TULSIRAMJI GAIKWAD-PATIL College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institute

Department of

Artificial Intelligence and Machine Learning

B.Tech.

Artificial Intelligence and Machine Learning

Syllabus of

Minor in Artificial Intelligence and Machine Learning

Considering

National Education Policy 2020

From

Academic Year 2025-26

Scheme of
Minor in Artificial Intelligence and Machine Learning

Sr. No.	Course Code	Course Title	T/P	Contact Hours			Credits	Total Marks
				L	P	Hrs.		
1	BAI12309	Introduction to AI	T	3	-	3	3	100
2	BAI12409	Fundamental of Problem solving in AI	T	3	-	3	3	100
3	BAI13513	Basics of Knowledge Representation & Reasoning	T	3	-	3	3	100
4	BAI13616	Introduction to Machine Learning	T	3	-	3	3	100
5	BAI14713	Fundamentals of Deep Learning	T	3	-	3	3	100
6	BAI14804	Introduction to Natural Language Processing	T	3	-	3	3	100
		Total	**-**	**18**	**-**	**18**	**18**	**600**

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NAAC Accredited (A+ Grade)

Second Year (Semester – III) B.Tech. Artificial Intelligence and Machine Learning

Teaching Scheme		Course Code: BAI12309 Course Name: Introduction to AI	Examination Scheme	
Theory	3 Hrs./wk.		**CT-1**	15 Marks
Tutorial	-		**CT-2**	15 Marks
Total Credit	3		**CA**	10 Marks
Duration of ESE: 3 Hrs.			**ESE**	60 Marks
			Total	100 Marks

Course Objective:

1	**Introduce** the fundamental concepts and history of Artificial Intelligence (AI).
2	**Develop understanding** of intelligent agents, knowledge representation, and search techniques.
3	**Apply AI problem-solving** approaches including search algorithms and constraint satisfaction.
4	**Analyze** different knowledge representation schemes and reasoning under uncertainty.
5	**Implement** basic AI applications and understand the role of learning in AI systems.

Course Contents

Unit I	**Foundations of Artificial Intelligence:** Introduction to AI: Definition, history, and scope; Turing Test and AI applications. Intelligent Agents: Types and characteristics, agent architectures, agent environments. Problem Solving by Searching: Uninformed search (BFS, DFS), informed (A*, greedy), problem formulation.
Unit II	**Knowledge Representation and Reasoning:** Knowledge Representation: Propositional and first-order predicate logic, inference, semantic networks. Automated Planning: Concepts, planning problem, solution strategies. Constraint Satisfaction Problems (CSP): Problem structure, backtracking, applications.
Unit III	**Uncertainty and Machine Learning:** Uncertainty in AI: Probabilistic reasoning, Bayes networks, reasoning with uncertainty. Machine Learning Overview: Types (supervised, unsupervised, reinforcement), basics of learning algorithms, decision trees.
Unit IV	**AI Techniques and Applications:** Game Playing: Minimax algorithm, evaluation functions, alpha-beta pruning. Natural Language Processing (NLP): Language models, parsing, basic NLP tasks. Expert Systems: Architecture, use-cases, shell design.
Unit V	**Advanced Topics in AI:** Robotics and Perception: Introduction to robotics, perception, and planning. Ethics in AI and Societal Impacts: Bias, fairness, explain ability, job impacts. Recent Trends: Generative AI, conversational agents, AI in vision and speech.

Text Books

T.1	Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Ed., Pearson, 2020.
T.2	Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", 4th Ed., Tata McGraw-Hill, 2019.
T.3	David Poole, Alan Mackworth, "Artificial Intelligence: Foundations of Computational Agents", 2nd Ed., Cambridge University Press, 2017.

Reference Books

R.1	N.P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford, 2015
R.2	Research papers from AAAI, IJCAI, NeurIPS, and ACM.

Useful Links

1	https://nptel.ac.in/courses/106105079
2	https://onlinecourses.nptel.ac.in/noc22_cs56

Course Outcomes		CL	Class Room
1	**Understand** foundational concepts, history, and intelligent agent architectures in AI.	2	9
2	**Apply** different search algorithms and strategies for AI problem-solving.	3	9
3	**Analyze** various knowledge representation techniques, logical inference, and reasoning under uncertainty.	4	9
4	**Evaluate** AI models in tasks such as planning, game playing, and language understanding.	5	9
5	**Design** and implement introductory AI solutions using appropriate algorithms and programming tools.	6	9

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Second Year (Semester – IV) B.Tech. Artificial Intelligence and Machine Learning

Teaching Scheme	
Theory	3 Hrs./wk.
Tutorial	-
Total Credits	3
Duration of ESE: 3 Hrs.	

Course Code: BAI12409
Course Name: Fundamental of Problem solving in AI

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks

Course Objective:

1	Introduce various problem-solving paradigms and the fundamental concepts of search in Artificial Intelligence.
2	Enable formulation of real-world problems as search tasks and apply appropriate search algorithms.
3	Equip students with knowledge of uninformed and informed search strategies, including their applications and complexities.
4	Expose students to advanced topics like constraint satisfaction, and game playing as search problems.
5	Familiarize with efficiency issues and optimizations, such as heuristic design and search space reduction techniques.

Course Contents

Unit I	**Introduction to Problem Solving in AI:** Problem characteristics: state space, initial and goal states, operators, Formulation of AI problems as search problems, Example problem domains: puzzles, games, route finding, robotics
Unit II	**Uninformed (Blind) Search Strategies:** Breadth-First Search (BFS) and its properties Depth-First Search (DFS), iterative deepening, backtracking Uniform Cost Search Complexities and limitations of blind search
Unit III	**Informed (Heuristic) Search Strategies:** Heuristics and evaluation functions Greedy Best-First Search A* Search: algorithm, admissibility and optimality Heuristic design: admissibility, consistency Local search: Hill-climbing, Simulated Annealing
Unit IV	**Advanced Search Topics:** Constraint Satisfaction Problems (CSP): definition, examples, backtracking algorithms, forward checking, arc consistency Search in game playing: Adversarial search Minimax algorithm and game trees Alpha-Beta pruning Real-world applications: pathfinding, automated planning
Unit V	**Search Optimization and Analysis:** Performance measures: completeness, optimality, time and space complexity Reducing search space: pruning, symmetry, abstraction Iterative improvement methods (Genetic Algorithms, Tabu Search - overview) Introduction to metaheuristics and their utility in AI problem solving

Text Books

T.1	Artificial Intelligence – A Modern Approach by Stuart Russell and Peter Norvig
T.2	Artificial Intelligence by Kevin Knight, Elaine Rich, and B. Shivashankar Nair
T.3	Problem Solving and Artificial Intelligence by R. J. Schalkoff.

Reference Books

R.1	Search in Artificial Intelligence by L. Nilsson; Introduction to Artificial
R.2	Intelligence by Philip C. Jackson; AI: A New Synthesis by Nils J. Nilsson.

Useful Links

1	https://assets.cambridge.org/97810092/84325/frontmatter/9781009284325_frontmatter.pdf

2	https://www.cet.edu.in/noticefiles/271_AI%20Lect%20Notes.pdf

Course Outcomes		CL	Class Session
1	**Formulate** and model problems as search tasks in Artificial Intelligence.	2	9
2	**Apply** and compare uninformed and informed search algorithms for solutions.	3	9
3	**Analyze** the effectiveness and limitations of various search strategies.	4	9
4	**Apply** constraint satisfaction and adversarial search techniques to problems.	3	9
5	**Evaluate** and optimize search-based solutions for real-world AI problems.	5	9

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Third Year (Semester-V) B. Tech. Artificial Intelligence and Machine Learning

Teaching Scheme		Course code: BAI13513 Course Name: - Basics of Knowledge Representation & Reasoning	Examination Scheme	
Theory	3 Hrs./wk.		CT-I	15 Marks
Tutorial	-		CT-II	15 Marks
Total Credits	3		CA	10 Marks
Duration of ESE: 3 Hrs.			ESE	60 Marks
			Total	100 Marks

Course Objectives:

1	Understand the informed and uninformed problem types and apply search strategies to solve them.
2	Apply difficult real-life problems in a state space representation so as to solve those using AI techniques like searching and game playing.
3	Design and evaluate intelligent expert models for perception and prediction from intelligent environment.
4	Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques.
5	Demonstrate and enrich knowledge to select and apply AI tools to synthesize information and develop models within constraints of application

Course Contents

Unit I	Introduction: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem Formulation.
Unit II	Searching: Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A* search Game Playing: Adverbial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search.
Unit III	Knowledge Representation**:** Using Predicate logic, representing facts in logic, functions and predicates, Conversion to clause form, Resolution in propositional logic, Resolution in predicate logic, Unification. Representing Knowledge Using Rules**:** Procedural Versus Declarative knowledge, Logic Programming, forward versus Backward Reasoning
Unit IV	Reasoning with Uncertain Knowledge: Uncertainty, non-monotonic reasoning, truth maintenance systems, default reasoning and closed world assumption, Introduction to probabilistic reasoning, Bayesian probabilistic inference, introduction to fuzzy sets and fuzzy logic, reasoning using fuzzy logic.
Unit V	Expert System: Representing and using Domain Knowledge, Reasoning with knowledge, Expert System Shells, Support for explanation examples, Knowledge acquisition-examples.

Text Books	
T.1	Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education.
T.2	Artificial Intelligence, Kevin Knight, Elaine Rich, B. Shivashankar Nair, 3rd Edition,2008
T.3	Artificial Neural Networks B. Yagna Narayana, PHI.
T.4	Artificial Intelligence, 2nd Edition, E.Rich and K.Knight (TMH).
Reference Books	
R.1	Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson.
R.2	PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.
Useful Links	
1	https://cyber.harvard.edu/topics/ethics-and-governance-ai
2	https://royalsocietypublishing.org/doi/full/10.1098/rsta.2018.0085
3	https://arxiv.org/abs/1812.02953

	Course Outcomes	CL	Class Session
CO1	**Identify** problems that are amenable to solution by specific AI methods	2	9
CO2	**Represent** knowledge in Prolog and write code for drawing inferences.	3	9
CO3	**Identify** appropriate AI technique for the problem at hand	3	9
CO4	**Compare** strengths and weaknesses of different artificial Intelligence techniques.	3	9
CO5	**Sensitive** towards development of responsible	4	9

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Third Year (Semester – IV) B.Tech. Artificial Intelligence and Machine Learning

Teaching Scheme		Course Code: BAI13616 Course Name: Introduction to Machine Learning	Examination Scheme	
Theory	3 Hrs./wk.		**CT-1**	15 Marks
Tutorial	-		**CT-2**	15 Marks
Total Credits	3		**CA**	10 Marks
Duration of ESE: 3 Hrs.			**ESE**	60 Marks
			Total	100 Marks

Course Objective:

1	**Identify** and explain the fundamental concepts and methods in machine learning, including various learning paradigms.
2	**Apply** and interpret core mathematical principles such as linear algebra, probability, and optimization to analyze and construct ML algorithms.
3	**Implement** and experiment with machine learning models on real-world datasets using modern tools and programming libraries.
4	**Evaluate** and compare machine learning algorithms based on their performance, strengths, limitations, and applicability to specific problems.
5	**Design** and plan machine learning-based solutions to practical problems and prepare for advanced studies or industry roles in AI and data science.

Course Contents

Unit I	**Introduction to Machine Learning:** What is Machine Learning? History and Evolution of ML Types of Machine Learning: Supervised Learning Unsupervised Learning Reinforcement Learning Applications of ML in various domains Challenges in Machine Learning.
Unit II	**Mathematical Foundations for ML:** Linear Algebra: Vectors, Matrices, Eigenvalues Probability & Statistics for ML: Bayes' Theorem, Expectation, Variance, Optimization Techniques: Gradient Descent Overfitting and Under fitting Bias-Variance Trade-off
Unit III	**Supervised Learning Algorithms and Unsupervised Learning Algorithms:** Regression Techniques: Linear Regression Logistic Regression Classification Algorithms: k-Nearest Neighbours (KNN) Decision **Trees** Support Vector Machines (SVM) Naive Bayes Model Evaluation: Accuracy, Precision, Recall, F1-Score, Confusion MatrixClustering: K-Means Hierarchical Clustering DBSCAN Dimensionality Reduction: PCA (Principal Component Analysis) t-SNE Applications of Unsupervised Learning
Unit IV	**Advanced Topics and Model Tuning:** Ensemble Methods: Random Forest Bagging & Boosting (AdaBoost, XGBoost) Cross-validation Techniques Feature Selection & Engineering Hyper parameter Tuning: Grid Search, Random Search Introduction to Neural Networks
Unit V	**Tools, Libraries & Real-world Projects:** Python Libraries: NumPy, Pandas, Scikit-learn, Matplotlib, TensorFlow/Keras (basics) Building and Evaluating ML Pipelines Hands-on Case Studies: Predictive Modelling (e.g., House Prices, Titanic Dataset) Classification Project (e.g., Email Spam Detection) Ethical Considerations in ML: Bias, Fairness, Transparency

Text Books

T.1	Pattern Recognition and Machine Learning – Christopher M. Bishop
T.2	The Elements of Statistical Learning – Hastie, Tibshirani, Friedman
T.3	Machine Learning: A Probabilistic Perspective – Kevin P. Murphy

Reference Books

R.1	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow – Aurélien Géron
R.2	Research Papers and Online Resources (Coursera, edX, MIT OCW)

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105214/
2	https://nptel.ac.in/courses/106/102/106102132

Course Outcomes		CL	Class Session
1	**Understand** and apply core ML algorithms.	2	9
2	**Implement** ML solutions in Python.	3	9
3	**Evaluate** and improve models using statistical techniques.	5	9
4	**Solve** real-world problems using ML methodologies.	3	9
5	**Understand** and apply core ML algorithms.	2	9

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Fourth Year (Semester – VII) B.Tech. Artificial Intelligence and Machine Learning

Teaching Scheme	
Theory	3 Hrs./wk.
Tutorial	-
Total Credits	3
Duration of ESE: 3 Hrs.	

Course Code: BAI14713
Course Name: Fundamentals of Deep Learning

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks

Course Objective:

1	**Explain** the fundamental concepts of deep learning, Bayesian learning, and optimization techniques.
2	**Apply** and implement various neural network architectures, including CNNs and MLPs, using appropriate tools.
3	**Analyze** optimization strategies (e.g., SGD, RMSProp, Adam) and regularization techniques in deep networks.
4	**Evaluate** different deep learning models and techniques for classification, detection, and segmentation.
5	**Design** and develop advanced deep learning architectures such as LSTM, GANs, and VAEs for real-world tasks.

Course Contents

Unit I	Foundations of Deep Learning: Introduction to Deep Learning and its Applications, Bayesian Learning and Decision Surfaces, Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques:, Gradient Descent, Batch Optimization
Unit II	Neural Networks and Backpropagation: Introduction to Neural Networks, Multilayer Perceptron (MLP), Backpropagation Learning Algorithm, Unsupervised Learning with Deep Networks, Autoencoders: Basic and Denoising Autoencoders
Unit III	Convolutional Neural Networks and Transfer Learning: Convolutional Neural Networks (CNN): Architecture and Concepts, Building Blocks of CNNs: Convolution, Pooling, Activation, Transfer Learning and Fine-tuning, Revisiting Gradient Descent: Momentum Optimizer, Respro, Adam Optimizer
Unit IV	Deep Network Regularization and Modern Architectures Effective Training in Deep Networks:, Early Stopping, Dropout ,Batch Normalization Instance Normalization, Group Normalization, Recent Trends in Architectures:, Residual Networks (ResNets),Skip Connections, Fully Connected CNNs
Unit V	Advanced Applications and Generative Models Classical Supervised Tasks with Deep Learning: Image Denoising Semantic Segmentation Object Detection, Recurrent Neural Networks:, LSTM (Long Short-Term Memory) Networks, Generative Modelling with Deep Learning:, Variational Autoencoders (VAEs),Generative Adversarial Networks (GANs)

Text Books

T.1	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
T.2	François Chollet, Deep Learning with Python, 2nd Ed., Manning, 2021.
T.3	Michael Nielsen, Neural Networks and Deep Learning, 2015 (online book).

Reference Books

R.1	Aurelien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 3rd Ed., O'Reilly, 2023.

R.2	Research papers from NeurIPS, ICLR, CVPR, and JMLR.
Useful Links	
1	https://nptel.ac.in/courses/106106184
2	https://nptel.ac.in/courses/106105215

	Course Outcomes	CL	Class Session
1	**Understand** key concepts of deep learning, including decision surfaces, linear classifiers, and neural networks.	2	9
2	**Apply** various optimization algorithms and training strategies to build and improve deep learning models.	3	9
3	**Analyze** the behaviour of deep neural architectures such as CNNs, RNNs, and Autoencoders in different tasks.	4	9
4	**Evaluate** model performance using standard metrics and select appropriate architectures for specific problems.	5	9
5	**Design** and implement deep learning solutions using advanced architectures like LSTM, GANs, and VAEs.	3	9

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Fourth Year (Semester – VIII) B.Tech. Artificial Intelligence and Machine Learning

Teaching Scheme	
Theory	3 Hrs./wk.
Tutorial	-
Total Credits	3
Duration of ESE: 3 Hrs.	

Course Code: BAI14804
Course Name:
Introduction to Natural Language Processing

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks

Course Objective:

1	**Explain** key NLP concepts like text processing, language modeling, and parsing.
2	**Apply** ML techniques to tasks such as tagging, parsing, and classification.
3	**Build** NLP pipelines using Python tools.
4	**Evaluate** NLP models using standard metrics
5	**Design** NLP solutions for real-world or research problems.

Course Contents

Unit I	**Text Processing & Language Modelling:** Introduction & basic text processing (tokenization, normalization, spelling correction) Language Modelling using n-grams and smoothing techniques
Unit II	**Sequence Labelling & Parsing:** POS tagging and advanced smoothing**,** Sequence labelling using Maximum Entropy models and CRFs**,** Syntax parsing—Constituency and Dependency Parsing
Unit III	**Distributional Semantics & Topic Models**: Distributional semantics and lexical semantics (e.g. WordNet, WSD): Topic modelling techniques (e.g. LDA), and embeddings
Unit IV	**Applications & Text Mining**: Entity Linking and Relation Extraction, Text summarization, classification, sentiment analysis, and opinion mining
Unit V	**Advanced & Emerging Approaches:** Introduction to neural approaches (if covered): e.g., word embeddings and neural tagging, Deep NLP architectures—RNNs/LSTMs, transformers (depending on depth in course) Ethical considerations and multilingual NLP (especially Indian languages)

Text Books

T.1	Speech and Language Processing – Dan Jurafsky & James H. Martin, 2nd Ed.
T.2	Foundations of Statistical NLP – Manning & Schütze, MIT Press, 1999

Reference Books

R.1	Natural Language Processing with Python**:** Steven Bird, Ewan Klein, Edward Loper
R.2	Neural Network Methods in Natural Language Processing**,** Yoav Goldberg, Morgan & Claypool

Useful Links

1	https://nptel.ac.in/courses/106101007
2	https://nptel.ac.in/courses/106105158

Course Outcomes		CL	Class Session
1	**Explain** core concepts of Natural Language Processing, including tokenization, language modelling, syntax, and semantics.	2	9
2	**Apply** statistical and machine learning methods for basic NLP tasks like tagging, parsing, and text classification.	3	9
3	**Develop** NLP applications and pipelines using Python-based frameworks (e.g., NLTK, spaCy, Hugging Face).	3	9
4	**Analyze** the strengths and limitations of NLP algorithms using appropriate evaluation metrics.	4	9
5	**Design** and **implement** solutions for real-world problems in NLP domains such as sentiment.	3	9