

1. Course Number and Course Title:

ML 555 – Advanced Artificial Intelligence

2. Credit Hours: 3 – 0 – 3

3. Prerequisites and/or Co-Requisites:

Prerequisite: Approval of the CSE Head of Department

Co-requisites: None

Competencies: Undergraduate-level knowledge of Artificial Intelligence and programming.

4. Name and Contact Information of Instructor:

Name: Dr. Omar Arif

Email: oarif@aus.edu

Office: ESB-2178

Phone: (06) 515-4821

Office Hours: Posted on office door and iLearn; also by appointment

5. Course Description (Catalog Description):

Introduces the fundamental concepts, techniques, architectures, and the ethics of AI. Studies advanced search algorithms, heuristics, constraint satisfaction models, adversarial search, and stochastic search techniques. Covers knowledge representations, reasoning and planning, probabilistic and fuzzy logic, causal and decision networks, uncertain reasoning over time, and Markov models. Examines reinforcement learning and its applications.

6. Textbook and other Supplemental Material:

Textbook:

- S. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach*, 4th edition, Prentice Hall, 2021.

Supplemental material:

- D. Vernon, *Artificial Cognitive Systems: A Primer*, MIT Press, 2014.
- R. Sutton, A.G. Barto, *Reinforcement Learning*, 2nd edition, MIT Press, 2018.
- Selected articles and journal papers, AI software tools and related data.

7. Course Learning Outcomes:

Upon completion of the course, students will be able to:

1. Appraise the importance of AI for society and of issues such as AI ethics.
2. Demonstrate a sound understanding of AI architectures, approaches, and algorithms.
3. Apply heuristic search algorithms and constraint satisfaction models to solve problems.
4. Formulate decision making problems using probabilistic and logic-based methods.
5. Apply stochastic approaches for effective decision making under uncertainty.
6. Compare reinforcement learning algorithms and optimization techniques.
7. Critically review current research work on AI techniques and their applications.
8. Conduct independent research in the field of AI.

8. Teaching and Learning Methodologies:

Methods include lectures, problem and project-based learning methods (assignments, exams, research project, presentation), and class discussions.

9. Course Topics and Schedule:

Topic/Activity	Weeks
Introduction to AI, Uninformed search algorithms	Week #1
Informed search algorithms	Week #2
Local Search Algorithms (Hill Climbing, Simulated Annealing, Genetic Algorithm)	Week #3
Constraint satisfaction Problems	Week #4
Adversarial search	Week #5
Probability Basics, Naïve Bayes,	Week #6
Bayesian Network, Approximate Inference	Week #7
Hidden Markov Models	Week #8
Midterm Exam	Week #9
Markov Decision Process	Week #10
Deep Learning	Week #11
Reinforcement Learning	Week #12
	Week #13
Large Language Models	Week #14
Review	Week #15
Final Exam	Week #16

10. Schedule of Laboratory and other Non-Lecture Sessions:

The survey paper is done individually and is due in week #12. Students must conduct a review on a specific, advanced topic of Artificial Intelligence then write a short paper to summarize their findings. They will also present the same to the class.

The research project is conducted by teams of 2 students and is due at the end of the semester. Students will select a non-trivial real-world problem and solve it by applying many of the concepts and techniques learned in the course. They need to submit a comprehensive report that justifies the techniques applied, explains the steps taken, and analyses the results in detail.

11. Out-of-Class Assignments with Due Dates:

Assignment	Due Date (tentative)
Homework 1: Problem Solving using searching	Week #5
Homework 2: CSP and Adversarial search	Week #7
Homework 3: Bayesian networks	Week #10
Homework 4: decision making	Week #13
Homework 5: Deep Learning	Week #14
Survey paper and presentation	Week #11
Research project	Week #15

12. Student Evaluation:

Assessment	Weight	Due Date (tentative)
Homework assignments	10%	Cf. Section 11
Survey and presentation	15%	Cf. Section 11
Research project	25%	Cf. Section 11
Midterm exam	20%	Week #8
Final Exam	30%	Week #16

13. Assessment Instruments:

Assessment	Course Learning Outcomes
Homework	O2–O5
Class presentation	O1, O2, O7, O8

Review paper	O1, O2, O7, O8
Research project	O2–O6, O8
Midterm exam	O1–O4
Final Exam	O1–O6

14. Contribution of Course to Program Outcomes:

MSML Program Outcomes	Emphasis in this course	Course Learning Outcomes
1. Perform research emphasizing creativity, independent learning, and scientific methods in the field of Machine Learning.	●	O3–O8
2. Apply advanced mathematics, computer science knowledge, and software tools in identifying, formulating, and solving real world problems.	•	O2–O7
3. Demonstrate an in-depth understanding of modern Machine Learning approaches, algorithms, and tools.	•	O1–O8
4. Select and use techniques, skills, and modern tools necessary for research or professional practice.	●	O3–O6, O8
5. Communicate effectively through technical presentations and reports.	•	O1–O8
6. Recognize the need for, and engage in, lifelong learning in professional areas.		
7. Attend to professional and ethical responsibilities within global and societal contexts.	○	O1, O7, O8

Emphasis: • High; ● Medium; ○ Low; Blank – Nothing Specific Expected

15. Letter Grade Policy:

Total (T)	Letter Grade
$90 \leq T$	A
$85 \leq T < 90$	A-
$80 \leq T < 85$	B+
$75 \leq T < 80$	B
$70 \leq T < 75$	B-
$65 \leq T < 70$	C+
$60 \leq T < 65$	C
$T < 60$	F