



JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE

Affiliated &
Autonomous under
University of Mysore



Accredited with Grade



Recognized by



as
College with Potential for Excellence

**Master of Science in Artificial Intelligence
& Machine Learning (AI & ML)**

(Choice Based Credit System)

2026 -2028

PG Department of Computer Science

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE

(Autonomous)

MYSURU

1	Title of the Course	M.Sc., (AI & ML)
2	Duration of the course	2 years (Four Semesters)
3	Eligibility criteria for admission	<p>The candidate seeking admission in to M.Sc. (AI & ML) should have passed an</p> <ul style="list-style-type: none"> • Under graduate in Computer Science/ Computer applications <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> • B.Voc with Computer Science/Computer Applications/Information Technology/Web Technologies, B.Sc (Data Science) & B.Sc(Artificial Intelligence/Machine Learning) <p style="text-align: center;">OR</p> <ul style="list-style-type: none"> • UG Degree in Engineering or Technology in CSE/ECE/EEE/E&I/IT with 50% of marks (inclusive all subjects)
4	Level of the Course	Post Graduate
5	Mode of Admission	The mode of admission is through PGCET conducted by University of Mysore.
6	Objectives of the course	The Objective of M.Sc., AI & ML course is to impart knowledge and skill-oriented training in the recent advancements in Data Science with an aim to develop research and innovations.
7	Course Requirement	The course shall include Theory papers, Labs, Assignments, Tests, Seminars and Project Work.
8	Number of working days	In each semester at least ninety working days must be dedicated for theory classes, practical classes and seminars.

MSc. (Artificial Intelligence & Machine Learning)

COURSE STRUCTURE

I SEMESTER

Course Code	Course Name	Teaching Hours/Week			CORE / IDC/DSE/ SEC/OEC/MO OCS	Internal Marks	External Marks	No. of Credits
		Lecture	Tutorial	Practical				
101	Data Structures and Algorithms	3	0	0	Core	30	70	3
102	Python Programming	3	0	0	Core	30	70	3
103	Artificial Intelligence	4	0	0	Core	30	70	4
104	Probability and Statistics	4	0	0	Core	30	70	4
105	3D Graphics and Animation	4	0	0	Core	30	70	4
106	Data Structures Lab	0	0	2	Core	15	35	1
107	Python Programming Lab	0	0	2	Core	15	35	1
TOTAL FOR FIRST SEMESTER						180	420	20

II SEMESTER

Course Code	Course Name	Teaching Hours/Week			CORE / IDC/DSE/ SEC/OEC/MO OCS	Internal Marks	External Marks	No. of Credits
		Lecture	Tutorial	Practical				
201	Object oriented programming using Java	3	0	0	Core	30	70	3
202	Mathematics for AI & ML	4	0	0	Core	30	70	4
203	Machine Learning	3	0	0	Core	30	70	3
204	Image Analysis and Computer Vision	4	0	0	SEC	30	70	4
DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)								
205E1	Reinforcement Learning	4	0	0	DSE	30	70	4
205E2	Principle of Explainable AI	4	0	0	DSE	30	70	4
205E3	Responsible AI	4	0	0	DSE	30	70	4
LAB PRACTICALS								
206	Object oriented programming using Java Lab	0	0	2	Core	15	35	1
207	Machine Learning Lab	0	0	2	Core	15	35	1
TOTAL FOR SECOND SEMESTER						180	420	20

At the end of 2nd semester, every student must undergo Summer Internship/Apprenticeship/Project Work/Industrial Training/Research based Project Work for Six Weeks and must prepare a report concerned as per approved project guidelines, and submit the same to the college 14 days before the commencement of third semester end examinations.

III SEMESTER

Course Code	Course Name	Teaching Hours/Week			CORE / IDC/DSE/ SEC/OEC/MOOC/CS	Internal Marks	External Marks	No. of Credits
		Lecture	Tutorial	Practical				
301	Neural Networks and Deep Learning	3	0	0	Core	30	70	3
302	Speech and Natural Language Processing	3	0	0	Core	30	70	3
DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY TWO)								
E1	Knowledge Representation and Reasoning in AI	4	0	0	DSE	30	70	4
E2	Deep Learning for Language And Speech Technologies	4	0	0	DSE	30	70	4
E3	Deep Learning for Computer Vision	4	0	0	DSE	30	70	4
E4	Robotics Process Automation	4	0	0	DSE	30	70	4
LAB PRACTICALS								
303	Neural Networks and Deep Learning lab	0	0	2	Core	15	35	1
304	Speech and Natural Language Processing lab	0	0	2	Core	15	35	1
ENTREPRENURAL & INNOVATION/IT SKILL RELATED TO DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)								
305	Cyber Security	4	0	0	OEC	30	70	4
306	Bio Informatics	4	0	0	OEC	30	70	4
307	Web Designing	4	0	0	OEC	30	70	4
						180	420	20

IV SEMESTER

Course Code	Course Name	Teaching Hours/ Week			CORE / IDC/DSE/ SEC/OEC/MOOCs	Internal Marks	External Marks	No. of Credits
		Lecture	Tutorials	Practical				
401	Image Processing and Video Analytics	3	0	0	Core	30	70	3
DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)								
E1	Big Data Frameworks	4	0	0	DSE	30	70	4
E2	Cloud Computing ecosystem	4	0	0	DSE	30	70	4
LAB PRACTICALS								
402	Image Processing and Video Analytics lab	0	0	2	Core	15	35	1
ENTREPRENEURIAL & INNOVATION/IT SKILL RELATED TO DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)								
403E1	AI concepts & techniques with python	4	0	0	SEC	30	70	4
404E2	Time Series Analysis	4	0	0	SEC	30	70	4
405	PROJECT WORK EVALUATION AND VIVA-VOCE				CORE	30	70	4
TOTAL FOR IV SEMESTER						105	345	16

Note

1. At the end of 2nd semester, every student must undergo Summer Internship/Apprenticeship/Project Work/Industrial Training/Research based Project Work for Six Weeks and must prepare a report concerned as per approved project guidelines, and submit the same to the college 14 days before the commencement of third semester end examinations.
2. Students may be allowed to register and appear for MOOCs from the third semester itself. However, students are to complete the MOOCs successfully and submit pass certificate of the same to the University through the Principal of the College concerned for approval and endorsement of the same on grade cards and PCs and ODs as per the regulations of the University.

Total number of credits at the end of course:

S.No	Semester	Credits
1	I Semester	20
2	II Semester	20
3	III Semester	20
4	IV Semester	16
TOTAL		76

SCHEME OF EXAMINATION AND ASSESSMENT:

In view of the CBCS syllabus, Each Course is Assess with Components . Component 1 (C1), Component 2 (C2), and Component 3 (C3), The following is the scheme which will be followed for the assessment of marks for theory (Core/ DSE/ SEC/PROJECT) irrespective of the Credits associated with each Course. Thirty percent of the marks will be assessed for the internals (C1 and C2) and remaining seventy percent will be for the semester end examinations (C3). Each Course carries 100 marks and hence thirty marks for internal assessment and remaining seventy marks will be for Semester End Examinations. Out of thirty marks for internals, fifteen marks will be allotted to each C1 and C2 components. Each Course (Core/ DSE/ SEC/PROJECT) consists of three components namely C1, C2 and C3. C1 and C2 are designated as Internal Assessment (IA) and C3 as Semester End Examination. Each Course (Core/ DSE/ SEC/PROJECT) carries 100 Marks and hence the allotment of marks to C1, C2 and C3 Components will be fifteen, fifteen and seventy marks respectively. i.e.,

C1 Component : 15 Marks C2 Component : 15 Marks	Internal Assessment Marks
C3 Component : 70 Marks	Semester End Examination
Total :	100 Marks

The above will be followed in common for all (Core/ DSE/ SEC/PROJECT) Courses in all the four semesters.

Practicals:

C1 and C2	Semester End Exam	Total
15 marks	35 marks	50

*Continuous assessment sheet given below.

Note:

For practical courses, there shall be a continuous evaluation during the semester for 15 sessional marks and end examination shall be for 35 marks. Day-to-day work in the laboratory shall be evaluated for 15 marks by the concerned laboratory teacher based on the regularity/record/viva. The end examination shall be conducted by the internal and external examiner from home University / Other University.

I SEMESTER

DATA STRUCTURES AND ALGORITHMS

3:0:0

COURSE OUTCOMES

CO1: Understand the fundamental concepts of algorithms including time and space complexity, asymptotic analysis and recurrence relations.

CO2: Apply linear and non-linear data structures such as stacks, queues, trees and graphs in problem solving.

CO3: Design and analyze searching and sorting algorithms using divide and conquer techniques.

CO4: Apply algorithm design paradigms such as Greedy method and Dynamic Programming.

CO5: Understand and apply advanced problem solving techniques including Backtracking and Branch and Bound.

UNIT I: INTRODUCTION TO ALGORITHMS AND ANALYSIS

Over view and importance of algorithms and data structures – Fundamentals of algorithm analysis – Space and time complexity of an algorithm – Asymptotic Notations – Order of growth – Algorithm Efficiency – Best case, Worst Case, Average Case – Recurrence Relations – Solving recurrence relations using substitution method, recurrence tree method and Master Method.

UNIT II: LINEAR AND NON-LINEAR DATA STRUCTURES

Linear Data Structures: Stacks – Queues – Lists – Applications. Non-linear Data Structures: Graphs – Trees – Binary Trees – Traversal Techniques – Binary Search Tree and its operations – AVL Trees.

UNIT III: SEARCHING AND SORTING ALGORITHMS, DIVIDE AND CONQUER APPROACH (9 hours)

Search Problem – Linear Search – Binary Search – Sorting Problem – Bubble Sort – Insertion Sort – Heap Sort – Divide and Conquer Paradigm – Merge Sort – Quick Sort – Complexity analysis of searching and sorting algorithms.

UNIT IV: GREEDY, DYNAMIC PROGRAMMING AND COMPLEXITY

Greedy Method: Activity Selection Problem. Dynamic Programming Paradigm: Knapsack problem – Matrix Chain Multiplication – Shortest Path problems. Backtracking: 8-Queens problem. Branch and Bound: 0/1 Knapsack Problem.

M.Sc., (AI & ML)

Text Book:

1. Introduction to Algorithms – Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein.
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Reference Books:

1. Algorithms – Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani.
2. The Design and Analysis of Computer Algorithms – Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman.
3. Fundamentals of Data Structures in C – Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed.

Course Outcomes

CO1: Understand basic concepts of Python programming and its environment.

CO2: Develop Python programs using variables, control structures and functions.

CO3: Apply Python data structures such as lists, tuples, dictionaries and sets.

CO4: Implement object-oriented concepts and file handling in Python.

CO5: Create simple plots and visualize data using Python libraries.

Unit:1 INTRODUCTION TO PYTHON

Introduction to programming language – History of Python – Python environment setup – Python 2 vs Python 3 – Keywords and identifiers – Comments and documentation – Programming errors – Writing and running Python programs.

Unit:2 VARIABLES, CONTROL STRUCTURES AND FUNCTIONS

Variables – Constants – Strings – Assignment statements – Expressions – Operators – Type conversion – Conditional statements – Loops – Functions.

Unit:3 DATA STRUCTURES IN PYTHON

Lists – Indexing and slicing – Appending and sorting – Tuples – Creation and operations – Dictionaries – Adding, modifying and retrieving values – Traversing keys – Sets – Operations and methods.

Unit:4 OBJECT ORIENTED PROGRAMMING, FILE HANDLING AND VISUALIZATION

Exception handling – Classes and objects – Object properties and methods – Inheritance – Polymorphism – File handling – Opening, reading and writing files – Introduction to plotting – Basic graphs – Data visualization – Plotting using Matplotlib.

Text Book

1. Python: The Complete Reference – Martin C. Brown, McGraw Hill Education, 2018.
2. Python in Easy Steps – Mike McGrath, McGraw Hill Education, 2014.

Reference Books

1. Python 3 Documentation – Python Software Foundation,
2. Python for Everybody – Charles R. Severance, Coursera,

Course Outcomes

CO1: Understand the fundamental concepts of Artificial Intelligence and search techniques.

CO2: Apply constraint satisfaction and reasoning techniques to solve problems.

CO3: Understand and apply probabilistic concepts for reasoning under uncertainty.

CO4: Apply decision making techniques and reinforcement learning concepts.

CO5: Analyze and implement basic AI algorithms for problem solving.

Unit:1 INTRODUCTION TO AI AND SEARCHING TECHNIQUES

Introduction to Artificial Intelligence – Types of AI – Problem-solving agents – Problem formulation – Search strategies – Performance measures (completeness, optimality, time and space complexity) – Uninformed search techniques – Breadth-first search – Depth-first search – Uniform cost search – Bidirectional search.

Unit:2 CONSTRAINT SATISFACTION AND LOGIC

Constraint Satisfaction Problems – Basic components and representation – Constraint types – Constraint propagation – Forward checking – Arc consistency – Local search for CSPs – Introduction to reasoning – Reasoning with default information – Simple case study.

Unit:3 UNCERTAINTY AND PROBABILISTIC REASONING

Uncertainty – Quantifying uncertainty – Basic probability concepts – Conditional probability – Bayes' rule – Independence – Inference using probability – Introduction to Bayesian networks – Representation and basic inference.

Unit:4 DECISION MAKING AND LEARNING

Bayesian networks – Basic concepts and inference – Reinforcement learning – Basic concepts and applications – Utility theory – Decision making – Decision networks – Sequential decision problems – Value iteration – Policy iteration.

M.Sc., (AI & ML)

Text Book

1. Artificial Intelligence: A Modern Approach – Stuart Russell and Peter Norvig, Pearson.
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Reference Books

1. Artificial Intelligence – Elaine Rich and Kevin Knight, McGraw Hill.
2. Artificial Intelligence: Foundations of Computational Agents – David L. Poole and Alan K. Mackworth, Cambridge University Press.

Course Outcomes

CO1: Understand the fundamentals of probability, random variables and distributions.

CO2: Apply concepts of expectation, correlation and regression.

CO3: Analyse standard probability distributions and their applications.

CO4: Apply statistical inference techniques including estimation and hypothesis testing.

CO5: Interpret data using statistical methods and draw conclusions.

Unit:1 RANDOM VARIABLES AND DISTRIBUTIONS

Random variables – Conditional probability – Probability density function – Distribution function – Marginal and conditional distributions – Two dimensional random variables – Joint distributions – Transformations of random variables.

Unit:2 EXPECTATION, CORRELATION AND REGRESSION

Mathematical expectation – Expectation of functions of random variables – Moment generating function – Correlation – Regression lines and curves.

Unit:3 STANDARD DISTRIBUTIONS

Normal distribution – Gamma distribution – Chi-square distribution – Tchebyshev's inequality and related problems.

Unit:4 SAMPLING THEORY AND STATISTICAL INFERENCE

Sampling theory – Point estimation – Unbiased and consistent estimators – Confidence intervals for mean, difference of means and variance – Curve fitting by least squares – Goodness of fit – Testing of hypothesis – Type I and Type II errors – Tests based on Normal, t and F distributions.

Text Book

1. Probability and Statistics – T. Veerarajan, McGraw Hill Education.
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M.Sc., (AI & ML)

Reference Books

1. Probability and Statistics – S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons.
2. Introduction to Probability and Statistics – William Mendenhall, Robert Beaver and Barbara Beaver.

Course Outcomes

CO1: Understand the mathematical foundations of 3D graphics including transformations and coordinate systems.

CO2: Apply 3D transformations and viewing techniques to construct scenes.

CO3: Understand modeling and rendering techniques for 3D objects.

CO4: Apply animation techniques to create interactive scenes.

CO5: Analyze and design basic 3D graphics and animation systems.

Unit:1 INTRODUCTION TO COMPUTER GRAPHICS

Computer graphics pipeline – Raster images – Coordinate reference frames – Coordinate systems – Graphics output primitives and algorithms.

Unit:2 3D TRANSFORMATIONS AND VIEWING

3D coordinate systems – Homogeneous coordinate systems – 3D transformations – Translation – Rotation – Scaling – Reflection – Shear – Composite transformations – Transformation between coordinate systems – 3D viewing pipeline.

Unit:3 3D MODELING AND REPRESENTATION

Camera transformations – Orthographic, isometric and perspective views – 3D object representation – Polygon, wireframe and boundary representation – Curves – Splines and Bezier curves – Triangle meshes – Procedural and fractal models – Octrees and sweep representations.

Unit:4 3D RENDERING AND ANIMATION

Rendering techniques – Back face detection – Z-buffer method – Painter's algorithm – Illumination models – Color models – Shading techniques – Flat, Gouraud and Phong shading – Principles of animation – Key framing – Character animation – Motion specification – Morphing.

Text Book

1. Computer Graphics: Principles and Practice – John F. Hughes, Andries Van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner and Kurt Akeley, Pearson, 3rd Edition, 2019.
 2. Computer Graphics with OpenGL – Donald D. Hearn, Pauline Baker and Warren Carithers, Pearson, 4th Edition, 2015.
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Reference Books

1. Interactive Computer Graphics – Edward Angel and Dave Shreiner.
2. Fundamentals of Computer Graphics – Peter Shirley and others.

Expected Course Outcome:

CO1: Understand the fundamental concepts of python and its main components.

CO2: Develop (Read and Write) python programs using variables, assignments, and conditional Statements using functions.

CO3: Illustrate and implement different data structures.

CO4: Demonstrate Object-oriented concepts and file handling.

CO5: Analyze and plot data using python visualization libraries.

List of Indicative Experiments

1. Stacks and Queues
2. Lists
3. Linear Search and Binary Search
4. Sorting Algorithms
5. Graph Traversal Algorithms
6. Tree Traversal Algorithms
7. Shortest Path Algorithms
8. Knapsack Problem
9. Travelling Sales man Problem
- 10 N-Queens's Problem

Course Objectives:

To find practical application across various domains, from software engineering and data analysis to game development and business analytics, showcasing the versatility and Importance of Python programming skills.

Expected Course Outcome:

CO1: Understand the fundamental concepts of python and its main components.

CO2: Develop (Read and Write) python programs using variables, assignments, and conditional statements using functions.

CO3: Illustrate and implement different data structures.

CO4: Demonstrate Object-oriented concepts and file handling.

CO5: Analyze and plot data using python visualization libraries.

List of Indicative Experiments

1. Test and Debug simple Python programs
2. Different data types in python(variables constants and strings)
3. Programs on different operators
4. Control statements and Loops
5. Working on Functions
6. Data structures in python (List, Tuple, Dictionary and Set)
7. Objects and Classes manipulation using python
8. Open, Read and write data from/to files in Python
9. Different plots using Mat plot lib
- 10 Visualization of data using sea born

II SEMESTER

OBJECT ORIENTED PROGRAMMING USING JAVA

3:0:0

Course Outcomes

CO1: Understand object-oriented programming concepts and basic Java programming constructs.

CO2: Design programs using classes, objects and methods.

CO3: Apply inheritance, interfaces, packages and exception handling for reusable programs.

CO4: Implement multithreading and use collection frameworks in Java.

CO5: Develop applications using Java I/O, JDBC and networking concepts.

Unit:1 INTRODUCTION TO OOP AND JAVA BASICS

Structured programming and its limitations – Object-oriented programming concepts – Benefits of OOP – Object modeling – Association, aggregation and generalization – Introduction to Java – Features of Java – Java environment – JVM – Data types – Variables – Operators – Control statements – Loops – Arrays – Strings – Wrapper classes.

Unit:2 CLASSES, OBJECTS AND METHODS

Classes and objects – Declaring objects – Methods – Constructors – this keyword – Garbage collection – Method overloading – Passing and returning objects – Access control – static and final – Nested and inner classes – Command line arguments.

Unit:3 INHERITANCE, INTERFACES AND EXCEPTION HANDLING

Inheritance – Constructors in inheritance – super keyword – Method overriding – Dynamic method dispatch – final keyword – Interfaces – Packages – Exception handling.

Unit:4 MULTITHREADING, COLLECTIONS AND JAVA APPLICATIONS

Multithreading – Thread creation and lifecycle – Synchronization – Inter-thread communication – Collection framework – Collection interfaces and classes – Iterators – Java I/O – File handling – JDBC basics – Database connectivity – Introduction to networking concepts

Text Book

1. Java: The Complete Reference – Herbert Schildt, McGraw Hill Education.
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Reference Books

1. Object Oriented Programming with Java – E. Balagurusamy, McGraw Hill.
2. Core Java Volume I – Cay S. Horstmann, Prentice Hall.

MATHEMATICS FOR AI & MACHINE LEARNING

4:0:0

Course Outcomes

CO1: Understand vector spaces and solve linear algebra problems.

CO2: Apply matrix operations and decomposition techniques.

CO3: Apply differential calculus for optimization problems.

CO4: Understand graph theory concepts and their applications.

CO5: Apply mathematical concepts in machine learning problems

Unit:1 VECTOR SPACES AND LINEAR ALGEBRA

Vector spaces – Subspaces – Linear combinations – System of linear equations – Linear independence and dependence – Basis and dimension.

Unit:2 LINEAR TRANSFORMATIONS AND MATRIX METHODS

Linear transformations – Null space and range – Matrix representation – Eigenvalues and eigenvectors – Diagonalization – Inner product spaces – Orthogonality – Singular Value Decomposition (SVD) – LU decomposition – Principal Component Analysis (PCA).

Unit:3 CALCULUS FOR MACHINE LEARNING

Functions – Limits – Continuity – Differentiation – Maxima and minima – Taylor series – Basic integration – Applications in optimization.

Unit:4 GRAPH THEORY AND OPTIMIZATION

Graphs – Directed and undirected graphs – Matrix representation – Connectivity – Cut-sets – Applications in networks – Introduction to optimization problems.

Text Book

1. Linear Algebra – Friedberg A. H., Insel A. J., and Spence L., Prentice Hall of India.
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Reference Books

1. Mathematics for Machine Learning – Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong.
2. Introduction to Linear Algebra – Gilbert Strang, MIT Press.

MACHINE LEARNING

3:0:0

Course Outcomes

CO1: Understand the basic concepts and workflow of machine learning.

CO2: Apply supervised learning algorithms for regression and classification problems.

CO3: Apply unsupervised learning techniques for clustering and dimensionality reduction.

CO4: Understand ensemble methods and ethical aspects in machine learning.

CO5: Apply basic reinforcement learning concepts for decision making problems.

Unit:1 INTRODUCTION AND DATA PREPROCESSING

Overview of machine learning – Definition, history and applications – Types of machine learning – Supervised, unsupervised and reinforcement learning – Machine learning process – Data collection, preprocessing, model training and evaluation – Features, labels and instances – Data cleaning – Handling missing values and outliers – Feature selection and feature engineering – Exploratory Data Analysis.

Unit:2 SUPERVISED LEARNING

Linear regression – Single and multiple variables – Gradient descent – Bias-variance trade-off – Overfitting and underfitting – Regularization – Classification – Logistic regression – Decision trees – Naive Bayes – Support Vector Machines – Model evaluation metrics – Accuracy, precision, recall, F1-score, ROC and AUC.

Unit:3 UNSUPERVISED LEARNING AND ENSEMBLE METHODS

Clustering techniques – K-means – Hierarchical clustering – Density-based clustering – Expectation maximization – Dimensionality reduction – t-SNE – Anomaly detection – Ensemble methods – Bagging – Boosting – Random forests – Hyperparameter tuning.

Unit:4 REINFORCEMENT LEARNING AND ETHICS

Basics of reinforcement learning – Agents, environment and rewards – Markov Decision Process – Q-learning – Introduction to Deep Q Networks – Ethical considerations – Bias, fairness, transparency and accountability.

Text Book

1. Introduction to Machine Learning – Ethem Alpaydin, MIT Press, 2021.
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Reference Books

1. Machine Learning: The Art and Science of Algorithms that Make Sense of Data – Peter Flach.
2. Foundations of Machine Learning – Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar.

IMAGE ANALYSIS AND COMPUTER VISION

4:0:0

Course Outcomes

CO1: Understand image processing techniques and filtering methods.

CO2: Apply segmentation and feature extraction techniques.

CO3: Implement object detection and recognition methods.

CO4: Understand 3D vision and depth estimation techniques.

CO5: Apply motion analysis and object tracking methods.

Unit:1 IMAGE PROCESSING BASICS

Image representation – Pixel operations – Image enhancement techniques – Histogram equalization – Contrast adjustment – Noise reduction – Filtering and convolution – Gaussian and median filtering – Edge detection (Sobel, Canny).

Unit:2 IMAGE SEGMENTATION AND FEATURE EXTRACTION

Thresholding – Global and local methods – Region-based segmentation – Region growing and splitting – Watershed transformation – Feature extraction – Histogram of Oriented Gradients (HOG) – Texture features using Local Binary Patterns.

Unit:3 OBJECT DETECTION AND RECOGNITION

Sliding window technique – Image pyramid – Haar-like features – Viola-Jones algorithm – Feature-based detection – Scale-Invariant Feature Transform (SIFT) – Speeded-Up Robust Features (SURF) – Applications in image stitching – Evaluation metrics – Intersection over Union (IoU) and mean Average Precision (mAP)

M.Sc., (AI & ML)

Unit:4 3D VISION AND MOTION ANALYSIS

Stereo vision – Depth perception – Epipolar geometry – Stereo correspondence – Depth map estimation – Optical flow – Lucas-Kanade and Horn-Schunck methods – Object tracking – Kalman filter – Particle filter.

Text Book

1. Computer Vision: Algorithms and Applications – Richard Szeliski, Springer.
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Reference Books

1. Digital Image Processing – Rafael C. Gonzalez and Richard E. Woods.
 2. Multiple View Geometry in Computer Vision – Richard Hartley and Andrew Zisserman.
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DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)

REINFORCEMENT LEARNING

4:0:0

Course Outcomes

CO1: Explain the fundamental concepts and elements of reinforcement learning.

CO2: Apply tabular methods such as Q-learning and SARSA.

CO3: Understand deep reinforcement learning and policy optimization methods.

CO4: Implement reinforcement learning techniques for real-world problems.

CO5: Analyze advanced RL methods and applications.

Unit:1 BASICS OF REINFORCEMENT LEARNING

Elements of reinforcement learning – RL framework – Markov property – Markov Decision Process (MDP) – Partially Observable MDP – Policies – Value functions – Bellman equations.

Unit:2 TABULAR METHODS AND TEMPORAL DIFFERENCE LEARNING

Dynamic programming – Monte Carlo methods – Temporal difference learning – TD(0) – SARSA – Q-learning – Policy evaluation and improvement.

Unit:3 DEEP REINFORCEMENT LEARNING AND Q-NETWORKS

Deep Q-Networks (DQN) – Double DQN – Dueling DQN – Experience replay – Prioritized experience replay – Introduction to deep RL architectures.

Unit:4 POLICY OPTIMIZATION AND APPLICATIONS

Policy gradient methods – REINFORCE algorithm – Actor-critic methods – A2C and A3C – Advanced methods – PPO, TRPO, DDPG – Applications of RL – Autonomous systems – Multi-agent systems – Overview of RL tools and libraries.

Text Book

1. Reinforcement Learning: An Introduction – Richard S. Sutton and Andrew G. Barto, MIT Press, 2nd Edition, 2018.
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Reference Books

1. Artificial Intelligence: A Modern Approach – Stuart Russell and Peter Norvig, Pearson.
2. Machine Learning: A Probabilistic Perspective – Kevin P. Murphy.
3. Algorithms for Reinforcement Learning – Csaba Szepesvari.
4. Reinforcement Learning – Marco Wiering and Martijn Van Otterlo.
5. Deep Reinforcement Learning – Yuxi Li.

Course Outcomes

CO1: Understand the need and concepts of explainable AI.

CO2: Apply interpretability techniques for machine learning models.

CO3: Analyze model-agnostic and deep learning explanation methods.

CO4: Develop interactive and user-centric explanation systems.

CO5: Evaluate fairness, bias and ethical issues in AI systems.

Unit:1 INTRODUCTION TO EXPLAINABLE AI

Need for explainability in AI – Interpretability vs explainability – Transparency vs complexity – Categories of XAI methods – Ante-hoc and post-hoc methods – Taxonomy of XAI techniques – Ethical considerations in XAI.

Unit:2 INTERPRETABILITY AND MODEL-AGNOSTIC METHODS

Local and global interpretability – Feature importance – Partial dependence plots – Model-agnostic methods – LIME – SHAP – Contrastive explanations – Explaining ensemble models.

Unit:3 INTERACTIVE AND DEEP LEARNING EXPLANATIONS

Interactive machine learning – Human-in-the-loop systems – Explanation interfaces – Neural network interpretability – Saliency maps – Class activation mapping (CAM) – Feature visualization – Attention mechanisms – Gradient-based explanation methods.

Unit:4 POST-HOC METHODS, EVALUATION AND ETHICS

Post-hoc explanation techniques – Model distillation – Counterfactual explanations – Evaluation of XAI methods – Fairness and bias – Ethical issues in AI – User-centric XAI approaches.

Text Book

M.Sc., (AI & ML)

1. Interpretable Machine Learning – Christoph Molnar.
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Reference Books

1. Explainable AI – Uday Kamath, John Liu and James Whitaker.
2. Machine Learning Explainability – Serg Masis.

Course Outcomes

CO1: Understand ethical issues and challenges in AI and ML.

CO2: Apply ethical theories to analyze AI-based decisions.

CO3: Identify and mitigate bias and fairness issues in AI systems.

CO4: Design AI systems with transparency, privacy and accountability.

CO5: Evaluate AI systems based on ethical guidelines and regulations.

Unit:1 INTRODUCTION TO AI ETHICS AND FRAMEWORKS

Introduction to AI and ML ethics – Importance of ethical considerations – Historical context and case studies – Ethical theories – Utilitarianism, deontology, virtue ethics – Applying ethical frameworks to AI decision-making.

Unit:2 BIAS, FAIRNESS AND MITIGATION TECHNIQUES

Bias in data and algorithms – Sources of bias – Types of bias – Bias detection techniques – Fairness in AI – Statistical, individual and group fairness – Methods to measure and mitigate bias.

Unit:3 TRANSPARENCY, EXPLAINABILITY AND PRIVACY

Transparency and explainability in AI – Interpretable models – Black-box vs explainable models – Privacy and security issues – Data protection – Privacy-preserving techniques – Differential privacy and federated learning.

Unit:4 RESPONSIBLE AI PRACTICES AND REGULATIONS

Accountability and responsibility in AI systems – Ethical AI design and development – Governance and policy frameworks – Global perspectives on AI ethics – Regulations and standards – Responsible AI deployment.

M.Sc., (AI & ML)

Text Book

1. Ethics of Artificial Intelligence – S. Matthew Liao.
-

Reference Books

1. Artificial Intelligence: A Guide for Thinking Humans – Melanie Mitchell.
2. Responsible Artificial Intelligence – Virginia Dignum.

LAB PRACTICALS

OBJECT ORIENTED PROGRAMMING USING JAVA LAB

0:0:1

Course Outcomes

CO1: Develop Java programs using basic programming constructs.

CO2: Implement object-oriented concepts such as classes, objects and inheritance.

CO3: Apply exception handling, packages and interfaces.

CO4: Implement multithreading and collection frameworks.

CO5: Develop applications using file handling, JDBC and networking.

LIST OF EXPERIMENTS

Unit:1 BASIC PROGRAMMING AND ARRAYS

1. Write Java programs using basic control structures.
 2. Implement operations on arrays.
 3. Develop a program to check for panagrams.
 4. Write a program to find duplicate elements in an array.
-

Unit:2 OBJECT ORIENTED CONCEPTS

5. Implement classes, objects and constructors.
 6. Demonstrate use of access specifiers.
 7. Program using static and non-static variables.
-

Unit:3 ADVANCED OOP FEATURES

8. Implement packages and interfaces.
9. Demonstrate exception handling techniques.

Unit:4 APPLICATION DEVELOPMENT

10. Implement multithreading in Java.
11. Develop programs using collection framework.
12. Implement file handling operations.
13. Develop database connectivity using JDBC.
14. Implement basic networking programs.

Course Outcomes

CO1: Understand and preprocess real-world datasets.

CO2: Apply machine learning algorithms for prediction and classification.

CO3: Analyze and interpret results from machine learning models.

CO4: Evaluate performance of algorithms using appropriate metrics.

CO5: Select suitable algorithms for real-world applications.

LIST OF EXPERIMENTS

Unit:1 SUPERVISED LEARNING – REGRESSION AND CLASSIFICATION

1. Implement Linear Regression and Multiple Linear Regression.
 2. Implement Logistic Regression for classification.
 3. Implement Naïve Bayes Classifier.
 4. Implement Decision Trees (ID3 and CART).
 5. Implement Support Vector Machines (Linear and Non-linear).
-

Unit:2 NEURAL NETWORKS AND ADVANCED MODELS

6. Implement Single Layer Perceptron.
 7. Implement Multi-layer Perceptron.
-

Unit:3 UNSUPERVISED LEARNING

8. Implement K-Nearest Neighbors (K-NN).
9. Implement K-Means Clustering.
10. Implement K-Mode Clustering.
11. Implement Principal Component Analysis (PCA).
12. Implement Self-Organizing Maps (SOM).

Unit:4 ENSEMBLE AND REINFORCEMENT LEARNING

13. Implement Random Forest algorithm.
 14. Implement AdaBoost and XGBoost algorithms.
 15. Implement Q-Learning for simple environments.
-

Text Book

1. Introduction to Machine Learning – Ethem Alpaydin, MIT Press, 2021.
 2. Reinforcement Learning: An Introduction – Richard S. Sutton and Andrew G. Barto, MIT Press, 2018.
-

Reference Books

1. Foundations of Machine Learning – Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, MIT Press.
2. Machine Learning – Tom Mitchell, McGraw Hill.
3. Data Classification Algorithms and Applications – Charu C. Aggarwal, CRC Press.

III Semester

NEURAL NETWORKS AND DEEP LEARNING

3:0:0

Course Outcomes

CO1: Understand the fundamentals of neural networks and deep learning.

CO2: Apply neural network models for classification and prediction tasks.

CO3: Analyze deep learning architectures such as CNNs and RNNs.

CO4: Implement deep learning models for real-world applications.

CO5: Evaluate performance of deep learning models.

Unit:1 INTRODUCTION TO MACHINE LEARNING AND NEURAL NETWORKS

Introduction to machine learning – Learning process – Logistic regression – Model evaluation – Basics of neural networks – Biological neuron – Perceptron – Multilayer feedforward networks – Backpropagation learning.

Unit:2 DEEP LEARNING FUNDAMENTALS

Activation functions – Linear, sigmoid, ReLU, softmax – Loss functions – Regularization – Deep networks – Unsupervised pretraining – Introduction to deep belief networks and generative models.

Unit:3 CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS

Convolutional neural networks – Architecture – Convolution, pooling and fully connected layers – Applications of CNNs – Recurrent neural networks – Bidirectional RNNs – Sequence models – LSTM and gated RNNs.

Unit:4 DEEP LEARNING MODELS AND APPLICATIONS

Autoencoders – Generative models – GANs (basic idea) – Model training and optimization – Applications of deep learning – Image processing – Natural language processing.

Text Book

1. Deep Learning – Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.
2. Deep Learning: A Practitioner's Approach – Josh Patterson and Adam Gibson, O'Reilly.

Course Outcomes

CO1: Understand language models and NLP concepts.

CO2: Apply techniques for syntactic and semantic analysis.

CO3: Analyze speech recognition systems and language models.

CO4: Understand text-to-speech synthesis methods.

CO5: Apply NLP and speech processing techniques to real-world problems.

Unit:1 INTRODUCTION AND LANGUAGE MODELING

Overview of NLP – Applications and challenges – Levels of language processing – Language models – Grammar-based models – Statistical language models – N-gram models – Smoothing techniques.

Unit:2 WORD LEVEL AND SYNTACTIC ANALYSIS

Regular expressions – Morphology – Tokenization – Stemming – Part-of-speech tagging – HMM-based tagging – Syntax – Context-free grammar – Dependency grammar – Parsing techniques – Top-down and bottom-up parsing – CYK parsing.

Unit:3 SEMANTIC ANALYSIS AND DISCOURSE PROCESSING

Lexical semantics – Word senses and relations – WordNet – Word sense disambiguation – Word similarity – Discourse processing – Reference resolution – Anaphora and co-reference resolution.

Unit:4 SPEECH PROCESSING AND SYNTHESIS

Speech recognition – Subword units – Language models in speech recognition – System architecture – Text-to-speech synthesis – Phonology – Phoneme representation – HMM-based speech synthesis.

Text Book

M.Sc., (AI & ML)

1. Speech and Language Processing – Daniel Jurafsky and James H. Martin, Prentice Hall.
 2. Fundamentals of Speech Recognition – Lawrence Rabiner and Biing-Hwang Juang, Pearson.
-

Reference Books

1. Natural Language Processing and Information Retrieval – Tanveer Siddiqui and U. S. Tiwary, Oxford.
2. Text to Speech Synthesis – Shrikanth Narayanan and Abeer Alwan, Prentice Hall.

DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)

KNOWLEDGE REPRESENTATION AND REASONING IN AI

4:0:0

Course Outcomes

CO1: Understand different knowledge representation techniques.

CO2: Apply propositional and predicate logic for knowledge representation.

CO3: Use representation methods such as semantic networks and ontologies.

CO4: Apply reasoning techniques under certainty and uncertainty.

CO5: Model and solve planning problems in AI.

Unit:1 INTRODUCTION AND LOGICAL FOUNDATIONS

Importance of knowledge representation – Types of knowledge – Approaches to knowledge representation – Role of logic in AI – Propositional logic – Syntax and semantics – Inference mechanisms.

Unit:2 PREDICATE LOGIC AND KNOWLEDGE REPRESENTATION

Predicate logic – Quantifiers – Knowledge encoding – Resolution and theorem proving – Semantic networks – Frames and slots – Advantages and limitations of representation methods.

Unit:3 ONTOLOGIES AND REASONING

Description logics – Ontological engineering – OWL – Knowledge sharing and interoperability – Default reasoning – Closed world reasoning – Non-monotonic reasoning – Probabilistic reasoning concepts.

Unit:4 ACTIONS, PLANNING AND APPLICATIONS

Representation of actions and events – Situation calculus – Frame problem – STRIPS representation – Hierarchical and conditional planning – Planning in AI systems.

M.Sc., (AI & ML)

Text Book

1. Knowledge Representation and Reasoning – Ronald J. Brachman and Hector J. Levesque, Morgan Kaufmann.
 2. Artificial Intelligence: A Modern Approach – Stuart Russell and Peter Norvig, Pearson.
-

Reference Books

1. Knowledge Representation, Reasoning and the Design of Intelligent Agents – Michael Gelfond and Yulia Kahl, Cambridge.
2. Handbook of Knowledge Representation – Frank van Harmelen, Vladimir Lifschitz, Bruce Porter, Elsevier.

Course Outcomes

CO1: Understand deep learning architectures for language and speech processing.

CO2: Apply deep learning techniques for NLP tasks and language modeling.

CO3: Analyze semantic and discourse-level language processing.

CO4: Develop question answering and dialogue systems.

CO5: Apply deep learning methods for speech recognition and synthesis.

Unit:1 DEEP LEARNING FOR LANGUAGE PROCESSING

Foundations of NLP – Recurrent neural networks – Language modeling – Word embeddings – GRU, LSTM, BiLSTM – Attention mechanisms – Transformer models – Encoder-decoder architecture – Machine translation – Transfer learning.

Unit:2 SEMANTIC AND DISCOURSE ANALYSIS

Word sense and WordNet – Word sense disambiguation – Semantic role labeling – Pragmatics – Coreference resolution – Discourse analysis – Coherence and discourse structure – Evaluation techniques.

Unit:3 QUESTION ANSWERING AND DIALOGUE SYSTEMS

Information retrieval – Relation extraction – Question answering systems – Entity linking – Knowledge-based QA – Chatbots – Dialogue systems – Dialogue state tracking – Evaluation of dialogue systems.

Unit:4 SPEECH RECOGNITION AND SYNTHESIS

Automatic speech recognition – Acoustic modeling – HMM and DNN models – Feature extraction – End-to-end ASR – Text-to-speech synthesis – Text normalization – Prosody – Deep learning-based TTS – WaveNet and modern TTS systems.

Text Book

1. Speech and Language Processing – Daniel Jurafsky and James H. Martin, 3rd Edition, 2022.
-

Reference Books

1. Natural Language Processing and Information Retrieval – Tanveer Siddiqui and U. S. Tiwary.
2. Fundamentals of Speech Recognition – Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana.

Course Outcomes

CO1: Understand fundamentals of computer vision and feature extraction.

CO2: Describe deep learning architectures for vision tasks.

CO3: Apply deep learning models for image recognition, detection and segmentation.

CO4: Analyze advanced deep learning techniques in computer vision.

CO5: Develop solutions for real-world computer vision problems.

Unit:1 VISUAL FEATURES AND IMAGE REPRESENTATION

Image formation – Image representation – Filtering, correlation and convolution – Visual features – Edge detection – Blobs – Scale space – Feature descriptors – SIFT, SURF, HOG, LBP – Optical flow.

Unit:2 CONVOLUTIONAL NEURAL NETWORKS AND SEGMENTATION

CNN fundamentals – Convolutional layers – Pooling – Fully connected layers – Image segmentation – Semantic and instance segmentation – Fully convolutional networks – U-Net – Mask R-CNN – GANs for image generation – Style transfer.

Unit:3 OBJECT DETECTION AND VISUAL UNDERSTANDING

Object detection – R-CNN family – Fast R-CNN – Faster R-CNN – YOLO – SSD – CNNs for recognition and verification – Siamese networks – Loss functions – CAM and Grad-CAM – Visualization techniques.

Unit:4 ADVANCED MODELS AND APPLICATIONS

Recurrent neural networks in vision – Video analysis and action recognition – Attention mechanisms – Transformer models – Image captioning – Visual question answering – Generative models – GANs and VAEs – Recent trends – Few-shot and zero-shot learning.

Text Book

M.Sc., (AI & ML)

1. Deep Learning – Ian Goodfellow, Yoshua Bengio and Aaron Courville.
 2. Computer Vision: Models, Learning, and Inference – Simon Prince.
-

Reference Books

1. Neural Networks and Deep Learning – Michael Nielsen.
2. Learning Deep Architectures for AI – Yoshua Bengio.

ROBOTIC PROCESS AUTOMATION

4:0:0

Course Outcomes

CO1: Understand RPA concepts, tools and applications.

CO2: Design and develop automation workflows using UiPath.

CO3: Apply data manipulation and UI automation techniques.

CO4: Handle exceptions, logging and workflow management.

CO5: Develop real-world automation solutions using RPA tools.

Unit:1 INTRODUCTION TO RPA AND TOOLS

Introduction to RPA – Benefits and applications – Types of bots – RPA lifecycle – RPA tools overview – UiPath environment – Development methodology and key considerations.

Unit:2 BOT DEVELOPMENT AND WORKFLOW DESIGN

Activities and workflows – Sequences, flowcharts and state machines – Variables and data types – Control flow – Loops and decision making – Best practices for bot development.

Unit:3 DATA MANIPULATION AND UI AUTOMATION

Data tables – File operations – Excel/CSV integration – Clipboard management – UI automation – Control identification – Mouse and keyboard automation – Recording and scraping.

Unit:4 EXCEPTION HANDLING, DEPLOYMENT AND REAL-WORLD AUTOMATION

Exception handling – Logging and debugging – Project organization – Assistant bots – Event triggers – Automation use cases – Email automation – Deployment and maintenance of bots.

LIST OF INDICATIVE EXPERIMENTS

Unit:1 BASICS AND WORKFLOWS

1. Setup and configure UiPath Studio.
 2. Create sequence to take user input and display output.
 3. Develop flowchart-based navigation.
 4. Implement state machine workflow.
-

Unit:2 UI AUTOMATION

5. Automate web interactions using UI activities.
 6. Implement system activities with variables and arguments.
 7. Use triggers for automation.
-

Unit:3 DATA AUTOMATION

8. Automate email login process.
 9. Record mouse and keyboard actions.
 10. Extract data from websites and store in CSV.
 11. Perform data manipulation using Excel and PDF extraction.
-

Unit:4 ADVANCED AUTOMATION

12. Implement exception handling and logging.
 13. Work with UiPath Orchestrator components.
 14. Develop automated applications (e.g., Gmail login, data entry automation).
-

Text Book

1. Learning Robotic Process Automation – Alok Mani Tripathi, Packt Publishing.
2. The Robotic Process Automation Handbook – Tom Taulli, Apress.

Reference Books

M.Sc., (AI & ML)

1. Robotic Process Automation – Richard Murdoch.
2. Robotic Process Automation: A Complete Guide – Gerardus Blokdyk.
3. Introduction to Robotic Process Automation – Frank Casale et al.

LAB PRACTICALS

NEURAL NETWORKS AND DEEP LEARNING LAB

0:0:1

Course Outcomes

CO1: Understand deep learning concepts and frameworks.

CO2: Implement neural network models using tools like TensorFlow and Keras.

CO3: Apply deep learning techniques for image and text processing.

CO4: Design and evaluate deep learning models for real-world applications.

CO5: Analyze performance and optimize deep learning models.

LIST OF EXPERIMENTS

Unit:1 BASICS OF NEURAL NETWORKS

1. Introduction to Python tools – Google Colab, GitHub integration, dataset handling.
 2. Implement Perceptron model.
 3. Digit classification using neural networks (MNIST dataset).
-

Unit:2 TRAINING AND OPTIMIZATION

4. Implement Multilayer Perceptron (MLP).
 5. Hyperparameter tuning techniques.
 6. Mini-batch gradient descent and regularization.
-

Unit:3 CONVOLUTIONAL NEURAL NETWORKS

7. Image classification using CNN (MNIST dataset).
8. Face recognition using CNN.
9. Object detection using transfer learning.

Unit:4 ADVANCED DEEP LEARNING APPLICATIONS

M.Sc., (AI & ML)

10. Image denoising using Autoencoders.
 11. Text processing and language modeling using RNN.
 12. Sentiment analysis using LSTM.
 13. Transfer learning for classification tasks.
 14. Image generation using GAN.
-

Text Book

1. Deep Learning – Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press.

Course Outcomes

CO1: Understand NLP modules and speech processing fundamentals.

CO2: Apply techniques for text representation and processing.

CO3: Implement sequence models for language processing tasks.

CO4: Analyze and process speech signals using computational methods.

CO5: Develop applications for speech and language processing.

LIST OF EXPERIMENTS

Unit:1 NLP BASICS AND TEXT PROCESSING

1. Installation and setup of NLP and speech libraries (NLTK, SpaCy, SpeechRecognition).
 2. Perform POS tagging and syntactic parsing.
 3. Implement Bag of Words (BOW) and topic modeling.
 4. Implement N-gram language models for next-word prediction.
-

Unit:2 ADVANCED NLP AND DEEP LEARNING

5. Implement word embedding-based text classification.
 6. Perform sentiment analysis using CNN.
 7. Implement Named Entity Recognition using RNN.
 8. Implement text summarization using deep learning.
-

Unit:3 NLP APPLICATIONS

9. Develop a chatbot using deep learning.
 10. Implement machine translation using encoder-decoder models.
-

Unit:4 SPEECH PROCESSING APPLICATIONS

11. Develop a speech recognition system for voice commands.
 12. Implement continuous speech recognition.
 13. Implement CNN-based speech recognition using Mel-spectrogram features.
-

Text Book

1. Natural Language Processing with PyTorch – Delip Rao and Brian McMahan, O’Reilly, 2019.
-

Reference Books

1. Make Python Talk – Mark Liu, No Starch Press, 2021.

**ENTREPRENEURIAL AND INNOVATION/ IT SKILLS RELATED TO DOMAIN
SPECIFIC ELECTIVE COURSES(Choose any one).**

CYBER SECURITY

4:0:0

Course Outcomes

CO1: Explain concepts of cybercrime, cyber laws and security principles.

CO2: Identify cyber-attacks and apply appropriate mitigation techniques.

CO3: Perform reconnaissance and information gathering using tools.

CO4: Detect intrusions using monitoring and analysis techniques.

CO5: Apply preventive mechanisms to secure systems.

Unit:1 INTRODUCTION TO CYBER SECURITY AND CYBER LAWS

Cyber security fundamentals – History of internet and cybercrime – CIA triad – Cybercriminals and types of cybercrimes – Global perspective – Cyber laws – Indian IT Act – Cybercrime and punishment.

Unit:2 CYBER ATTACKS AND COUNTERMEASURES

Security threats and vulnerabilities – Types of cyber-attacks – Malware and attack vectors – Social engineering – Wireless and web application attacks – Attack tools – Countermeasures and security practices.

Unit:3 RECONNAISSANCE AND INFORMATION GATHERING

Information gathering techniques – WHOIS, Netcraft, DNS analysis – Email reconnaissance – Social engineering techniques – Scanning – Port scanning and network scanning – Vulnerability scanning – Nmap tools and techniques.

Unit:4 INTRUSION DETECTION AND PREVENTION SYSTEMS

Intrusion detection systems – Host-based and network-based IDS – Honeypots – Snort – Firewalls – Types and configurations – Intrusion prevention systems – Unified threat management.

Text Book

1. The Basics of Hacking and Penetration Testing – Patrick Engebretson, Elsevier.
2. Computer Security: Principles and Practice – William Stallings and Lawrie Brown, Pearson.
3. Introduction to Cyber Security – Anand Shinde, Notion Press.

Course Outcomes

CO1: Understand bioinformatics concepts and biological databases.

CO2: Apply sequence alignment and database search techniques.

CO3: Analyze phylogenetic relationships and genomic data.

CO4: Use predictive methods for gene and protein analysis.

CO5: Apply molecular modeling and drug design techniques.

Unit:1 BIOINFORMATICS DATABASES AND SEQUENCE ANALYSIS

Introduction to bioinformatics – Biological databases – NCBI, EBI, ExPASy, RCSB – GenBank, EMBL, DDBJ – Protein databases – UniProt, SWISS-PROT – File formats – FASTA, PDB – Sequence alignment – Substitution matrices – PAM, BLOSUM – BLAST – Multiple sequence alignment – MUSCLE – Motifs and patterns – PROSITE.

Unit:2 PHYLOGENETIC ANALYSIS AND GENOME BIOINFORMATICS

Phylogenetic trees – Rooted and unrooted trees – Tree construction methods – Distance and character-based methods – Bootstrapping – Genome sequencing – SNPs and polymorphism detection – Microarray data analysis – Comparative genomics tools.

Unit:3 PREDICTIVE METHODS IN BIOINFORMATICS

Gene prediction – Codon bias – Functional site detection – Promoters and transcription sites – RNA gene detection – Tools such as GENSCAN and GRAIL – Protein structure prediction – Secondary and tertiary structures – Tools like JPRED, SOPMA, DSSP.

Unit:4 MOLECULAR MODELING AND DRUG DESIGN

Restriction mapping – Primer design – Molecular modeling – Drug discovery – Molecular docking – QSAR – Pharmacophore modeling – Ligand-receptor interaction – Docking tools such as AutoDock and HEX.

M.Sc., (AI & ML)

Text Book

1. Computational Methods for Macromolecular Sequence Analysis – R. F. Doolittle.
2. Bioinformatics: Methods and Applications – P. Rastogi and S. C. Rastogi.
3. Computational Methods in Molecular Biology – Salzberg, Searls and Kasif

Course Outcomes

CO1: Design and develop web pages using HTML and CSS.

CO2: Create responsive layouts and forms for web applications.

CO3: Develop client-side applications using JavaScript and DOM.

CO4: Implement server-side scripting using PHP and object-oriented concepts.

CO5: Apply modern web technologies such as AJAX, jQuery and web services.

Unit:1 HTML AND CSS FUNDAMENTALS

Introduction to HTML – Structure of HTML documents – HTML5 semantic elements – CSS basics – Selectors – Box model – Text styling – Layout fundamentals.

Unit:2 TABLES, FORMS AND RESPONSIVE DESIGN

HTML tables and forms – Form elements and validation – Accessibility – CSS layout techniques – Positioning and floating – Responsive design – CSS frameworks.

Unit:3 JAVASCRIPT AND CLIENT-SIDE DEVELOPMENT

JavaScript basics – Syntax and objects – DOM manipulation – Events and form handling – Introduction to server-side scripting – PHP basics – Control structures and functions.

Unit:4 PHP, STATE MANAGEMENT AND MODERN WEB TECHNOLOGIES

PHP arrays and superglobals – File handling – Object-oriented programming in PHP – Error handling – State management – Cookies and sessions – AJAX – jQuery – JSON and XML – Web services.

Text Book

1. Fundamentals of Web Development – Randy Connolly and Ricardo Hoar, Pearson.
2. Learning PHP, MySQL & JavaScript – Robin Nixon, O'Reilly.

Reference Books

1. JavaScript & jQuery: The Missing Manual – David McFarland, O'Reilly.
2. Murach's HTML5 and CSS3 – Zak Ruvalcaba and Anne Boehm.

IV Semester

IMAGE PROCESSING AND VIDEO ANALYTICS

3:0:0

Course Outcomes

CO1: Understand basic concepts of digital image processing.

CO2: Apply image enhancement, segmentation and compression techniques.

CO3: Analyze features and perform object recognition in images.

CO4: Understand video processing and motion analysis techniques.

CO5: Apply video analytics for tracking and real-world applications.

Unit:1 IMAGE PROCESSING FUNDAMENTALS

Image processing system – Pixel relationships – Image transforms – Image enhancement – Histogram processing – Spatial filtering – Frequency domain filtering.

Unit:2 IMAGE SEGMENTATION, COMPRESSION AND COLOUR PROCESSING

Image segmentation – Edge detection and boundary detection – Thresholding – Region-based segmentation – Image compression – Lossy and lossless methods – JPEG and JPEG 2000 – Colour models – Colour transformations – Colour image enhancement and segmentation.

Unit:3 FEATURE EXTRACTION AND IMAGE ANALYSIS

Feature extraction – Shape and intensity features – PCA – SIFT and SURF – Texture analysis – Statistical and structural methods – Object recognition – Pattern classification – Template matching – Content-based image retrieval.

Unit:4 VIDEO PROCESSING AND ANALYTICS

Digital video fundamentals – Video sampling – Video enhancement – Compression standards – MPEG, H.264 – Motion estimation and compensation – Video segmentation – Background modeling – Motion tracking – Multi-object tracking – Action recognition and scene understanding.

Text Book

1. Digital Image Processing – Rafael C. Gonzalez and Richard E. Woods, Prentice Hall.
 2. Digital Video Processing – A. Murat Tekalp, Prentice Hall.
-

Reference Books

1. Practical Image and Video Processing Using MATLAB – Oge Marques, Wiley.
2. Image Engineering: Processing, Analysis and Understanding – Yu Jin Zhang.

DOMAIN SPECIFIC ELECTIVE COURSES (Choose any one).

BIG DATA FRAMEWORK

4:0:0

Course Outcomes

CO1: Understand big data concepts and challenges.

CO2: Explain Hadoop architecture and ecosystem tools.

CO3: Develop MapReduce programs for data processing.

CO4: Apply Spark framework for large-scale data analytics.

CO5: Implement Spark SQL, Streaming and Graph processing.

Unit:1 INTRODUCTION TO BIG DATA AND HADOOP

Big data concepts – Characteristics of big data – Big data analytics – Analytical architecture – Challenges in big data – Need for big data frameworks – Introduction to Hadoop – Hadoop architecture – HDFS – Hadoop components.

Unit:2 HADOOP FRAMEWORK AND ECOSYSTEM

Hadoop design principles – Hadoop 1 vs Hadoop 2 – Hadoop daemons – HDFS commands – MapReduce programming – I/O formats – Map-side and reduce-side join – Secondary sorting – Hadoop ecosystem – Hive, Pig, HBase, Zookeeper.

Unit:3 SPARK FRAMEWORK AND PROGRAMMING

Introduction to Spark – Hadoop vs Spark – Cluster architecture – RDD – RDD operations – Lazy evaluation – Spark jobs – Spark API – Data processing using Spark.

Unit:4 ADVANCED SPARK AND REAL-TIME PROCESSING

Spark SQL – DataFrames – GraphX – Graph processing – Spark Streaming – Real-time data processing – Error handling and recovery – Applications of big data frameworks.

LIST OF INDICATIVE EXPERIMENTS

Unit:1 HADOOP BASICS

1. HDFS commands and file operations.
 2. MapReduce program demonstrating combiner usage.
 3. MapReduce input/output formats (Text, Key-Value).
-

Unit:2 MAPREDUCE ADVANCED

4. NLine and Multi-line input formats.
 5. Sequence file input/output formats.
 6. Secondary sorting implementation.
 7. Distributed cache and joins (Map-side & Reduce-side).
-

Unit:3 SPARK PROGRAMMING

8. Building and running Spark applications.
 9. Word count using Hadoop and Spark.
 10. RDD manipulation operations.
 11. Inverted indexing using Spark.
 12. Matrix operations using Spark.
-

Unit:4 ADVANCED SPARK APPLICATIONS

13. Spark SQL programming.
 14. Spark Streaming applications.
 15. Sequence alignment problem using Spark.
-

M.Sc., (AI & ML)

Text Book

1. Hadoop: The Definitive Guide – Tom White.
 2. Spark: The Definitive Guide – Bill Chambers and Matei Zaharia.
 3. Big Data: Principles and Best Practices – Nathan Marz and James Warren.
-

Reference Books

1. Mastering Apache Spark – Mike Frampton, Packt.
2. Big Data: A Revolution That Will Transform How We Live – Viktor Mayer-Schönberger.

Course Outcomes

CO1: Understand cloud computing concepts and architecture.

CO2: Differentiate service and deployment models in cloud computing.

CO3: Apply cloud platforms for real-world applications.

CO4: Implement DevOps practices for cloud-based applications.

CO5: Analyze cloud infrastructure and data center requirements.

Unit:1 INTRODUCTION TO CLOUD COMPUTING

Cloud computing overview – Characteristics, benefits and challenges – Evolution of cloud computing – Cloud architecture – NIST reference model – Cloud ecosystem basics.

Unit:2 CLOUD SERVICE MODELS AND RESOURCE MANAGEMENT

Service models – IaaS, PaaS, SaaS – Deployment models – Public, private and hybrid cloud – Resource management – Virtualization – Elasticity – Security – Workload distribution and dynamic provisioning.

Unit:3 CLOUD ECOSYSTEM AND DEVOPS

Cloud ecosystem – Roles and stakeholders – Cloud adoption strategies – Use case identification – DevOps fundamentals – DevOps culture and lifecycle – Continuous integration and deployment – Monitoring and optimization.

Unit:4 CLOUD INFRASTRUCTURE AND APPLICATION DEPLOYMENT

Cloud platforms – AWS, Azure, Google Cloud – OpenStack architecture – Computer, networking and storage – Data center design – Automation tools – Application deployment and scaling – Cloud-based applications.

LIST OF INDICATIVE EXPERIMENTS

Unit:1 CLOUD BASICS

1. Create virtual machines using VirtualBox.
 2. Configure web server and access from another VM.
-

Unit:2 CLOUD SERVICES (AWS)

3. Deploy static web pages using AWS EC2 and S3.
 4. Implement load balancing and auto-scaling in AWS.
-

Unit:3 CLOUD APPLICATIONS

5. Deploy web applications using DaaS/PaaS platforms.
 6. Develop IoT-based application using cloud services.
 7. Deploy SaaS-based collaborative applications.
-

Unit:4 DEVOPS AND CLOUD AUTOMATION

8. Install and configure OpenStack environment.
 9. Implement DevOps deployment (CI/CD pipeline).
 10. Automate deployment using tools like Chef/Puppet.
-

Text Book

1. Cloud Computing: Principles and Paradigms – Rajkumar Buyya et al.
 2. Cloud Computing: Concepts, Technology & Architecture – Thomas Erl et al.
-

Reference Books

1. Distributed and Cloud Computing – Kai Hwang, Geoffrey Fox, Jack Dongarra.
2. Enterprise Cloud Computing – Gautham Shroff.

Lab Practicals

IMAGE PROCESSING AND VIDEO ANALYTICS LAB

0:0:1

Course Outcomes

CO1: Perform image operations using OpenCV.

CO2: Apply image enhancement and filtering techniques.

CO3: Process video data and perform frame-based analysis.

CO4: Implement motion detection and object tracking techniques.

CO5: Develop real-world image and video analytics applications.

LIST OF EXPERIMENTS

Unit:1 IMAGE PROCESSING BASICS

1. Read, display and save images using OpenCV.
 2. Convert color images to grayscale.
 3. Generate negative of an image.
 4. Plot histogram and apply histogram equalization.
-

Unit:2 IMAGE ENHANCEMENT AND TRANSFORMATIONS

5. Apply smoothing filters (Mean, Gaussian, Median).
 6. Perform geometric transformations (Scaling, Rotation, Translation).
 7. Apply morphological operations (Erosion, Dilation).
 8. Perform contour detection.
-

Unit:3 VIDEO PROCESSING

9. Read frames from video and create video sequences.

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10. Convert video frames to grayscale.
 11. Background subtraction for motion detection.
 12. Frame differencing method for moving object detection.
-

Unit:4 VIDEO ANALYTICS APPLICATIONS

13. Object detection using Haar Cascades (Face detection).
14. Object tracking using color-based techniques (HSV thresholding).

ENTREPRENEURIAL AND INNOVATION/ IT SKILLS RELATED TO DOMAIN SPECIFIC ELECTIVE COURSES(Choose any one).

AI CONCEPTS AND TECHNIQUES WITH PYTHON

4:0:0

Course Outcomes

CO1: Understand core concepts and techniques of Artificial Intelligence.

CO2: Apply search algorithms and knowledge representation methods.

CO3: Implement machine learning models using Python.

CO4: Develop deep learning models for real-world applications.

CO5: Build AI-based applications integrating ML, NLP and decision-making techniques.

Unit:1 INTRODUCTION TO AI AND PROBLEM SOLVING

Introduction to Artificial Intelligence – History and applications – Types of AI – Intelligent agents – Problem solving – State space representation – Uninformed search – Informed search – Heuristic search techniques.

Unit:2 KNOWLEDGE REPRESENTATION AND REASONING

Knowledge representation – Types of knowledge – Knowledge-based agents – Logical representation – Reasoning techniques – Decision-making concepts.

Unit:3 MACHINE LEARNING USING PYTHON

Supervised learning – Regression and classification – Decision trees, Naïve Bayes, SVM – Unsupervised learning – K-means clustering, PCA – Data preprocessing using NumPy and Pandas – Model building using Scikit-learn – Evaluation metrics – Overfitting and underfitting – Cross-validation and hyperparameter tuning.

Unit:4 DEEP LEARNING AND AI APPLICATIONS

Neural networks – Backpropagation – Activation functions – Optimization techniques – Introduction to CNN, RNN and LSTM – NLP basics (tokenization, stemming, sentiment analysis) – Reinforcement learning basics – Minimax and alpha-beta pruning – AI applications using Python libraries (TensorFlow, OpenCV, NLTK, spaCy).

Text Book

1. Artificial Intelligence: Beyond Classical AI – Reema Thareja, Pearson.
 2. Deep Learning with Python – François Chollet.
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Reference Books

1. Python Machine Learning – Sebastian Raschka & Vahid Mirjalili.
2. Introduction to Machine Learning with Python – Andreas Müller & Sarah Guido.
3. Make Your Own Neural Network – Tariq Rashid.

TIME SERIES ANALYSIS

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Course Outcomes

CO1: Understand time series components and preprocessing techniques.

CO2: Apply statistical models such as AR, MA, ARIMA and SARIMA.

CO3: Analyze multivariate and volatile time series using advanced models.

CO4: Implement machine learning models for forecasting.

CO5: Apply deep learning techniques for real-world time series problems.

Unit:1 INTRODUCTION AND EXPLORATORY ANALYSIS

Time series data types – Components (trend, seasonality, cyclic, irregular) – Time plots and lag plots – Autocorrelation (ACF) and Partial Autocorrelation (PACF) – Smoothing techniques – Moving average and exponential smoothing – Forecasting basics and error metrics (MSE, RMSE, MAPE, AIC, BIC).

Unit:2 STATISTICAL MODELS FOR TIME SERIES

Stationarity and tests (ADF, KPSS) – White noise – AR, MA and ARMA models – Model identification using ACF/PACF – Parameter estimation – Model diagnostics and selection – ARIMA and SARIMA models – Box-Jenkins methodology.

Unit:3 ADVANCED MODELS AND MACHINE LEARNING

Vector Autoregression (VAR) – Granger causality – ARCH and GARCH models – State-space models and Kalman filter – Feature engineering – Machine learning models (Linear regression, KNN, Random Forest, Gradient boosting) – Time series cross-validation and evaluation.

Unit:4 DEEP LEARNING AND APPLICATIONS

Neural networks for time series – RNN, LSTM, GRU – Sequence models – 1D CNN – Transformer models – Prophet model – Applications in finance, healthcare, IoT, energy and weather forecasting.

M.Sc., (AI & ML)

Text Book

1. Time Series Analysis: Forecasting and Control – Box, Jenkins, Reinsel, Ljung.
 2. Introduction to Time Series and Forecasting – Brockwell and Davis.
 3. Forecasting: Principles and Practice – Hyndman & Athanasopoulos.
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Reference Books

1. Applied Time Series Analysis – Woodward and Gray.
2. Deep Learning for Time Series Forecasting – Francesca Lazerri.