Artificial Intelligence – Detailed Syllabus with Explanations

Unit 1: Introduction to AI

Introduction to AI

Artificial Intelligence (AI) is the simulation of human intelligence in machines programmed to think and learn. It includes reasoning, learning, problem-solving, perception, and language understanding.

History & Foundations of AI

AI began in the 1950s with pioneers like Alan Turing and John McCarthy. Major milestones include expert systems, machine learning, deep learning, and modern generative AI.

Applications of AI

AI is used in healthcare, robotics, finance, NLP, computer vision, transportation, gaming, cybersecurity, and more.

Intelligent Agents

Agents perceive their environment and act upon it. Types include simple reflex agents, goal-based agents, utility-based agents, and learning agents.

Structure of Intelligent Agents

Includes sensors, actuators, performance measures, and the agent function.

Computer Vision Basics

Computer vision enables computers to interpret images/videos using techniques like edge detection, segmentation, and CNNs.

Natural Language Processing (NLP)

NLP allows machines to understand and generate human language using tokenization, syntax parsing, embeddings, and transformers.

Unit 2: Searching for Solutions

State-space & Problem Formulation

A problem is defined by initial state, actions, transition model, and goal state.

Uninformed Search: BFS, DFS, UCS

BFS explores level-wise, DFS goes deep-first, and UCS expands the least-cost node.

*Informed Search: Heuristics, Greedy, A**

Heuristics estimate the cost-to-go. Greedy chooses lowest heuristic; A* uses f(n)=g(n)+h(n).

Local Search: Hill climbing, Simulated Annealing

Hill climbing improves iteratively; SA escapes local maxima by probabilistic moves.

Adversarial Search: Minimax, Alpha-Beta pruning

Used for games like chess; minimax selects optimal moves; alpha–beta pruning reduces exploration.

Search for Games

Game trees, utility functions, evaluation functions are used to simulate multi-agent competition.

Unit 3: Logic & Probabilistic Models

Propositional Logic

Uses propositional variables and logical operators (AND, OR, NOT, IMPLIES).

First-order Predicate Logic

More expressive; uses quantifiers, predicates, constants, and functions.

Inference in FOL: Unification & Modus Ponens

Unification makes expressions identical; GMP derives new facts.

Forward & Backward Chaining

Forward chaining applies rules to known facts; backward chaining works backward from the goal.

Resolution

A complete inference rule used in logical proofs and SAT solving.

Probabilistic Reasoning

Handles uncertainty using probability theory, conditional probability, and inference.

Hidden Markov Models (HMM)

Used for speech and sequence modeling; defined by states, transitions, emissions.

Bayesian Networks

Graphical models representing dependencies among variables using conditional probabilities.

Unit 4: Machine Learning

Supervised & Unsupervised Learning

Supervised uses labeled data; unsupervised discovers hidden patterns.

Decision Trees

A tree-based classification/regression model using entropy and information gain.

Statistical Learning Models

Includes logistic regression, linear regression, probabilistic classifiers.

Learning with Complete Data

Assumes all features are available; simplifies learning and inference.

Naive Bayes Models

Assume feature independence; used in spam filtering, sentiment analysis.

Reinforcement Learning

Agents learn by interacting and receiving rewards; includes Q-Learning and policy gradients.

Pattern Recognition Principles

Steps include sensing, segmentation, feature extraction, classification, and post-processing.

Unit 5: Statistical Pattern Recognition

Statistical Pattern Recognition

Uses statistical decision theory to classify data based on distributions.

Parameter Estimation Methods

MLE and MAP approaches are used to estimate model parameters.

Principal Component Analysis (PCA)

Dimensionality reduction using eigenvalues and eigenvectors.

Linear Discriminant Analysis (LDA)

Projects data to maximize class separability.

Classification Techniques

Includes SVM, KNN, Logistic regression, Decision trees, and Neural Networks.