

Teaching Scheme and Syllabus

For

Bachelor of Technology

In

Artificial Intelligence

Minors in Artificial Intelligence



Department of Artificial Intelligence

**Sardar Vallabhbhai National Institute of Technology**

**Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat****Department of Artificial Intelligence****B.Tech. Artificial Intelligence****Minors in Artificial Intelligence**

Sr. No.	Semester	Subject	Code	Schema	Credit
1	4	INTRODUCTION TO ARTIFICIAL INTELLIGENCE (B. Tech./M.Sc., 4th Semester (Second Year) except B.Tech. AI and B.Tech. CSE)	MAI212	3-1-0	4
2	5	FUNDAMENTALS OF MACHINE LEARNING (B. Tech./M.Sc., 5th Semester (Third Year) except B.Tech. AI and B.Tech. CSE)	MAI313	3-0-2	4
3	6	INTRODUCTION TO DEEP LEARNING (B. Tech./M.Sc., 6th Semester (Third Year) except B.Tech. AI and B.Tech. CSE)	MAI314	3-0-2	4
4	7	INTELLIGENT SYSTEMS (B. Tech./M.Sc., 7th Semester (Fourth Year) except B.Tech. AI and B.Tech. CSE)	MAI415	3-1-0	4
5	7	Mini Project (B. Tech./M.Sc., 7th Semester (Fourth Year) except B.Tech. AI and B.Tech. CSE)	MAI417	0-0-8	4

# Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

## Department of Artificial Intelligence

### B.Tech. Artificial Intelligence

<b>B. Tech. II (AI) Semester – IV</b> <b>INTRODUCTION TO ARTIFICIAL INTELLIGENCE (MINORS)</b> <b>MAI212</b>	<b>Scheme</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
		<b>3</b>	<b>1</b>	<b>0</b>	<b>04</b>

<b>1. Course Outcomes (COs):</b>	
<b>At end of the program, students will be able to</b>	
CO1	understand the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
CO2	apply various knowledge representation technique, searching techniques, constraint satisfaction problem and example problems- game playing techniques.
CO3	analyse the current scope, potential, limitations, and implications of intelligent systems.
CO4	evaluate the AI techniques suitable for recent areas of applications like expert systems, neural networks, fuzzy logic, robotics, natural language processing, and computer vision.
CO5	design a real world problem for implementation and understand the dynamic behaviour of a system.

<b>2.</b>	<b>Syllabus</b>	
	<b>INTRODUCTION TO AI</b>	<b>(05 Hours)</b>
	Intelligent Agents, AI Techniques, AI-Problem formulation, AI Applications, Production Systems, Control Strategies.	
	<b>KNOWLEDGE REPRESENTATION</b>	<b>(06 Hours)</b>
	Knowledge Representation Using Predicate Logic, Introduction to Predicate Calculus, Resolution, Use of Predicate Calculus, Knowledge Representation Using other Logic-Structured Representation of Knowledge.	
	<b>PRODUCTION SYSTEM</b>	<b>(06 Hours)</b>
	Defining the Problems as a State Space Search, Production Systems, Production Characteristics, Production System Characteristics, Forward and Backward, State-Space Search, Problem Solving Methods – Problem Graphs, Matching, Indexing.	
	<b>PROBLEM-SOLVING THROUGH SEARCH</b>	<b>(06 Hours)</b>
	Generate and Test, BFS, DFS, Blind, Heuristic, Problem-Reduction, A, A*, AO*, Minimax, Constraint Propagation, Neural, Stochastic, and Evolutionary Search Algorithms, Sample Applications, Measure of Performance and Analysis of Search Algorithms, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis, Issues in the Design of Search Programs.	
	<b>KNOWLEDGE INFERENCE</b>	<b>(06 Hours)</b>
	Knowledge Representation -Production Based System, Frame Based System; Inference – Backward Chaining, Forward Chaining, Rule Value Approach; Fuzzy Reasoning – Certainty Factors, Bayesian Theory-Bayesian Network-Dempster – Shafer Theory; Symbolic Logic Under	

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### B.Tech. Artificial Intelligence

Uncertainty: Non-Monotonic Reasoning, Logics for Non-Monotonic Reasoning; Statistical Reasoning : Probability and Bayes Theorem, Certainty Factors, Probabilistic Graphical Models, Bayesian Networks, Markov Networks, Fuzzy Logic.	
<b>GAME PLAYING AND PLANNING</b>	<b>(06 HOURS)</b>
Overview and Example Domain: Overview, Minimax, Alpha-Beta Cut-Off, Refinements, Iterative Deepening, The Blocks World, Components of a Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques.	
<b>NATURAL LANGUAGE PROCESSING</b>	<b>(05 Hours)</b>
Introduction, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing, Spell Checking.	
<b>EXPERT SYSTEMS</b>	<b>(05 Hours)</b>
Expert Systems, Architecture of Expert Systems, Roles of Expert Systems, Knowledge Acquisition, Meta Knowledge, Heuristics, Typical Expert Systems – MYCIN, DART, XOON, Expert Systems Shells.	
<b>Tutorials will be based on the coverage of the above topics.</b>	<b>(15 Hours)</b>
<b>(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)</b>	

#### **3. Tutorials:**

1	Representation of Knowledge Using Predicate Logic
2	Problems on various search strategies.
3	Understand evolutionarily and genetic algorithm
4	Explore various algorithms based on game theory.
5	Study heuristic based search techniques.
6	Modelling of neural network.
7	Implementation of fuzzy logic based application.
8	Apply fuzzy inference-based engine for an application.
9	Implementation of neuro-fuzzy based system.

#### **4. Books Recommended:**

1.	Elaine Rich and Kevin Knight, "Artificial Intelligence", 2nd Edition, Tata McGraw-Hill, 2003.
2.	Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, 2009.
3.	Nils Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann, 1998,
4.	W. Patterson, 'Introduction to Artificial Intelligence and Expert Systems', Prentice Hall of India, 2010.
5.	I. Bratko, "Prolog Programming for Artificial Intelligence", 3/E, Addison-Wesley, 2001, 0-201-40375-7.

# Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

## Department of Artificial Intelligence

### B.Tech. Artificial Intelligence

<b>B. Tech. III (AI) Semester – V</b> <b>FUNDAMENTALS OF MACHINE LEARNING (MINORS)</b> <b>MAI313</b>	<b>Scheme</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
		<b>3</b>	<b>0</b>	<b>2</b>	<b>04</b>

<b>1. Course Outcomes (COs):</b>	
<b>At the end of the course, students will be able to</b>	
CO1	acquire knowledge of pattern recognition, regression, classification, clustering algorithms and statistics.
CO2	apply different classification, regression, machine learning algorithms and modelling.
CO3	analyze the data patterns and modelling for applying the learning algorithms.
CO4	evaluate the performance of an algorithm and comparison of different learning techniques.
CO5	design solution for real life problems like biometric recognition, natural language processing and its related applications using various tools and techniques of machine learning.

<b>2. Syllabus</b>	
<b>INTRODUCTION TO MACHINE LEARNING AND RELATED MATHEMATICS</b>	<b>(08 Hours)</b>
Introduction to Machine Learning, Why Machine Learning?, Types, Applications of M/L, Python libraries for ML, Fundamentals- Scalars, vectors, tensors, Equations, matrix, determinant, norms, kernel, Eigen values and Eigen vectors, introduction to probability and statistics, stochastic descent	
<b>DATA SAMPLING, PRE-PROCESSING AND PERFORMANCE EVALUATION</b>	<b>(06 Hours)</b>
Data sampling, Data preprocessing, Training, Validation, Testing, Performance Evaluation	
<b>SUPERVISED LEARNING</b>	<b>(08 Hours)</b>
Classification and Regression, Linear Regression, Logistic Regression, k-Nearest Neighbors, Naive Bayes Classifiers, Decision Trees, Support vector machine, Bagging, Boosting, Recommender system	
<b>ARTIFICIAL NEURAL NETWORKS</b>	<b>( 05 Hours)</b>
Artificial neural network- Neurons, Multilayered networks, Backpropagation model, RBM, Recurrent networks, Applications of Neural Networks	
<b>UNSUPERVISED LEARNING AND DIMENSIONALITY REDUCTION TECHNIQUES</b>	<b>(07 Hours)</b>
Clustering: k-Means Clustering, Density-based clustering, Agglomerative Clustering, Association rules, Dimensionality reduction, Principal Component Analysis, Linear Discriminant Analysis	
<b>DEEP LEARNING</b>	<b>(05 Hours)</b>
Deep Neural Networks, Deep learning models/algorithms: CNN, RNN, Deep belief networks, Auto-encoders, LSTM	
<b>APPLICATIONS</b>	<b>(06 Hours)</b>

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Signal Processing Application, Biometric Recognition, Information Retrieval, Natural Language Processing, Robotics and other case studies
<b>(Total Contact Time: 45 Hours+ 30 Hours = 75 Hours)</b>

#### 3. Practicals:

1. Handle missing values, normalize features, and perform exploratory data analysis (EDA) on a given dataset.
2. Implement linear regression using gradient descent and evaluate it using Mean Squared Error (MSE).
3. Build a logistic regression model for binary classification and evaluate using accuracy, precision, recall, and F1-score.
4. Implement the K-NN algorithm from scratch and evaluate it on a classification dataset.
5. Build a decision tree classifier from scratch and visualize the tree after training on a dataset.
6. Implement the K-Means algorithm from scratch and apply it for clustering on a given dataset.
7. Implement PCA and reduce a high-dimensional dataset to two components, then visualize the data.
8. Train a Random Forest classifier on a dataset and evaluate performance with accuracy and confusion matrix
9. Build and train a simple feedforward neural network for classification tasks using a deep learning framework.
10. ML project development

#### 4. Books Recommended:

1. Tom Mitchell, Machine Learning, McGraw-Hill Science/Engineering/Math
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Franchis Bach, Deep Learning (Adaptive Computation and Machine Learning series), MIT Press, 2017
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer, Second edition
4. Christopher M. Bishop, "Pattern Recognition and Machine Learning", 1st Edition, Springer, 2006.
5. Geoff Dougherty, "Pattern Recognition and Classification: An Introduction", 1st Edition, Springer, 2013.

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## Department of Artificial Intelligence

### B.Tech. Artificial Intelligence

<b>B. Tech. III (AI) Semester – VI</b> <b>INTRODUCTION TO DEEP LEARNING (MINORS)</b> <b>MAI314</b>	<b>Scheme</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credit</b>
		<b>3</b>	<b>0</b>	<b>2</b>	<b>04</b>

#### 1. Course Outcomes (COs):

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

CO1	Identify problems that could be solved using Deep learning.
CO2	Understand major components and key concepts of CNN, RNN, GAN, and Transformers.
CO3	Understand recent advancements in GANs.
CO4	Analyze and apply deep learning models for image and text tasks.
CO5	Design applications of Deep learning in Pytorch and Keras.

#### 2. Syllabus

<b>Introduction to Deep learning</b>	<b>(09 Hours)</b>
Motivation and History of Deep Learning, Overview of Applications (e.g., Vision, Speech, NLP), Supervised learning, Unsupervised learning, Reinforcement learning, Artificial Neural Networks (ANNs) ,Shallow neural network, From fully Connected Layers to Convolutions, Convolutions for images, Padding and Stride, Pooling, Activation Functions: Sigmoid, ReLU, Tanh, Forward and Backpropagation Algorithms, Convolution Neural Networks (LeNet) and floating point operations (FLOP), Gradient Descent, Optimization Algorithms in Deep learning, Weight Initialization and Regularization Techniques, Hyperparameter Tuning (Learning Rate, Batch Size), Overfitting and Underfitting	
<b>Modern Convolution Neural Networks</b>	<b>(05 Hours)</b>
Deep Convolution Neural Networks (AlexNet), Network using Blocks (VGG), Network in Network (NiN), Multi-Branch Networks (GoogLeNet), BatchNormalization, Layer Normalization, Instance Normalization, Group Normalization, Residual Networks (ResNet), Densely Connected Network (DenseNet), Transfer Learning and Fine-Tuning, Applications: Image Classification, Object Detection.	
<b>Modern Recurrent Neural Networks</b>	<b>(08 Hours)</b>
Working with sequences, Converting Raw Text into Sequence Data, Basic of Language models, Recurrent Neural Networks, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Applications: Text Generation, Sentiment Analysis	
<b>Introduction to Generative Modeling</b>	<b>(08 Hours)</b>
Generative modeling, Auto-encoder, Variational Auto encoders (VAE), Generative Adversarial Networks (GANs), GAN Training and loss function, GAN Challenges, Mode Collapse, Variants of GANs (DCGAN, cGAN, WGAP, WGAN-GP), Applications: Image Synthesis, Style Transfer	
<b>Applications of GANs and Advanced Topics</b>	<b>(06 Hours)</b>

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### B.Tech. Artificial Intelligence

Image-to-Image Translation (pix2pix), Neural Style Transfer (Style GAN), Face Manipulation, Superresolution, Inpainting, Image Segmentation, future of Generative Modeling, Explainable AI (XAI)	
<b>Introduction to Transformers and its Applications</b>	<b>(09 Hours)</b>
Attention Mechanisms, Natural Language, Transformer Language Models, Sequence-to-Sequence transformers, Vision Transformers. Text classification, Question Answering, Translation, Text Generation, future of Transformers, Applications: Machine Translation, BERT, GPT	
<b>(Total Contact Time: 45 Hours +30 Hours = 75 Hours)</b>	

#### 3. Practicals:

1. Basic Programming on deep learning frameworks Pytorch/Keras deep learning frameworks
2. Image classification using difference CNN architecture in Pytorch/Keras.
3. Transfer Learning of pretrained models on MNIST dataset.
4. Time-Series Forecasting with the LSTM Model in Pytorch/Keras.
5. Deep learning Techniques for image segmentation in Pytorch/Keras.
6. Autoencoders using MNIST Handwritten digits in Pytorch/Keras.
7. GAN for generating synthetic image on MNIST Handwritten digits dataset.
8. DCGAN for generating synthetic image on CIFAR dataset.
9. Text classification using Transformer and Fine-tune a pre-trained Transformer (e.g., BERT) for sentiment analysis.
10. Minor Project on classification and synthetic image generation and Deploy a trained DL model as a REST API using Flask.

#### 4. Books Recommended:

1. Dive into Deep Learning: Book by Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola.
2. Deep Learning. Book by Ian Goodfellow and Yoshua Bengio and Aaron Courville, The MIT
3. Deep Learning Foundations and Concepts, Book by, Christopher M. Bishop, Hugh Bishop
4. Josh Patterson and Adam Gibson, "Deep learning: A practitioner's approach", O'Reilly Media, First Edition, 2017.
5. Seth Weidman, Deep Learning from Scratch: Building with Python from First Principles, O'Reilly

# Sardar Vallabhbhai National Institute of Technology (SVNIT) Surat

## Department of Artificial Intelligence

### B.Tech. Artificial Intelligence

B. Tech. IV (AI) Semester – VII INTELLIGENT SYSTEMS (MINORS) MAI415	Scheme	L	T	P	Credit
		3	1	0	04

#### 1. Course Outcomes (COs):

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

CO1	understand the fundamentals of multi-agent systems: Grasp the core concepts, architectures, and challenges of multi-agent systems.
CO2	design and implement multi-agent systems: Apply techniques for designing, implementing, and analyzing multi-agent systems.
CO3	apply knowledge representation and reasoning techniques: Utilize knowledge representation languages and reasoning algorithms for building intelligent agents.
CO4	develop expert systems: Design and implement expert systems using various knowledge representation and reasoning techniques.
CO5	evaluate and analyze intelligent systems: Critically evaluate the performance and limitations of intelligent systems, including multi-agent and expert systems.

#### 2. Syllabus

<b>Introduction to Artificial Intelligence and Multi-Agent Systems</b>	<b>(06 Hours)</b>
Introduction to Artificial Intelligence: What is AI, History and Milestones, Multi-Agent Systems: Definition and characteristics, Types of agents: reactive, deliberative, hybrid, Agent architectures: BDI, SOAR, Challenges and limitations	
<b>Knowledge Representation and Reasoning</b>	<b>(08 Hours)</b>
Knowledge Representation Languages: Propositional and first-order logic, Semantic networks and ontologies, Frame-based representations, Reasoning Techniques: Inference rules - Modus Ponens, Modus Tollens, Forward and backward chaining, Uncertainty reasoning: Bayesian networks, fuzzy logic, Constraint satisfaction problems	
<b>Multi-Agent Coordination and Negotiation</b>	<b>(07 Hours)</b>
Coordination Mechanisms: Centralized and decentralized coordination, Task allocation and scheduling, Negotiation and bargaining strategies, Communication Protocols, Message passing and shared memory, Cooperation and Competition	
<b>Learning in Multi-Agent Systems</b>	<b>(06 Hours)</b>
Reinforcement Learning: Single-agent reinforcement learning, Multi-agent reinforcement learning, Machine Learning Techniques: Supervised learning, Unsupervised learning, Semi-supervised learning, Learning from Human Behavior: Imitation learning, Apprenticeship learning	
<b>Expert Systems</b>	<b>(10 Hours)</b>

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### B.Tech. Artificial Intelligence

Expert System Architecture: Knowledge base, Inference engine, User interface, Explanation facility, Knowledge Acquisition Techniques: Knowledge elicitation, Machine learning for knowledge acquisition, Expert System Applications: Medical diagnosis, Financial analysis	
<b>Ethical and Social Implications of Multi-Agent and Expert Systems</b>	<b>(08 Hours)</b>
Ethical Considerations: Bias and fairness, Privacy and security, Accountability and transparency, Social Impact: Increase in Productivity, Impact on Jobs, Impact on Policy Design	
<b>Tutorials will be based on the coverage of the above topics separately.</b>	<b>(15 Hours)</b>
<b>(Total Contact Time: 45 Hours + 15 Hours = 60 Hours)</b>	

#### 3. Tutorials:

1. Modelling of simple rule-based expert system
2. Solving forward and backward chaining algorithms
4. Analyze a Semantic Network with Knowledge Representation and Inference Rules
5. Designing a Simple Multi-Agent System
6. Explore Negotiation Strategies using a negotiation protocol
7. Design and explore a Medical Diagnosis Expert System using a knowledge-based system to diagnose diseases based on symptoms and uncertainty reasoning techniques
8. Gathering requirements and design of a Financial Advisor Expert System
9. Study Reinforcement Learning for Multi-Agent Systems to learn optimal policies through interaction with the environment
10. Explore Machine Learning for Agent Behavior to learn agent behaviors from data

#### 4. Books Recommended:

1. Russell, S., & Norvig, P. (2016). Artificial Intelligence: A Modern Approach. Pearson.
2. Wooldridge, M. J. (2009). An Introduction to MultiAgent Systems. John Wiley & Sons.
3. Giarratano, J., & Riley, G. (2021). Expert Systems: Principles and Programming. Cengage Learning.
4. Gerhard Welss (1999). Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence
5. Victor Dibia (2024). Multi-Agent Systems with AutoGen