 3:Ensemble Learning Methods	14 Hrs
Ensemble Learning: Definition and motivation for ensemble methods, Types of ensemble methods, Advantages of ensemble learning over single models. **Bagging and Random Forests:** Bootstrap Aggregating (Bagging) concept, Random Forests: construction, feature selection, and out-of-bag error estimation, Comparison of Random Forests with Decision Trees. **Boosting Techniques:** Overview of boosting, AdaBoost: algorithm, weight updates, and practical considerations, Gradient Boosting Machines (GBM): concept, learning rate, and overfitting prevention.	

LAB Manual

1. Installing a Python Distribution
2. Familiarization with NumPy, Pandas, Matplotlib, scikit-learn, SciPy
3. Write a python program to import and export data using Pandas library functions
4. Write a Python program to demonstrate various Data Visualization Techniques.
5. Demonstrate various data pre-processing techniques for a given dataset
6. Working with Google Colab
   Understanding what Google Colab does
   Working with Notebooks
   Performing Common Tasks
7. Create a Linear Regression Model using Python/R to predict home prices using Boston Housing Dataset (https://www.kaggle.com/c/boston-housing). The Boston Housing dataset contains information about various houses in Boston through different parameters. There are 506 samples and 14 feature variables in this dataset.
   The objective is to predict the value of prices of the house using the given features.
8. Implement logistic regression using Python/R to perform classification on the dataset of your choice
   - Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given dataset.
9. Implement a Decision Tree classifier using ID3 algorithm, Visualize the tree and evaluate its performance on a dataset.
10. Extract rules from a decision tree trained on a dataset (like the Iris dataset). Convert the tree structure into a set of IF-THEN rules.
11. Implement the K-means algorithm from scratch.Visualize clusters on a 2D dataset.
12. Modify the K-means algorithm with K-means++ for better centroid initialization.Compare the results with standard K-means.
13. Implement agglomerative clustering with different linkage methods (single, complete, average). Generate and plot dendrograms.
14. Implement a random forest classifier, perform feature selection, and analyze its performance on a dataset.Visualize the importance of features and compare the random forest to a single decision tree.

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Textbooks

1. Introduction to Machine Learning by Ethem Alpaydin, MIT Press4th Edition (2020)
2. Pattern Classification by Duda and Hart. John Wiley publication 2nd Edition.
3. Tom M. Mitchell, "Machine Learning", McGraw-Hill, 2010

Reference Books

1. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer1st Edition (2006)
2. Machine Learning: A probabilistic Perspective, by Kevin P. Murphy, MIT Press1st Edition (2012)
3. Introduction to Machine Learning by Ethem Alpaydin, MIT Press, 4th Edition (2020)
4. Pattern Classification by Duda and Hart. John Wiley publication, 2nd Edition (2000)
5. The Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer, 2nd Edition (2009)

COURSEOUTCOMES(CO):

CO1: Apply inductive learning algorithms such as Decision Trees, ID3, and AQ for rule extraction and classification.

CO2: Implement and evaluate clustering techniques like K-Means, Hierarchical Clustering, and DBSCAN for data segmentation.

CO3: Develop ensemble models using Bagging, Random Forests, and Boosting for enhanced predictive accuracy.

CO4: Differentiate between supervised, unsupervised, and reinforcement learning to solve real-world problems effectively.

LEVELOFCO-PO MAPPINGTABLE

COs	Pos											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	2	2	3	1	-	-	2	1	-	2
2	3	3	2	2	3	1	-	-	1	1	-	2
3	3	3	3	3	3	2	-	1	2	1	1	3
4	3	3	3	3	3	1	1	1	2	2	2	3

To be effective from year-2024

COURSE TITLE: Cloud Computing

Course Code:	IMDAMJCC0524					Examination Scheme	
TotalnumberofLectureHours:56						External	80
						Internal	20
Lecture(L):	4	Practicals (P):	0	Tutorial(T):	0	Total Credits	4

Course Objectives

- Understand core cloud computing concepts and service models.
- Gain practical skills in deploying and managing cloud applications.
- Understand how to manage cloud service performance, reliability, and security.
- Analyze the cost and benefits of different cloud platforms.

Course Content	TEACHING HOURS
UNIT1:CLOUD COMPUTING FUNDAMENTALS	–Hrs
Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds. Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.	14
UNIT2:VIRTUALIZATIONANDCLOUDAPPLICATIONS	–Hrs
VIRTUALIZATION: Role of virtualization in enabling the cloud: Types of Virtual Machines, Advantages of Virtualization, Components of Virtualization. **CLOUD APPLICATIONS:** Technologies and the processes required when deploying web services; Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages.	14
UNIT3: MANAGEMENT OF CLOUDSERVICES	–Hrs
Reliability, availability, and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment. **Cloud Economics:** Cloud computing infrastructures available for implementing cloud-based services. Economics of choosing a cloud platform for an organization, based on application requirements, economic constraints, and business needs (e.g., Amazon, Microsoft, Google, Salesforce.com, Ubuntu, and Red Hat).	14
UNIT4:APPLICATION DEVELOPMENT	–Hrs
Application Development: Design and implementation in cloud environments. Development Platforms: AWS, Azure, Google App Engine. Deployment and Management Strategies for cloud applications.	14

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Textbooks

1. Gautam Shroff, "Enterprise Cloud Computing: Technology, Architecture, Applications," Cambridge University Press; 2nd Edition [ISBN: 9780521137355], 2023.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach," McGraw-Hill Education; 2nd Edition [ISBN: 9780071826400], 2022.
3. Dimitris N. Chorafas, "Cloud Computing Strategies," CRC Press; 2nd Edition [ISBN: 9780367338611], 2021.

Reference Books

1. Thomas Erl, "Cloud Computing: Concepts, Technology & Architecture," Prentice Hall; 3rd Edition [ISBN: 9780133994164], 2024.
2. Rajkumar Buyya, Christian Vecchiola, and Selvi, S. Thamarai, "Mastering Cloud Computing: Foundations and Applications Programming," Morgan Kaufmann; 3rd Edition [ISBN: 9780128180747], 2022.

COURSE OUTCOMES (CO):

CO1: Explain cloud computing principles and service models.

CO2: Successfully deploy and manage cloud-based applications.

CO3: Apply best practices for cloud service management.

CO4: Assess the economic aspects of cloud computing platforms.

LEVELOFCO-POMAPPINGTABLE

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	1	2	3	1	2	-	1	2	-
2	2	3	2	3	3	2	1	1	2	2	1
3	1	2	3	2	2	3	3	1	3	1	2
4	2	1	2	3	1	2	1	3	1	3	3

MINOR SUBJECTS

To be effective from year-2024

COURSETITLE:DATA MINING

Course Code:	IMDAMNDM0524					Examination Scheme	
Total number of LectureHours:56						External	80
						Internal	20
Lecture(L):	4	Practicals (P):	0	Tutorial(T):	0	Total Credits	4

Course Objectives

- Ability to understand the data mining process techniques and various data pre-processing techniques.
- Characterize the various kinds of patterns that can be discovered by association rule mining and learn different prediction, classification, and clustering algorithms.
- Study the knowledge representation methods and the various attributes.
- Analyze and distinguish different data mining techniques for different applications.

Course Content	TEACHING HOURS
UNIT1: Introduction to Data Mining	- Hrs
Introduction to Data Mining: Data, Types of Data. Data Mining Functionalities. Classification of Data Mining systems. Stages of the Data Mining Process. **Data Pre-processing:** Data Cleaning, Data Integration, Data Reduction, Data Transformation, Data Discretization. **Data Warehouse and DBMS:** Integration of Data Mining systems with a Data Warehouse. Major issues in Data Mining.	14
UNIT2: Classification And Prediction	-Hrs
Basic issues regarding classification and prediction, Comparison of Classification and Prediction Methods. Classification by Decision Tree, Bayesian classification classification by back propagation, Associative classification, Statistical-Based Algorithms, Prediction, Accuracy and Error Measures, Rule-Based Algorithms Other Classification Methods.	14
UNIT3: Cluster Analysis	-Hrs
Cluster analysis, types of data, computing distances, types of cluster analysis methods: partitioned methods, hierarchical methods, density-based methods. Dealing with large databases. Quality and validity of cluster analysis methods. Cluster analysis software.	14
UNIT4:AdvancedConcepts	-Hrs
Basic concepts in mining data streams. Mining Time–series data. Mining sequence patterns in Transactional databases. Mining Object, Spatial, Multimedia, Text and Web data. Spatial Data mining, Multimedia Data mining, Text Mining, Mining the World Wide Web.	14

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Textbooks

1. Han, Jia, Micheline Kamber, and Jian Pei. "Data Mining: Concepts and Techniques." 4th ed., Morgan Kaufmann, 2022.
2. Larose, Daniel T., and Chantal D. Larose. "Data Mining and Data Visualization: A Practical Guide for Decision Makers." 1st ed., Wiley, 2022.
3. Weiss, Samuel M., and Nitin Indurkhya. "Predictive Data Mining: A Practical Guide." 2nd ed., Morgan Kaufmann, 2019.

Reference Books

1. Fayyad, Usama M., Gregory P. Shapiro, and Padhraic Smyth, editors. "Advances in Knowledge Discovery and Data Mining." 1st ed., AAAI Press, 1996.
2. Jain, Anil K., et al. "Data Mining: Concepts and Techniques." 1st ed., Springer, 2021.
3. Aggarwal, Charu C. "Data Mining: The Textbook." 1st ed., Springer, 2015.

COURSE OUTCOMES (CO):

CO1: Ability to understand the types of the data to be mined and present a general classification of tasks and primitives to integrate a data mining system.
CO2: Apply preprocessing methods for any given raw data.
CO3: Extract interesting patterns from large amounts of data.
CO4: Discover the role played by data mining in various fields.

LEVELOFCO-POMAPPINGTABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2	2	1	2	1	1	1	1	2	1	2
2	3	2	2	2	3	1	1	1	2	2	1	2
3	3	3	2	2	3	2	1	2	2	2	2	2
4	2	2	2	2	2	2	1	2	2	2	2	3

To be effective from year-2024

SEMESTER VI

To be effective from year-2024

MAJOR SUBJECTS

To be effective from year-2024

COURSE TITLE: Deep Learning Essentials

Course Code:	**IMDAMJDL0624**					**Examination Scheme**	**T**	**P**
Total number of Lecture Hours: 56 **Total number of Practical Hours: -**						**External**	**80**	**-**
						Internal	**20**	**-**
Lecture(L):	**4**	**Practical(P):**	**-**	**Tutorial(T):**	**-**	**Total Credits**	**4**	

Course Objectives

- To provide a comprehensive understanding of deep learning principles, including the distinction between shallow and deep architectures.
- To equip students with the skills to design, implement, and train artificial neural networks (ANNs) and convolutional neural networks (CNNs) for various applications.
- To introduce students to advanced deep learning architectures, techniques, and challenges.

Course Content	**TEACHING HOURS**
UNIT I	**14 Hrs**
Deep Learning- Historical Overview, Importance and Applications, Deep Learning vs. Traditional Machine Learning, Key Deep Learning Terminology, Shallow Architectures and Deep Architectures, Deep Learning Basics: Biological Neural Network, Artificial Neural Networks, Neuron as a basic building element of ANN, Activation Functions, Perceptron, learning with Perceptron, Limitations of Perceptron, Multilayer neural network, Learning with Multilayer Perceptron, Training ANN using Backpropagation algorithm	
Unit II	
Bayesian Classifiers: Naive Bayes, assumptions, advantages, limitations, and Bayesian networks. **Support Vector Machines (SVM):** SVM for linearly separable data, kernel methods for non-linearly separable data, hyperplane and margin concepts. **K-Nearest Neighbors (KNN):** KNN algorithm, choice of K, distance metrics, and performance optimization.	

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UNIT III	14 Hrs
Introduction to Dimensionality Reduction: Importance, challenges of high-dimensional data, and the curse of dimensionality. **Principal Component Analysis (PCA)**: Eigenvalues, eigenvectors, explained variance, and interpretation of PCA components. **Linear Discriminant Analysis (LDA)**: Fisher's criterion, maximizing class separability, and LDA vs. PCA. **Feature Selection Methods**: Filter methods, wrapper methods, and embedded methods.	
UNIT IV	**14 Hrs**
Loss Functions, Hyper parameters, Vanishing and Exploding Gradient Regularization Techniques: L1 and L2 regularization, Dropout, Batch Normalization, Convolutional Neural networks: Convolution Operation, Pooling, Advanced Convolutional Architectures: AlexNet, Visual Geometry Group, Residual Networks, Inception Networks and recent trends. Deep Learning in Iris, Fingerprint and Face Recognition	

Textbooks:

1. Deep Learning by Ian GoodFellow, MIT Press.2016
2. Advanced Deep Learning with Python, Ivan Vasilev, 2019
3. Advances in Deep Learning, M. Arif Wani, 2019

Reference Books:

1. Deep Learning with Python, Francois Chollet, 2ndedition, 2021
2. Deep Reinforcement Learning Hands-On, MaximLapan, 2ndedition, 2020
3. Automated Machine Learning Methods, Systems, Challenges, 2019
4. Deep Learning: A Visual Approach, Andrew Glassner, 2021
5. Selected Journal and Conference Papers.

COURSEOUTCOMES(CO):

CO1: Differentiate between traditional machine learning and deep learning, and explain the importance and applications of deep learning.

CO2: Implement and train artificial neural networks (ANNs) using multilayer perceptrons and backpropagation, and address challenges like vanishing/exploding gradients.

CO3: Apply regularization techniques, design and analyze convolutional neural networks (CNNs), and explore advanced architectures like ResNet and Inception Networks.

To be effective from year-2024

LEVELOFCO-PO MAPPINGTABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2	2	2	2	1	1	-	1	1	-	2
2	3	3	2	2	3	-	1	-	1	1	1	3
3	3	3	3	3	3	-	1	1	2	2	2	3

To be effective from year-2024

COURSE TITLE: Calculus

Course Code:	IMDAMJCC0624					Examination Scheme	
Total number of Lecture Hours: 56						External	80
						Internal	20
Lecture(L):	4	Practicals (P):	0	Tutorial(T):	0	Total Credits	4

Course Objectives

1. Understand the foundational concepts of calculus and its application in computer science.
2. Learn about limits, derivatives, and integrals and their use in optimization problems.
3. Explore multi-variable calculus and its application in machine learning and algorithms.
4. Understand series, sequences, and their applications in algorithm analysis.

Course Content	TEACHING HOURS
UNIT 1:Introduction to Differential Calculus	--Hrs
Limits and Continuity: Definitions, techniques for finding limits, L'Hopital's Rule, and understanding the concept of continuity. **Applications:** Finding limits in optimization and machine learning algorithms. Derivatives and Their Interpretations: Basic rules of differentiation (power, product, quotient, chain rules), higher-order derivatives. Optimization problems in computer science (e.g., gradient-based methods in machine learning, finding maxima and minima in algorithms).	14
UNIT 2: Integral Calculus	-Hrs
Definite and Indefinite Integrals: Understanding integration as an inverse of differentiation, rules of integration. **Techniques:** Substitution, integration by parts, partial fraction decomposition. Practical Applications: Solving accumulation problems, calculating areas, and volumes in physical simulations. **Applications in Computer Science:** Using integrals in graphics (computing the area under curves), data compression, and algorithms.	14
UNIT 3:Multi-variable Calculus	-Hrs
Functions of Several Variables: Understanding and visualizing functions of two or more variables. Partial derivatives, gradients, and Hessians. Applications in optimization and machine learning (e.g., gradient descent). **Optimization in Multiple Dimensions:** Using partial derivatives to find maxima and minima in multi-variable functions. Using integrals for area calculation and in graphics algorithms.	14
UNIT 4: Sequences, Series, and Their Applications	- Hrs
Introduction to Sequences and Series: Definitions, convergence, and divergence. **Taylor and Maclaurin Series:** Expanding functions as infinite series and their applications in approximation. **Applications in Algorithm Analysis:** Using series in analyzing time complexity and approximating functions in computational tasks.	14

To be effective from year-2024

Textbooks

1. Calculus" by Michael Spivak, 4th Edition, 2020, Published by: Publish or Perish, Inc.
2. "Higher Engineering Mathematics" by B.S. Grewal, 44th Edition, 2020, Published by: Khanna Publishers.
3. "Calculus: A Complete Introduction" by Robert G. Bartle and Donald R. Sherbert, 2nd Edition, 2021.
4. "Calculus: Early Transcendentals" by James Stewart, 8th Edition, 2015.
5. "Calculus" by Michael Spivak, 4th Edition, 2020.

Reference Books

1. "Thomas' Calculus" by George B. Thomas Jr., Maurice D. Weir, and Joel Hass, 15th Edition, 2020.
2. "Engineering Mathematics" by K.A. Stroud, 7th Edition, 2016, Published by: Palgrave Macmillan.
3. "Calculus" by Ron Larson and Bruce H. Edwards, 11th Edition, 2020.

COURSEOUTCOMES(CO):

CO1: Understand and apply the concepts of limits, continuity, and derivatives in solving optimization and computational problems

CO2: Utilize integral calculus to solve real-world problems related to area, volume, and accumulation in computational tasks

CO3: Analyse multi-variable functions and compute partial derivatives for optimization in machine learning and data science

CO4: Apply numerical integration techniques for solving practical problems in computer science.

LEVEL OF CO-PO MAPPING TABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	2	1	1	1	2	-	2	1	1	1	1	1
2	1	2	1	1	2	1	2	1	2	2	2	2
3	2	1	3	2	3	2	3	1	2	2	2	2
4	2	1	2	2	2	2	1	1	2	2	2	2

To be effective from year-2024

COURSE TITLE: Digital Image Processing

Course Code:	IMDAMJDI0624					Examination Scheme	
Total number of Lecture Hours: 42 Total number of Lab Hours: 14						External	80
						Internal	20
Lecture(L):	3	Practicals (P):	1	Tutorial(T):	-	Total Credits	4

Course Objectives

- Understand the fundamental concepts of digital image processing and its applications.
- Explore the mathematical foundations of image formation, sampling, and quantization.
- Develop proficiency in various image enhancement techniques in spatial and frequency domains.
- Analyze algorithms for edge detection, image segmentation, and restoration.
- Study image compression techniques and their application in reducing redundancy.

Course Content	TEACHING HOURS
Unit 1: Introduction to Digital Image Processing	15 Hrs
Introduction to Digital Image Processing, Origins of DIP, Examples, Fundamental steps in DIP, Components of DIP. Fundamental elements of visual perception: brightness, contrast, hue, saturation, Mach-band effect; Light and the electromagnetic spectrum. Image formation and digitization concepts; Image sensing and acquisition; Image sampling and quantization. Basic relationships between pixels: Neighbours of pixel, adjacency, connectivity, regions and boundaries, distance measures.	
Unit 2: Image Enhancement	14Hrs
Image enhancement in the spatial domain: Background; Point and arithmetic/logic operations; Some basic grey-level transformations; Histogram processing: Equalization, Matching. Mechanics of spatial filtering: Correlation, Convolution; Smoothing spatial filters; Sharpening spatial filters. Image enhancement in the frequency domain: Background, Introduction to the Fourier transform and the frequency domain, Smoothing Frequency-Domain filters, Sharpening Frequency-Domain filters.	
UNIT 3: Edge Detection, Segmentation, Image Restoration, and Compression	14hrs

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Edge detection: Basic formulation, gradient, edge linking via Hough transform; Thresholding: Basic global thresholding, basic adaptive thresholding.

Region-based segmentation: Basic formulation, region growing, region splitting and merging; Segmentation by morphological watersheds: Basic concepts, dam construction, watershed algorithm.

Model of image degradation/restoration process: Noise models; Restoration by spatial filtering: Mean filters, order-statistics filters; Restoration by frequency domain filtering: Bandreject filters, bandpass filters.

Image compression fundamentals: Types of redundancies; Image compression models; Lossy and lossless compression.

Digital Image Processing LAB

Week 1:

- Create two 4x4 matrices X and Y in MATLAB and perform the following operations on them:
    - Transpose
    - Multiplication and Division by a scalar x
    - Array Multiplication and Division between the two matrices
    - Matrix Multiplication and Division between the two matrices

Week 2:

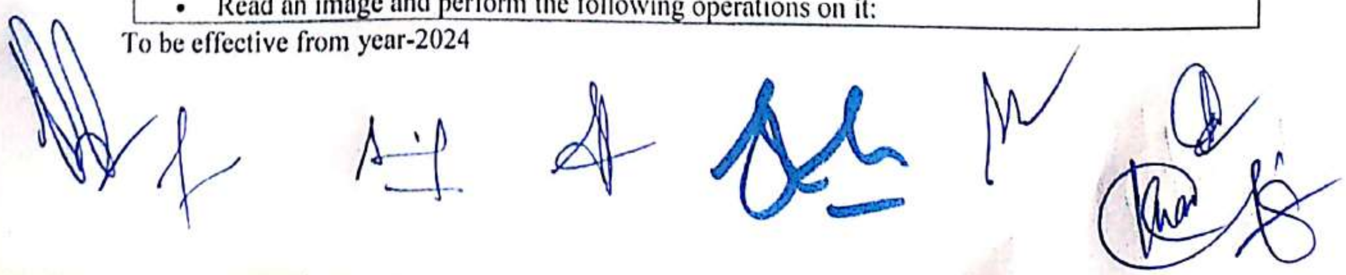
- Create an M-file containing a function which takes as input a vector with values within a specific continuous range and returns a discretized/quantized mapping of the values. The output range and number of levels are also provided as input to the function.

Week 3:

- Read an RGB image from the disk [use imread()] and perform the following operations on it:
    - Convert it into grayscale
    - Extract a sub-image from it
    - Display its histogram [use imhist()]
    - Perform contrast stretching on it [use imadjust()]
    - Perform log transformation on the previous result
    - Save the resulting image to the disk [use imwrite()]

Week 4:

- Read an image and perform the following operations on it:



- Display the image and its histogram
- Perform histogram equalization on it [use histeq()] and display the resulting image and histogram
- Perform histogram matching on it [use histeq()] and display the resulting image and histogram
- Perform adaptive histogram equalization on it [use adapthisteq()] and display the resulting image and histogram

Week 5:

- Use fspecial() to generate any three 3x3 spatial filters and display them.
- Read an image in grayscale and using imfilter(), perform the following operations on it:
  - Smooth the image
  - Sharpen the image

Week 6:

- Read an image in grayscale and add salt & pepper noise to it using imnoise() and display the image.
- Use ordfilt2() to perform min and max filtering on the noise-induced image and display the resulting images.
- Use medfilt2() on the noise-induced image and document the effect of using a median filter to reduce the salt & pepper noise.

Week 7:

- Calculate the Discrete Fourier Transform of a grayscale image [use fft2()] and display its Fourier spectrum [use abs() on fft2()].
- Display the effect of shifting the DFT of an image using fftshift().
- Shift back the shifted DFT using ifftshift() and display the result.
- Compute the inverse Discrete Fourier Transform from the previous result using ifft2() and display its real part using real().
- Comment on the observations you make.

Week 8:

- Generate the following frequency domain filters from spatial domain filters created in week 5 using freqz2():
  - Lowpass filter
  - Highpass filter [use 1 - Lowpass]
- Create meshgrid arrays for use in direct implementation of frequency domain filters:
  - Use them to generate the distance matrix using hypot().
  - Use the distance matrix to generate the following filters:
    - Bandpass
    - Bandreject

Reference: Pages 140, 144, and 154 of "Digital Image Processing Using MATLAB"

Week 9:

- Create an M-function which implements all the steps for filtering in the frequency domain:
  - Read the image to grayscale

- Obtain a frequency domain filter H from week 8
- Obtain the FFT of the padded input
- Perform the filtering by multiplying the FFT with H
- Obtain the inverse transform of the result
- Crop to original image
- Display the result

NOTE: Image and the filter have to be of the same dimension and use float type during processing.

Week 10:

- Use a specific point-detection filter for identifying isolated points in an image:
  - Use spatial filtering and thresholding to achieve your goal.
- Use the edge() function to detect edges in an input image by the following filters:
  - Sobel
  - Prewitt
  - Roberts
  - Canny

Week 11:

- Demonstrate the use of the following Toolbox Hough Functions to detect lines in an input image:
  - hough()
  - houghpeaks()
  - houghlines()
- Demonstrate the use of watershed() function for identifying segments in an image.

Week 12:

- Model of image degradation/restoration process: Noise models
- Restoration by spatial filtering: Mean Filters
- Order-Statistics Filters
- Problem/Numerical: Specifying the PDF of bipolar salt and pepper noise
- Problem/Numerical: Problems on removing/reducing noise using spatial filtering

Week 13:

- Apply global thresholding using a specific threshold value.
- Perform adaptive thresholding using the local mean.

Week 14:

- Implement connected components labeling for region segmentation.
- Implement region growing segmentation algorithm.
- Apply region splitting and merging for segmentation.

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Textbooks

- Rafael C. Gonzalez, Richard E. Woods. *Digital Image Processing*, Pearson, Second Edition, 2004.
- Anil K. Jain. *Fundamentals of Digital Image Processing*, Pearson, 2002.

Reference Books

- Digital Image Processing: An Algorithmic Approach (2nd Edition, 2019) **by William K. Pratt.**
- Digital Image Processing and Analysis: Applications with MATLAB and CVIP tools (2nd Edition, 2020) **by Scott E. Umbaugh**

COURSE OUTCOMES(CO):

CO1: Gain a solid foundation in the principles and techniques of digital image processing.

CO2: Apply image processing methods to improve image quality and extract useful information.

CO3: Implement spatial and frequency domain filtering techniques for image enhancement.

CO4: Solve real-world problems using edge detection, segmentation, and restoration algorithms.

CO5: Demonstrate knowledge of image compression models for efficient storage and transmission.

LEVELOFCO-PO MAPPINGTABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	2	2	1	3	-	-	-	2	1	1	2
2	3	3	2	2	3	1	1	-	2	1	1	2
3	3	3	3	2	3	2	1	-	2	1	1	2
4	3	3	3	2	3	2	2	1	3	2	2	3
5	3	3	3	1	3	1	2	1	2	1	2	3

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COURSE TITLE: Time Series Analysis and Forecasting

Course Code:		**IMDAMJTS0624**				**Examination Scheme**	
Total number of Lecture Hours: 56						**External**	**80**
						Internal	**20**
Lecture(L):	**4**	**Practicals (P):**	**0**	**Tutorial(T):**	**0**	**Total Credits**	**4**

Course Objectives

1. Gain a solid understanding of key concepts and components of time series data, including trend, seasonality, and noise.
2. Learn and apply various statistical methods for analyzing time series data.
3. Develop skills to evaluate and select appropriate models for forecasting, including model diagnostics and validation techniques.
4. Implement advanced forecasting techniques, including exponential smoothing and machine learning approaches.
5. Use statistical software to perform time series analysis and forecasting, and interpret results in the context of real-world data.

Course Content	TEACHING HOURS
UNIT 1: Introduction to Time Series Analysis	**14 Hrs**
Stochastic process. Time series as a discrete stochastic process. Main characteristics of stochastic processes- Auto-covariation and Autocorrelation functions. Stationary stochastic processes. Components of time series: trend, seasonality, cyclicity, and noise.	
UNIT 2: Time Series Models	**14 Hrs**
Moving average (MA), Auto regressive (AR), ARMA and AR integrated MA (ARIMA) models. Box-Jenkins models, choice of AR and MA periods. Seasonal ARIMA models. Exponential Smoothing methods: Simple, Holt's, and Holt-Winters exponential smoothing	
UNIT 3: Estimation and Forecasting	**14 Hrs**
Fitting ARIMA models with Box-Jenkins procedure, Identification, Estimation, Verification, Test for white noise, and Forecasting with ARMA models. Forecasting with exponential smoothing.	
UNIT 4: Model Selection and Validation	**14 Hrs**
Criteria for model selection (AIC, BIC). Cross-validation techniques. Forecast accuracy metrics (MAE, RMSE, MAPE). GARCH models for volatility. State space models and Kalman filter. Machine learning approaches to time series forecasting. Introduction to R/Python for time series analysis. Practical sessions on data analysis and model implementation	
Textbooks	

To be effective from year-2024

1. Cryer, J. D., and K. S. Chan. "*Time Series Analysis with Applications in R*". 2nd ed., Springer, 2021.
2. Hyndman, Rob J., and George Athanasopoulos. "*Forecasting: Principles and Practice*". 3rd ed., OTexts, 2021.
3. Box, George E. P., Gwilym M. Jenkins, and Gregory C. Reinsel. "*Time Series Analysis: Forecasting and Control*". 5th ed., Wiley, 2016.

Reference Books

1. Shumway, R. H., and D. S. Stoffer. "*Time Series Analysis and Its Applications: With R Examples*". 4th ed., Springer, 2017.
2. Tsay, Ruey S. "*Analysis of Financial Time Series*". 4th ed., Wiley, 2018.
3. Hamilton, James D. "*Time Series Analysis*"s. 2nd ed., Princeton University Press, 2020.

COURSE OUTCOMES(CO):

CO1: Accurately identify and describe the main components of time series data, including trends, seasonal effects, and cyclic patterns.

CO2: Fit and diagnose standard time series models (e.g., ARIMA) and assess their performance using appropriate metrics and validation techniques.

CO3: Develop and implement forecasting models using techniques such as exponential smoothing and ARIMA, and provide reliable forecasts with associated uncertainty measures.

CO4: Efficiently use statistical software (e.g., R, Python) to conduct time series analysis and produce forecasts, including data manipulation, visualization, and model implementation.

CO5: Apply time series analysis and forecasting methods to real-world problems, interpret results, and make informed decisions based on data.

LEVEL OF CO-PO MAPPING TABLE

COs	POs											
	1	2	3	4	5	6	7	8	9	10	11	12
1	3	3	2	2	2	2	1	1	2	2	1	2
2	3	3	2	3	3	2	1	1	2	2	2	3
3	3	3	3	3	3	2	1	1	2	3	2	3
4	2	2	2	2	3	1	1	1	3	3	2	2
5	3	3	3	3	2	3	2	2	3	3	2	3

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MINOR SUBJECTS

To be effective from year-2024

COURSE TITLE: Expert System								
Course Code: IMDAMNES0624						Examination Scheme	T	P
Total number of LectureHours:56 Total number of Practical Hours: -						External	80	-
						Internal	20	-
Lecture(L):	4	Practical(P):	-	Tutorial(T):	0	Total Credits	4	

Course Objectives

- To introduce the history, evolution, and core components of expert systems and provide an understanding of various knowledge representation techniques.
- To explore different inference and reasoning methods, including deductive logic, rules of inference, and reasoning under uncertainty, in the context of expert systems.
- To provide an understanding of expert system development processes, knowledge engineering, and the role of development tools and shells.
- To examine the latest advancements in expert systems, including hybrid systems, self-learning systems, and ethical challenges, while addressing future trends in the field.

Course Content	TEACHING HOURS
UNIT 1: Expert Systems and Knowledge Representation	Hrs.
Overview of Expert Systems: History and Evolution of Expert Systems, Characteristics and Capabilities of Expert Systems **Components of an Expert System-** Knowledge Base, Inference Engine, User Interface. **Rule-based Systems vs. Other Knowledge-based Systems** **Knowledge Representation:** Productions, Semantic Nets, Frames, Schemata, Propositional Logic, Trees, Lattice and Graphs	14
UNIT 2: Methods of Inference and Reasoning	Hrs.
Inference Methods – Deductive Logic and Syllogism, Rules of Inference, Logic Systems, Resolution Systems and Deduction, Shallow and Casual Reasoning, Forward and Backward Chaining **Reasoning under Uncertainty –** Hypothetical Reasoning and Backward Induction, Temporal Reasoning and Markov Chains, Inference Nets **Inexact Reasoning –** Dempster-Shafer Theory	14
UNIT 3: Expert System Development and Tools	Hrs.
Design of Expert Systems – Selecting the appropriate problem, Expert System Development Stages, Errors in Development Stages, Expert System Life Cycle. Knowledge Engineering and the Role of the Knowledge Engineer Tools and Shells for Expert System Development (e.g., CLIPS, Drools) Knowledge Acquisition Techniques -(Interviews, Questionnaires, Observation) Maintenance and Evaluation of Expert Systems	14
UNIT 4: Advanced Topics and Future of Expert Systems	Hrs.

Hybrid Systems (Integration of Expert Systems with Machine Learning and Neural Networks) Adaptive and Self-Learning Expert Systems .Distributed and Web-based Expert Systems, Expert Systems in Big Data and IoT Ethical Issues and Challenges in Expert System Development Future Trends and Research Directions in Expert Systems	**14**

Textbooks:

1. Expert Systems: Principles and Programming, by Joseph C. Giarratano , Gary D. Riley, 4th Edition. 2004.

Reference Books:

1. Artificial Intelligence: A Guide to Intelligent Systems by Michael Negnevitsky , 2nd edition, Addison-Wesley - 2005
2. Artificial Intelligence and Expert Systems: Technologies and Applications" by John Durkin, 1994
3. **Expert Systems:** The Technology of Knowledge Management and Decision Making for the 21st Century by Cornelius T. Leondes, Elsevier Science, 2002

COURSEOUTCOMES(CO):

CO1: Demonstrate a comprehensive understanding of expert systems' historical evolution, characteristics, and components like the knowledge base, inference engine, and user interface.
CO2: Apply various knowledge representation methods such as semantic nets, frames, and propositional logic in designing expert systems.
CO3: Analyze and implement inference techniques like forward and backward chaining, syllogism, and reasoning under uncertainty using different models (e.g., Dempster-Shafer Theory).
CO4: Design, develop, and evaluate expert systems using appropriate tools and shells, incorporating the full lifecycle from knowledge acquisition to maintenance.

LEVELOFCO-PO MAPPINGTABLE

COs	POs											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	2	1	1	1	1	2	2	1	1	1	1	1
2	3	2	2	1	1	1	1	2	2	1	1	1
3	2	2	1	1	1	1	1	1	2	1	1	1
4	2	1	1	2	2	1	1	1	1	2	1	1

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