PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600123

Minor Degree

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Curriculum & Syllabus

DEPARTMENT OF

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

REGULATION 2023

PANIMALAR ENGINEERING COLLEGE

Department of Artificial Intelligence and Machine Learning

MINOR DEGREE
on
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1.	23ML4001	Artificial Intelligence	PE	3/0/0	3	3	60/40
2.	23ML4002	Machine Learning I	PE	3/0/0	3	3	60/40
3.	23ML4003	Machine Learning II	PE	3/0/0	3	3	60/40
4.	23ML4004	Reinforcement Learning	PE	3/0/0	3	3	60/40
5.	23ML4005	Natural Language Processing	PE	3/0/0	3	3	60/40
6.	23ML4006	Deep Learning	PE	3/0/0	3	3	60/40
7.	23ML4007	Computer Vision	PE	3/0/0	3	3	60/40
8.	23ML4008	AI for Gaming	PE	3/0/0	3	3	60/40

23ML4001	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To introduce the basic concepts and techniques of Artificial Intelligence.
- To understand knowledge representation and reasoning.
- To explore search strategies, game playing, and planning.
- To design intelligent agents capable of learning and decision making.
- To study AI applications in natural language processing and computer vision.

UNIT I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE ***9***

History and Foundations of AI – AI vs Human Intelligence – AI Techniques – Applications of AI – Intelligent Agents: Types of Agents – Rationality – PEAS Representation – Problem Solving – Formulating Problems — Solving Problems by Searching — Uninformed Search Strategies — Heuristics – Informed Search Strategies.

UNIT II: KNOWLEDGE REPRESENTATION AND REASONING ***9***

Knowledge-Based Agents — Logic — Propositional Logic — First Order Logic — Forward and Backward Chaining – Unification – Resolution – Ontological Engineering – Semantic Networks – Frames – Scripts – Truth Maintenance Systems.

UNIT III: PLANNING AND GAME PLAYING ***9***

Classical Planning — Planning Graphs — Partial Order Planning — Planning with State Space Search — Game Playing: Minimax Algorithm — Alpha-Beta Pruning — Stochastic Games — Evaluation Functions – Constraint Satisfaction Problems (CSPs) – Backtracking Search – Arc Consistency.

UNIT IV: MACHINE LEARNING AND UNCERTAINTY ***9***

Supervised Learning — Unsupervised Learning — Decision Trees — Neural Networks — Introduction to Deep Learning – Naive Bayes – Bayesian Networks – Probabilistic Reasoning – Markov Decision Processes – Hidden Markov Models.

UNIT V: ADVANCED TOPICS AND AI APPLICATIONS ***9***

Natural Language Processing: Syntax, Semantics, Parsing – Information Retrieval – Machine Translation — Computer Vision — Image Classification — AI in Robotics — Ethics and Societal Impacts of AI — Future of AI.

TOTAL HRS: 45 Periods

COURSE OUTCOMES

Upon completion of the course the student will be able to

CO1: Understand fundamental concepts and history of AI.
CO2: Apply logical reasoning and knowledge representation techniques.
CO3: Develop problem-solving strategies using search and planning algorithms.
CO4: Implement machine learning models and manage uncertainty.
CO5: Explore AI applications in NLP, vision, and robotics.

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson Education, 2021.
2. Elaine Rich, Kevin Knight, Shivashankar B. Nair, *Artificial Intelligence*, 3rd Edition, McGraw Hill, 2017.

REFERENCE BOOKS:

1. Deepak Khemani, *A First Course in Artificial Intelligence*, McGraw Hill Education, 2013.
2. Ethem Alpaydin, *Introduction to Machine Learning*, 4th Edition, MIT Press, 2020.

CO – PO Mapping Table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**2**	**2**	**1**			**1**						3	2	
CO2	**2**	**2**	**1**		**2**							3	2	
CO3	**2**	**2**	**1**		**2**							3	2	
CO4	**2**	**1**	**1**			**2**						3	2	
CO5	**2**	**2**	**1**			**2**						3	2	
CO6	**2**	**2**	**2**		**2**							3	2	

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ML4002	MACHINE LEARNING I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce fundamental concepts of machine learning.
- To familiarize students with supervised and unsupervised learning techniques.
- To explore linear and nonlinear models and performance evaluation methods.
- To apply learning algorithms to real-world problems.

UNIT I: INTRODUCTION TO MACHINE LEARNING 9

Definition of Machine Learning — Applications — Types of Learning: Supervised, Unsupervised, Reinforcement — Steps in Developing a ML Application — Overfitting & Underfitting – Bias-Variance Tradeoff – Evaluation Metrics: Accuracy, Precision, Recall, F1- Score.

UNIT II: SUPERVISED LEARNING - I 9

Linear Regression – Multiple Linear Regression – Logistic Regression – Gradient Descent – Regularization: L1, L2 – Performance Evaluation.

UNIT III: SUPERVISED LEARNING - II 9

Decision Trees — Random Forest — Support Vector Machines — k-Nearest Neighbors — Naive Bayes Classifier – Model Selection.

UNIT IV: UNSUPERVISED LEARNING 9

Clustering: K-Means, Hierarchical Clustering, DBSCAN – Dimensionality Reduction: PCA, t-SNE – Association Rule Learning.

UNIT V: ENSEMBLE LEARNING & APPLICATIONS 9

Bagging – Boosting – Stacking – Introduction to Neural Networks – Case Studies in Image, Text and Data Analysis.

TOTAL HRS: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

CO1: Understand basic machine learning concepts and models.

CO2: Apply supervised learning techniques to regression and classification problems.

CO3: Implement unsupervised learning for clustering and dimensionality reduction.

CO4: Evaluate model performance and improve accuracy.

CO5: Use ensemble methods for advanced prediction tasks.

CO6: Develop ML models for real-world data problems.

TEXTBOOKS:

1. Ian Goodfellow, Yoshua Bengio**,** Aaron Courville, Deep Learning, MIT Press, 2016.
2. Francois Chollet, Deep Learning with Python, Manning Publications, 2nd Edition, 2021.

REFERENCE BOOKS:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 3rd Edition, 2022.
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015 (available free online).
3. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, MIT Press, 2nd Edition, 2018.
4. Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 2018.

CO – PO/PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1							3	2	
CO2	3	2	2	2	2						1	3	2	
CO3	1	1	1	3	1	1						3	2	
CO4	3	3	1	3	1							3	2	
CO5	2	2	2	2	3	1		1				3	2	
CO6	2	2	2	2	3	1		1				3	2	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23ML4003	MACHINE LEARNING II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore advanced machine learning techniques beyond basic models.
- To understand ensemble methods, kernel-based algorithms, and probabilistic models.
- To analyze structured prediction and anomaly detection techniques.
- To introduce reinforcement learning and model evaluation strategies.
- To apply advanced ML methods to real-world structured and unstructured data.

UNIT I – ADVANCED SUPERVISED LEARNING METHODS 9

Limitations of Basic Models — Gradient Boosting Machines (GBM), AdaBoost — XGBoost — LightGBM – Hyperparameter Tuning – Grid Search & Random Search – Bias-Variance Revisited.

UNIT II – KERNEL METHODS AND SVMs 9

Kernel Trick — Polynomial and RBF Kernels — Support Vector Machines for Classification and Regression – Soft Margin and Hinge Loss – Dual Form – SMO Algorithm – Applications.

UNIT III – PROBABILISTIC GRAPHICAL MODELS 9

Bayesian Networks – Markov Random Fields – Inference Techniques – Expectation-Maximization (EM) Algorithm – Hidden Markov Models (HMMs) – Applications in Speech and Bioinformatics.

UNIT IV – UNSUPERVISED LEARNING & STRUCTURED DATA 9

Hierarchical Clustering — Spectral Clustering — Gaussian Mixture Models (GMMs) — Anomaly Detection — t-SNE and UMAP — Feature Engineering for Structured Data — Feature Selection Techniques.

UNIT V – REINFORCEMENT LEARNING AND MODEL DEPLOYMENT 9

Introduction to Reinforcement Learning – Markov Decision Processes (MDP) – Q-learning – Policy vs Value Methods – Evaluation Strategies – Model Interpretability – Deployment & Monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs):

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

CO1: Apply boosting and ensemble techniques to improve model performance.
CO2: Utilize kernel-based learning methods for classification and regression.
CO3: Construct probabilistic models and perform inference in real-world tasks.
CO4: Implement advanced clustering and anomaly detection for unsupervised problems.
CO5: Understand foundational reinforcement learning algorithms.
CO6: Analyze, interpret, and deploy machine learning models effectively.

TEXTBOOKS:

1. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, 4th Edition, 2020.

REFERENCE BOOKS:

1. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer, 2nd Edition, 2009.
3. Andriy Burkov, The Hundred-Page Machine Learning Book, 2019.
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

CO-PO/PSO Mapping Table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**2**	**2**	**1**			**1**						3	2	
CO2	**2**	**2**	**1**		**2**							3	2	
CO3	**2**	**2**	**1**		**2**							3	2	
CO4	**2**	**1**	**1**			**2**						3	2	
CO5	**2**	**2**	**1**			**2**						3	2	
CO6	**2**	**2**	**2**		**2**							3	2	

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ML4004	REINFORCEMENT LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the fundamental concepts of reinforcement learning, including agents, environments, and reward signals.
- Analyze decision-making problems using Markov Decision Processes (MDPs).
- Evaluate various RL algorithms including dynamic programming, Monte Carlo methods, and temporal difference learning.
- Explore model-free control strategies and function approximation techniques.
- Apply RL concepts to real-world scenarios through case studies and modern applications.

UNIT – I Multi-Armed Bandits and Foundations **9**

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

UNIT – II Markov Decision Processes **9**

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

UNIT – III Monte Carlo Methods and Model-Based Learning **9**

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

UNIT – IV Temporal Difference Learning and Model-Free Control **9**

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

UNIT – V Function Approximation **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student should be able to

CO1: Explain the fundamental principles and terminology of reinforcement learning.
CO2: Describe and implement Markov Decision Processes and the associated solution methods.
CO3: Analyze and apply dynamic programming and Monte Carlo methods to prediction and control problems.
CO4: Implement and evaluate temporal difference learning methods including TD(0) and TD(λ).
CO5: Apply function approximation techniques and policy gradient methods to solve practical RL problems.
CO6: Demonstrate the ability to design and analyze RL algorithms through hands-on case studies.

TEXTBOOKS:

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

REFERENCES:

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

WEB REFERENCES:

1. Reinforcement Learning: An Introduction (Official Sutton & Barto Book Site) http://incompleteideas.net/book/the-book.html
2. OpenAI – Spinning Up in Deep RLhttps://spinningup.openai.com
3. Berkeley Deep RL Course http://rail.eecs.berkeley.edu/deeprlcourse/

ONLINE RESOURCES:

1. Coursera (University of Alberta) Reinforcement Learning Specialization by Richard S. Sutton https://www.coursera.org/specializations/reinforcement-learning
2. edX (Columbia University) Machine Learning for Data Science and Analytics – RL Unit Included https://www.edx.org/course/machine-learning-for-data-science-and-analytics
3. Udacity Deep Reinforcement Learning Nanodegreehttps://www.udacity.com/course/deep-reinforcement-learning-nanodegree--nd893
4. YouTube (David Silver, DeepMind)Reinforcement Learning Course (Highly Recommended) https://www.youtube.com/playlist?list=PLqYmG7hTraZBiG_XpjnPrSNw-1XQaM_gB

CO – PO/PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	1	1		2	2	3	3	2	
CO2	2	2	1	2	1	1	1		2	2	3	3	2	
CO3	3	3	2	3	3	1	1	1	2	2	3	3	2	
CO4	2	2	1	2	3	2	1		1	1	2	2	1	
CO5	2	2	1	2	3	2	1		1	1	2	2	1	
CO6	2	2	1	2	1	1	1		2	2	3	2	1	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ML4005	NATURAL LANGUAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

- To learn the fundamentals of natural language processing
- To understand word level and syntactic analysis.
- To understand the syntax analysis and parsing
- To understand the role of semantics of sentences and pragmatics
- To get knowledge about the machine translation

UNIT I OVERVIEW AND LANGUAGE MODELLING 9

Overview: Origins and challenges of NLP Language and Grammar-Processing Indian Languages- NLP Applications Information Retrieval. Language Modeling: Various Grammar-based Language Models- Statistical Language Model.

UNIT II WORD LEVEL ANALYSIS AND MORPHOLOGY 9

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff — Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging — Hidden Markov and Maximum Entropy models

UNIT III SYNTACTIC ANALYSIS 9

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs

UNIT IV INFORMATION RETRIEVAL AND LEXICAL RESOURCES 9

Information Retrieval: Design features of Information Retrieval Systems-Classical, Non classical,

Alternative Models of Information Retrieval — valuation Lexical Resources: World Net-Frame Net- Stemmers-POS Tagger- Research Corpora.

UNIT V APPLICATIONS IN NLP 9

Question Answering with SQUAD – Dependency Parsing – Machine Translation – Conference Resolution – Text Summarization-WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC)

TOTAL HOURS:45 Periods

Course Outcomes:

CO1:Understand the fundamentals of NLP, its applications, and challenges.
CO2:Analyze various language models and evaluate their performance in NLP tasks.
CO3:Apply part-of-speech tagging methods using rule-based, stochastic, and transformation-based approaches.
CO4:Develop syntactic parsers using context-free grammar (CFG) and probabilistic models.
CO5:Analyze and evaluate information retrieval systems and their relevance in various models.
CO6:Implement applications such as machine translation, text summarization, and question answering using NLP techniques.

Text Books:

1. Daniel Jurafsky, James H. Martin, —Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition‖, Second Edition, Pearson Publication, 2014
2. Christopher Manning, —Foundations of Statistical Natural Language Processing‖, MIT Press, 2009.
3. Nitin Indurkhya and Fred J. Damerau, ‖Handbook of Natural Language Processing‖, Second Edition, Chapman & Hall/CRC Press, 2010.

References:

1. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python‖, First Edition, OReilly Media, 2009.
2. Breck Baldwin, —Natural Language Processing with Java and LingPipe Cookbook‖, Atlantic Publisher, 2015.
3. Richard M Reese,‖ Natural Language Processing with Java‖, First Edition,Packt Publishing,2015.
4. Yoav Goldberg, GraemeHirst, —Neural Network Methods for Natural Language Processing - Synthesis Lectures on Human Language Technologies‖, Morgan and Claypool Life Sciences, 2017.
5. Deepti Chopra,Nisheeth JoshiItiMathur, —Mastering Natural Language Processing with Python‖, First Edition, Packt Publishing Limited, 2016
6. Mohamed ZakariaKurdi —Natural Language Processing and Computational Linguistics 1: Speech, Morphology and Syntax‖, First Edition, ISTE Ltd. Wiley, 2016

7. AtefehFarzindar,DianaInkpen, —Natural Language Processing for Social Media,Second Edition, Morgan and Claypool Life Sciences, 2015

CO – PO/PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2						1	3	1	
CO2	3	3	2	2	3						1	3	2	
CO3	3	3	2	3	3						1	3	2	
CO4	3	2	3	3	3						2	3	2	
CO5	3	3	2	2	3						2	3	2	
CO6	3	2	3	2	3						2	3	2	1

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23ML4006	DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of deep neural networks.
- To explore convolutional and recurrent neural architectures.
- To study generative deep learning models.
- To apply deep learning techniques to image, text, and speech data.
- To introduce advanced topics like attention and transformer models.

UNIT I – FUNDAMENTALS OF DEEP LEARNING 9

Basics of Neural Networks – Perceptron – Multilayer Perceptron – Backpropagation – Activation Functions (ReLU, Sigmoid, Tanh) – Loss Functions – Optimizers (SGD, Adam) – Overfitting and Regularization (Dropout, Batch Normalization).

UNIT II – CONVOLUTIONAL NEURAL NETWORKS (CNNs) 9

Convolution and Pooling Layers – CNN Architecture – Feature Extraction – Image Classification – Transfer Learning – Pre-trained Models (VGG, ResNet, Inception).

UNIT III – RECURRENT NEURAL NETWORKS (RNNs) 9

RNN Basics – LSTM – GRU – Applications in Sequence Modeling – Time Series Forecasting – Language Modeling – Attention Mechanism – Introduction to Transformers.

UNIT IV – GENERATIVE MODELS 9

Autoencoders — Variational Autoencoders — Generative Adversarial Networks (GANs) — Applications in Image Generation – Denoising – Deep Belief Networks.

UNIT V – ADVANCED TOPICS AND APPLICATIONS 9

Natural Language Processing using Deep Learning – BERT, GPT (Overview) – Reinforcement Learning (Basics) – Real-Time Deep Learning Deployment – Edge AI – Ethics and Bias in Deep Learning Systems. **TOTAL: 45 PERIODS**

COURSE OUTCOMES (COs):

CO1: Build and train deep neural network models.

CO2: Apply CNNs to visual data and image recognition.

CO3: Model sequential data using RNNs and attention-based methods.

CO4: Develop and evaluate generative deep learning models.

CO5: Implement NLP applications using advanced transformer models.

CO6: Analyze ethical aspects and deploy deep learning models in real-time systems.

TEXTBOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville,Deep Learning, MIT Press, 016. (Comprehensive theoretical foundation for deep learning.)
2. Francois Chollet,Deep Learning with Python, Manning Publications, 2nd Edition, 2021.(Hands-on introduction using Keras and TensorFlow.)

REFERENCES:

1. Aurélien Géron,Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 3rd Edition, 2022.(Practical guide for building production-ready models.)
2. Michael Nielsen,Neural Networks and Deep Learning, Determination Press, 2015. (Free online resource, beginner-friendly.)
3. Charu C. Aggarwal,Neural Networks and Deep Learning: A Textbook, Springer, 2018.(Covers both basic and advanced models in a clear academic style.)
4. Richard S. Sutton and Andrew G. Barto,Reinforcement Learning: An Introduction, MIT Press, 2nd Edition, 2018.(Essential for understanding deep RL concepts.)
5. Sridhar Alla & Suman Kalyan Adari,Deep Learning with TensorFlow 2 and Keras, Packt Publishing, 2020.(Application-focused text with real-world case studies.)

CO – PO/PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	3	2	
CO2	**3**	**1**	**2**	**2**	**1**	**2**	**2**	**1**			**2**	3	2	
CO3	**3**	**1**	**2**	**2**	**1**	**2**	**3**	**1**			**2**	3	2	
CO4	**3**	**2**	**1**	**2**	**1**	**2**	**2**		**1**	**1**	**1**	3	2	
CO5	**3**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	3	2	
CO6	**3**	**3**	**2**	**2**	**2**	**3**	**1**	**2**	**2**	**2**	**3**	3	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23ML4007	COMPUTER VISION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the fundamental concepts and techniques of computer vision.
- To understand image formation, filtering, and feature detection.
- To study object detection, recognition, and motion analysis.
- To apply deep learning techniques in vision tasks.
- To explore applications in real-time and embedded vision systems.

UNIT I – INTRODUCTION TO COMPUTER VISION (9 periods)

Overview of Computer Vision – Applications – Human vs Computer Vision – Image Formation and Representation — Color Spaces — Sampling and Quantization — Camera Models — Image Pyramids.

UNIT II – IMAGE PROCESSING AND FEATURE DETECTION (9 periods)

Image Filtering: Gaussian, Median, Sobel – Edge Detection: Canny, Laplacian – Corner Detection: Harris, FAST – Feature Descriptors: SIFT, SURF, ORB – Image Matching – Hough Transform.

UNIT III – IMAGE SEGMENTATION AND OBJECT DETECTION (9 periods)

Thresholding — Region Growing — Clustering: K-means, Mean Shift — Watershed Algorithm — Object Detection Methods – Bounding Box and Non-Max Suppression – YOLO, SSD, Faster R- CNN (introduction).

UNIT IV – MOTION ANALYSIS AND 3D VISION (9 periods)

Optical Flow – Background Subtraction – Object Tracking: Kalman Filter, Mean Shift, Deep SORT – Structure from Motion – Stereo Vision – Depth Estimation – 3D Reconstruction.

UNIT V – DEEP LEARNING FOR VISION & APPLICATIONS (9 periods)

CNN Architectures for Vision — Transfer Learning — Image Classification and Segmentation — Semantic & Instance Segmentation — Real-Time Vision Applications — Face Recognition — Embedded Vision – Vision Ethics.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs):

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

CO1: Understand the fundamentals of image formation and representation.
CO2: Apply filtering and feature detection techniques to analyze images.
CO3: Perform object detection, segmentation, and tracking.
CO4: Use motion and depth cues for 3D reconstruction.
CO5: Implement vision models using deep learning frameworks.
CO6: Develop real-time computer vision applications.

TEXTBOOKS:

1. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2022. *(Comprehensive academic guide to the field.)*
2. Gonzalez and Woods, *Digital Image Processing*, Pearson, 4th Edition, 2018. *(Foundation in image processing techniques.)*

REFERENCE BOOKS:

1. Simon J. D. Prince,*Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012.
2. Adrian Rosebrock,*Practical Python and OpenCV*, PyImageSearch, 2016. *(Hands-on OpenCV and real-world projects.)*
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 2016. *(For deep learning applications in CV.)*
4. Joseph Redmon et al.,Research papers on YOLO and real-time object detection.

CO –PO/PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**1**									3	2	
CO2	**3**	**3**	**2**	**1**								3	2	
CO3	**3**	**3**	**3**	**2**	**2**	**1**						3	2	
CO4	**2**	**3**	**3**	**3**	**2**	**1**						3	2	
CO5	**3**	**3**	**3**	**2**	**3**	**2**						3	2	1
CO6	**3**	**2**	**3**		**3**	**3**						3	2	1

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

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		3	0	0	3

COURSE OBJECTIVE:

- To introduce the fundamental concepts and structure of Game AI, including models, complexity, and analytical geometry.
- To explain movement algorithms such as simple state machines and steering behaviours using computational geometry.
- To develop understanding of coordinated movement, motor control, and various path finding techniques like A and hierarchical planning.
- To impart knowledge of decision-making processes and tactics in games using state machines, fuzzy systems, and blackboard architectures.
- To explore learning techniques including decision trees, Bayesian methods, reinforcement learning, and neural networks in game environments.
- To enable students to apply AI strategies in game playing, including game theory, minimax, transposition tables, and turn-based games.

UNIT - I INTRODUCTION TO GAME AI 9

Introduction — Nature of Game AI — Models of game AI — AI Engine structure — representations, complexity, and constraints — Analytical Geometry 1.

UNIT - II MOVEMENT ALGORITHMS AND STEERING BEHAVIOUR 9

Simple State Machines — Computational Geometry — Kinetic and Dynamic Movement — Steering and combining steering — Analytical Geometry 2.

UNIT - III COORDINATED MOVEMENT, MOTOR CONTROL AND PATHFINDING 9

Interaction with Physics engine — Jumping — Coordinated movement — Motor Control — Pathfinding: pathfinding graphs — Dijkstra A* — hierarchical pathfinding — motion planning.

UNIT - IV DECISION MAKING, TACTICS AND LEARNING 9

Decision Making: Decision tree — State Machines — Fuzzy Logic Markov Systems — Goal- oriented behavior — Rule-based systems — black board architectures — Tactics and Strategy: waypoint tactics, tactical analyses, tactical pathfinding, coordinated action.

UNIT - V LEARNING AND GAME PLAYING 9

Learning: Decision tree learning, Naive Bayes, Reinforcement learning, Artificial Neural Networks —Game Playing: game theory, minimax, transposition tables, opening books and set plays, turn- based strategy games.

TOTAL HRS: 45 Periods

COURSE OUTCOMES

Upon completion of the course the student will be able to

CO1: Identify tasks that can be tackled using AI techniques.

CO2: Select the appropriate AI technique for the problem under investigation.

CO3: Design and implement efficient and robust AI algorithms for game tasks.

CO4: Develop Al game engines.
CO5: Evaluate performance and test the implemented algorithms.
CO6: Apply learning solutions to real world gaming techniques.

TEXT BOOKS

1. Ian Millington, *Artificial Intelligence for Games*, 2nd Edition, Morgan Kaufmann, 2009.
2. Steven Rabin, *AI Game Programming Wisdom*, Charles River Media, 2002.
3. David M. Bourg & Glenn Seemann, *AI for Game Developers*, O'Reilly Media, 2004.

REFERENCE BOOKS

1. Georgios N. Yannakakis & Julian Togelius, *Artificial Intelligence and Games*, Springer, 2018.
2. John David Funge, *AI for Games and Animation: A Cognitive Modeling Approach*, A K Peters/CRC Press, 1999.
3. Mat Buckland, *Programming Game AI by Example*, Wordware Publishing, 2005.

ONLINE RESOURCES

1. https://www.gdcvault.com – GDC Vault offers talks and resources on game AI from industry experts.
2. https://aigamedev.com – A community and resource hub for professionals working in game AI.
3. https://www.coursera.org/learn/artificial-intelligence-gaming — Coursera: *Artificial Intelligence in Games* (University-level MOOC).

CO – PO/PSO Mapping Table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2		2						1	3	2	
CO2	3	3	2		2						1	3	2	
CO3	3	3	3	2	3						2	3	2	
CO4	3	2	3	2	2						2	3	1	
CO5	3	2	2	3	3						2	3	1	1
CO6	3	3	3	3	3						2	3	1	1

Internal Assessment				**End Semester Examinations**
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40%				**60 %**