

NUCL 497T: The Fundamentals of Artificial and Natural Intelligence

Purdue University – FALL 2026

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The Fundamentals of Artificial and Natural Intelligence

Aims & Scope: To “look under the hood of AI,” that is, learn how it works, familiarize students with key AI technologies and their underlying methods and techniques used in Machine Learning. Exploit AI and Machine Learning to advance solutions across different Engineering domains including nuclear applications.

Topics and Schedule

Week 1: The AI/ML Revolution: Hype, Reality, and Human Aspirations

Week 2: Intelligence in Nature: From Simple Systems to Complex Minds

Week 3: Defining Intelligence: A Philosophical Journey for Humans and Machines

Week 4: Data: The Fuel and Foundation of AI

Midterm 1

Week 5: Unpacking Learning Paradigms: The Recipes for Machine Learning

Week 6: Neural Networks and Deep Learning: Brain-Inspired Computation

Week 7: Evolutionary Algorithms: Learning from Natural Selection

Week 8: Bio-Inspired Robotics and Embodied AI

Week 9: Neuroscience for AI: Inspirations for Next-Generation AI

Midterm 2

Week 10: Natural Language Processing (NLP): Teaching Machines to Speak and Understand – Creativity and Transfer Learning

Week 11: Logic, Reasoning, and Knowledge Representation in AI

Week 12: Social Intelligence and Human-AI Interaction

Week 13 AI Across Disciplines: Impact and Applications

Week 14 The future of Intelligence: Challenges and Opportunities

Project Presentations

Course Requirements

Prerequisites: Calculus 1 and 2 or Consent of the Instructor.

Course Policy: There are three items needed for the successful completion of the course:

- a. Homework: A few HW sets (8-10) will be given during the semester. These are typically problems from the book and should help with developing AI-ML competences and sharpen understanding of how AI works (20%)
- b. Midterm 1 and 2: Two midterm exams will be given to review and sharpen your analytical skills in AI-ML (20%+20%)
- c. Project: Group projects in AI topics including presentation and final report (40%)

Grade Policy: >95% A+, 90-95% A, 85-90% A- , similarly 70-85% B+, B, B-, 55-70% C, 50-55% D, <50% F.

Required Books

Tsoukalas, L.H., *The Fundamentals of Natural and Artificial Intelligence: An AI-ML Primer*, Cognella Academic Publishers, San Diego, 2026.