

AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER
Department of Computer Engineering
Honors in Advanced Artificial Intelligence (18 Credits)

Year	Semester	Course Code	Course Name	Credits
Second Year	Sem III	R25-CO-HOC-201	AI for Industry and Business Applications	3
	Sem IV	R25-CO-HOC-202	Computational Problem-Solving using AI	3
Third Year	Sem V	R25-CO-HOC-301	Natural Language Processing and Intelligent Systems	3
	Sem VI	R25-CO-HOC-302	Computer Vision and Intelligent Image Analytics	3
Final Year	Sem VII	R25-CO-HOC-401	Autonomous AI Systems and Intelligent Agents	3
	Sem VIII	R25-CO-HOC-402	Generative AI & Large Language Models	3


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 Sangamner-422608

Program:	S. Y. B. Tech (Computer Engineering)			Semester:	III		
Course:	Artificial Intelligence in Industrial and Management Engineering			Course Code:	R25-CO-HOC-201		
Teaching Scheme (Hrs. / week)			Credits (TH)	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
3	-	-	3	40	60	-	-
Course Description: Artificial intelligence is enabling innovative solutions across industrial and management sectors, increasing the demand for professionals with AI knowledge. This course introduces the fundamental concepts and major subdomains of AI along with their practical applications. Python is used to demonstrate key concepts and encourage students to explore different areas of AI based on their interests.							
Course Relevance: The course develops interdisciplinary competence to use AI for data-driven decision making, intelligent business systems, industrial analytics, production planning, process improvement, and optimization. It is relevant to learners seeking to apply AI methods in manufacturing, services, operations, supply chains, and management systems.							
Prerequisite: The student should have completed two semesters of UG Engineering or Science program.							
Bridge Content: Overview of basic AI terminology and its role in business and industrial decision-making.							
Course Objectives: ● To introduce AI, its evolution, latest advancements, and roles in business. ● To explain knowledge representation, logic, reasoning systems, and expert systems. ● To develop understanding of search algorithms and natural language processing techniques. ● To introduce machine learning basics, inductive learning, decision trees, and neural networks. ● To apply metaheuristic concepts to production scheduling and facility layout problems.							
Course Outcomes: After learning the course, students will be able to:							
CO	Course Outcome					Bloom's Level	
CO1	EXPLAIN AI evolution, latest advancements, roles in business, knowledge representation, logic, and reasoning systems.					2	
CO2	EXPLAIN expert-system architecture and backward-chaining concepts through medical expert-system case studies.					2	
CO3	APPLY search techniques and natural-language-processing concepts to basic problem scenarios.					3	
CO4	EXPLAIN machine-learning basics, inductive learning, decision trees, and neural networks.					2	
CO5	ANALYZE production-scheduling and facility-layout problems using metaheuristic approaches and case studies.					4	
Course Contents							
Unit 1	AI Foundations, Knowledge Representation and Reasoning					Weeks 1-2	CO1
Introduction to AI, Evolution of AI, Latest advancements in AI, Roles of AI in business, Introduction to knowledge representation, Introduction to logic, Reasoning systems, Advantages and disadvantages of knowledge representation methods.							

Exemplars / Practical Applications and usage: ● Role of AI in business applications and decision-making. ● Comparison of knowledge representation methods based on their advantages and disadvantages. ● Use of logic and reasoning systems for representing and solving structured problems.			
Assignments: 1. Prepare a short timeline showing the evolution of AI and identify recent AI advancements with their business roles. 2. Compare knowledge representation methods and explain their advantages and disadvantages for a selected reasoning problem.			
Unit 2	Expert Systems and Backward Chaining	Week 3	CO2
Basic architecture of expert systems, Simple backward chaining expert systems, Medical expert system case study - I, Medical expert system case study - II.			
Exemplars / Practical Applications and usage: ● Basic expert-system architecture showing knowledge base, inference process, & user interaction. ● Backward chaining in a simple expert system. ● Medical expert-system case study for understanding rule-based reasoning.			
Assignments: 1. Draw and explain the basic architecture of an expert system. 2. Demonstrate simple backward chaining using a small medical expert-system case study.			
Unit 3	Search Techniques and Natural Language Processing	Weeks 4-5	CO3
Search algorithms, Local search, Solving puzzles, Limitations of search techniques, Introduction to NLP, Processing stages in NLP, Speech processing, Applied NLP.			
Exemplars / Practical Applications and usage: ● Use of search algorithms and local search for solving puzzles. ● Study of limitations of search techniques for different problem types. ● NLP processing stages, speech processing, and applied NLP examples.			
Assignments: 1. Apply a suitable search technique to a puzzle and explain the search process and its limitations. 2. Explain the processing stages in NLP and illustrate speech processing or an applied NLP use case.			
Unit 4	Machine Learning and Neural Networks	Week 6	CO4
Machine learning basics, Inductive learning, Decision trees, Neural Network.			
Exemplars / Practical Applications and usage: ● Inductive learning for learning patterns from examples. ● Decision-tree based classification and decision making. ● Neural-network concepts for basic learning and prediction tasks.			
Assignments: ● Explain machine learning basics with one real-life application. ● Create a simple example showing how a decision tree can be used for classification or decision-making.			
Unit 5	Production Scheduling and Facility Layout Using Metaheuristics	Weeks 7-8	CO5
Introduction to production scheduling, Metaheuristics for scheduling, Applied scheduling case study using metaheuristics - I, Applied scheduling case study using metaheuristics - II, Introduction to facility layout problems, Metaheuristics for facility layouts, Applied case study on facility layout - I, Applied case study on facility layout - II.			

Exemplars / Practical Applications and usage:

- Production scheduling using metaheuristic approaches.
- Applied facility-layout case studies.

Assignments:

1. Analyze a production-scheduling case and explain how a metaheuristic approach can be used.
2. Analyze a facility-layout case and explain how metaheuristics can support layout improvement.

Textbooks:

1. Russell, S. J., Norvig, P., Chang, M.-W., Devlin, J., Dragan, A., Forsyth, D., Goodfellow, I., Malik, J., Mansinghka, V., Pearl, J., & Wooldridge, M. J. (2022). Artificial intelligence : a modern approach (Fourth edition. Global edition). Pearson.
2. Rich, E., Knight, K., & Nair, S. B. (2009). Artificial intelligence (3rd ed). Tata McGraw-Hill.

Reference Books:

1. Patrick Henry Winston, Artificial Intelligence, Pearson, Latest Edition.

MOOCs Links and additional reading material:

1. Artificial Intelligence in Industrial and Management Engineering (NPTEL – IIT Kanpur)
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge105

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	–	–	1	1	–	–	–	1	2	2	1	1
CO2	3	2	2	1	2	–	–	–	–	1	2	3	2	2
CO3	3	3	2	2	3	–	–	–	–	1	2	3	3	2
CO4	3	3	2	2	3	–	–	–	–	1	2	3	3	2
CO5	3	3	3	3	3	1	–	–	1	1	2	3	3	3
Avg	2.8	2.4	2.2	2.0	2.4	1.0	–	–	1.0	1.0	2.0	2.8	2.4	2.0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern**a) Continuous Comprehensive Evaluation (CCE) – 40 Marks**

The Continuous Comprehensive Evaluation shall be carried out by the Department based on the student's performance throughout the duration of the SWAYAM-NPTEL course.

- Performance in NPTEL Weekly Assignments: 30 Marks
- Course Progress and Participation (completion of video lectures, timely submission of weekly assignments, and periodic progress monitored by the Faculty Mentor): 10 Marks

b) End Semester Evaluation (ESE) – 60 Marks

1. Students shall register for and appear in the SWAYAM-NPTEL Proctored Certification Examination.
2. The marks obtained in the NPTEL Proctored Examination shall be converted proportionally to 60 marks using the following formula:

$$\text{ESE Marks} = \left(\frac{\text{NPTEL Proctored Examination Score}}{100} \right) \times 60$$

3. Students who successfully obtain the NPTEL certificate shall have the converted score considered as the End Semester Evaluation (ESE) marks.
4. Students who fail to obtain the NPTEL certificate, fail to appear for the NPTEL certification examination, or fail the certification examination shall appear for the Institute End Semester Examination conducted by the College.
5. If a student appears for both the SWAYAM-NPTEL Certification Examination and the Institute End Semester Examination, the higher of the two ESE scores shall be considered for the award of the final grade.
6. The decision of the Department regarding verification of NPTEL scores and award of marks shall be final and binding.

BT Level	CCE						ESE
	CT1	CT2	Assignments	Course Project	Field Activity / Case Study	Quiz / presentation etc.	
K1	-	-	✓	-	-	-	✓
K2	-	-	✓	-	-	-	✓
K3	-	-	✓	-	-	-	✓
K4	-	-	✓	-	-	-	✓
K5	-	-	-	-	-	-	-
K6	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses: The course provides a foundation for advanced study in Artificial Intelligence, Machine Learning, Natural Language Processing, Intelligent Systems, Industrial Engineering Analytics, Production Scheduling, and Facility Layout Optimization.

Job Mapping:

- AI / Machine Learning Associate
- Industrial Engineering Analyst
- Operations / Scheduling Analyst
- NLP / Intelligent Systems Associate

Program:	S. Y. B. Tech (Computer Engineering)			Semester:	IV		
Course:	Artificial Intelligence: Search Methods for Problem Solving			Course Code:	R25-CO-HOC-202		
Teaching Scheme (Hrs. / week)			Credits (TH)	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
3	-	-	3	40	60	-	-
Course Description: This course introduces artificial intelligence from the perspective of problem solving by search. It develops the ability to formulate problems as state-space or solution-space search problems and to select suitable search strategies for reaching desired goal states. The course covers uninformed, heuristic, local, population-based and optimal search methods, followed by game playing, automated planning, problem decomposition, rule-based systems, deduction as search, and constraint processing.							
Course Relevance: The course develops algorithmic competence for intelligent problem solving in autonomous agents, robotics, route planning and optimization, game AI, planning systems, expert systems, and other AI applications.							
Prerequisite: Exposure to data structures, programming, and the ability to discuss algorithms.							
Bridge Content: : Overview of AI terminology, intelligent agents, problem formulation, state-space representation, goal states, search trees, and basic algorithm analysis.							
Course Objectives: ● To introduce the historical, philosophical, and computational foundations of artificial intelligence and intelligent problem solving. ● To develop understanding of state-space, heuristic, local, population-based, and optimal search methods. ● To apply search methods to path finding, puzzles, TSP, SAT, and other structured problem-solving scenarios. ● To explain game playing, automated planning, problem decomposition, and rule-based problem-solving approaches. ● To introduce deduction as search and constraint-processing methods for systematic AI problem solving.							
Course Outcomes: After learning the course, students will be able to:							
CO	Course Outcome					Bloom's Level	
CO1	EXPLAIN the historical, philosophical, and computational foundations of Artificial Intelligence and intelligent problem-solving approaches.					2	
CO2	EXPLAIN state-space, heuristic, local, population-based, and optimal search methods and their characteristics for AI problem solving.					2	
CO3	APPLY appropriate search techniques to solve path-finding, puzzles, TSP, SAT, and other structured problem-solving scenarios.					3	
CO4	ANALYZE game-playing, automated planning, problem decomposition, and rule-based approaches for solving AI problems.					4	
CO5	APPLY deduction-as-search and constraint-processing techniques to systematically model and solve AI problem-solving tasks.					3	

Course Contents			
Unit 1	AI Foundations and State-Space Search	Weeks 1-2	CO1
Introduction to AI; history of AI; can machines think; Turing Test; Winograd Schema Challenge; philosophy, mind and reasoning; computation; Dartmouth Conference; agents; problem solving; state-space search; domain-independent search; deterministic search; Depth First Search (DFS); Breadth First Search (BFS); Depth First Iterative Deepening (DFID).			
Exemplars / Practical Applications and usage: • Formulate a simple problem as an initial state, operators, goal state, and search space. • Compare DFS, BFS, and DFID on a small state-space problem. • Discuss the role of intelligent agents in problem solving.			
Assignments: 1. Prepare a concise timeline of major milestones in AI and explain their relevance to problem solving. 2. Implement or trace DFS, BFS, and DFID for a small puzzle and compare their behavior.			
Unit 2	Heuristic, Local and Population-Based Search	Week 3	CO2
Heuristic search; heuristic functions; search landscape; Best First Search; Hill Climbing; solution-space search; Traveling Salesman Problem (TSP); escaping local optima; stochastic local search; population-based methods; Genetic Algorithms; SAT; Genetic Algorithms for TSP; emergent systems; Ant Colony Optimization.			
Exemplars / Practical Applications and usage: • Use heuristic functions to guide search toward promising states. • Study local-search behavior using TSP and other optimization examples. • Illustrate Genetic Algorithms and Ant Colony Optimization on combinatorial problems.			
Assignments: 1. Apply Hill Climbing or Best First Search to a selected problem and explain local-optima limitations. 2. Develop a small worked example of Genetic Algorithm or Ant Colony Optimization for TSP/SAT.			
Unit 3	Optimal Path Search and Space-Saving A* Methods	Weeks 4-5	CO3
Finding optimal paths; Branch & Bound; A* algorithm; admissibility of A*; informed heuristic functions; Weighted A*; IDA*; RBFS; monotone condition; sequence alignment; memory-aware search variants including DCFS, SMGS, and Beam Stack Search.			
Exemplars / Practical Applications and usage: • Trace A* and Branch & Bound on weighted graphs and compare solution quality. • Explain admissibility and the role of informed heuristic functions. • Analyze memory-saving variants of A* for large search spaces.			
Assignments: 1. Solve a weighted graph problem using A* and demonstrate the effect of an admissible heuristic. 2. Compare A*, IDA*, RBFS, and Weighted A* in terms of solution quality, memory, and search effort.			
Unit 4	Game Playing, Automated Planning and Problem Decomposition	Week 6	CO4
Game theory; board games and game trees; Minimax; Alpha-Beta pruning; SSS*; automated planning; domain-independent planning; Blocks World; forward and backward search; Goal Stack Planning; Plan Space Planning; Means-Ends Analysis; Graphplan; AO* algorithm.			

Exemplars / Practical Applications and usage: ● Construct and evaluate game trees using Minimax and Alpha-Beta pruning. ● Represent planning problems using states, actions, goals, and plans. ● Apply problem decomposition and AO*/Graphplan concepts to structured problems. Assignments: 1. Construct a small game tree and demonstrate Minimax with Alpha-Beta pruning. 2. Model a Blocks World problem and compare forward, backward, or Goal Stack planning approaches.			
Unit 5	Rule-Based Systems, Deduction and Constraint Processing	Weeks 7-8	CO5
Rule-based expert systems; production systems; inference engine; Match-Resolve-Execute cycle; Rete Net; logic; soundness; completeness; First Order Logic; forward chaining; backward chaining; Constraint Satisfaction Problems (CSPs); consistency-based diagnosis; backtracking; arc consistency; forward checking.			
Exemplars / Practical Applications and usage: ● Explain production-system architecture and the role of the inference engine and Rete Net. ● Treat deduction as search using forward and backward reasoning. ● Formulate CSPs and apply backtracking, arc consistency, and forward checking.			
Assignments: 1. Design a small rule-based expert system and trace its Match-Resolve-Execute cycle. 2. Formulate a CSP and demonstrate backtracking with arc consistency or forward checking.			
Textbooks:			
1. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education India, 2013. 2. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th ed., Pearson, 2022.			
Reference Books:			
1. Patrick Henry Winston, Artificial Intelligence, Pearson. 2. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, Artificial Intelligence, 3rd ed., Tata McGraw-Hill.			
MOOCs Links and additional reading material:			
1. Artificial Intelligence: Search Methods for Problem Solving (NPTEL – IIT Madras), Prof. Deepak Khemani. https://nptel.ac.in/courses/106106226			

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CO2	3	3	3	3	3	1	-	-	1	1	2	3	3	3
CO3	3	3	3	3	3	1	-	-	1	1	2	3	3	3
CO4	3	3	3	3	3	1	-	-	1	1	2	3	3	3
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K2	-	-	✓	-	-	-	✓
K3	-	-	✓	-	-	-	✓
K4	-	-	✓	-	-	-	✓
K5	-	-	-	-	-	-	-
K6	-	-	-	-	-	-	-
This course serves as a prerequisite for / maps with the following future courses: Artificial Intelligence: Knowledge Representation and Reasoning, Artificial Intelligence: Constraint Satisfaction Problems, Machine Learning, Intelligent Systems, Automated Planning, Optimization and Robotics.							
Job Mapping: - AI / Machine Learning Associate - AI Search / Optimization Engineer - Intelligent Systems Developer - Robotics / Autonomous Systems Engineer - Operations Research / Optimization Analyst							