CS-466/566: Math for AI

Module 01: Course Introduction

Dr. Mahmoud Mahmoud
The University of Alabama

2026-01-07

TABLE OF CONTENTS

Welcome

Welcome to **CS-466/566: Math for AI**!

Instructor Information

Instructor: Dr. Mahmoud Mahmoud
Institution: The University of Alabama
Email: mmahmoud@ua.edu
Office Hours: By appointment

Course Website

You can find all course materials, announcements, and updates on the Blackboard.

Prerequisites

A background in programming is recommended for this course. We will cover the basics from scratch.

Academic Integrity

All students are expected to adhere to the university's academic integrity policy. Collaboration is encouraged, but all submitted work must be your own.

About Me

Experience

- **Associate Professor**, CS, The University of Alabama (Current)
- **Associate Professor**, ECE, NC A&T State University (2024-2025)
- **Assistant Professor**, ECE, NC A&T State University (2019-2024)

Research & Achievements

- **Interests:** Trustworthy AI, Cybersecurity, and Privacy in CPS.
- **Fellowship:** Summer Faculty Fellow at Fermi National Accelerator Laboratory.
- **Editor:** Editor IEEE Transactions on Dependable and Secure Computing
- **Funding:** Active external funding from **NSF, NASA, DOE, CIA**, etc.

What do you think this course is about?

- Is this a traditional pure mathematics course?
  - **Answer:** ❌ not exactly
- Is this a pure machine learning course?
  - **Answer:** ❌ not exactly
- Is this a programming course?
  - **Answer:** ❌ not exactly

- **Answer:** The course spans the **four pillars of machine learning**: ✔
  - Linear Algebra
  - Calculus
  - Probability & Statistics
  - Optimization

Machine Learning and AI Everywhere!

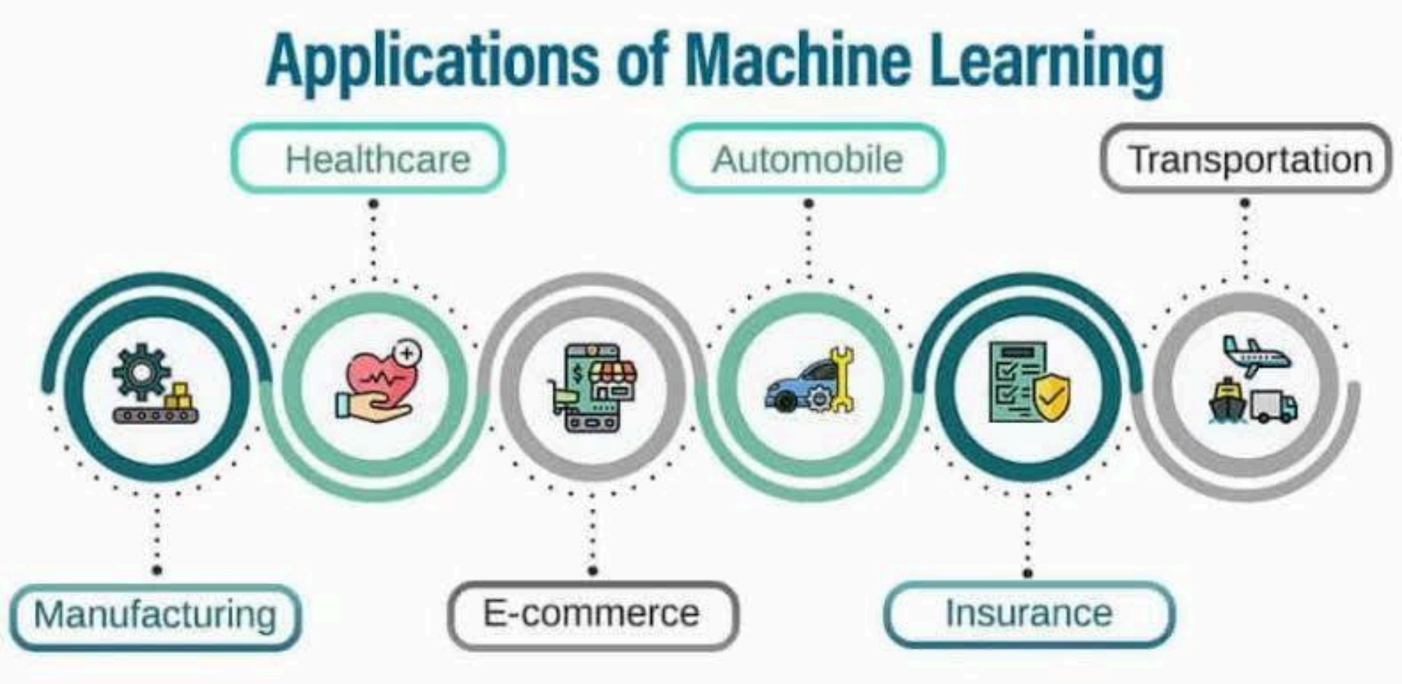


TABLE OF CONTENTS

Course Structure and Content

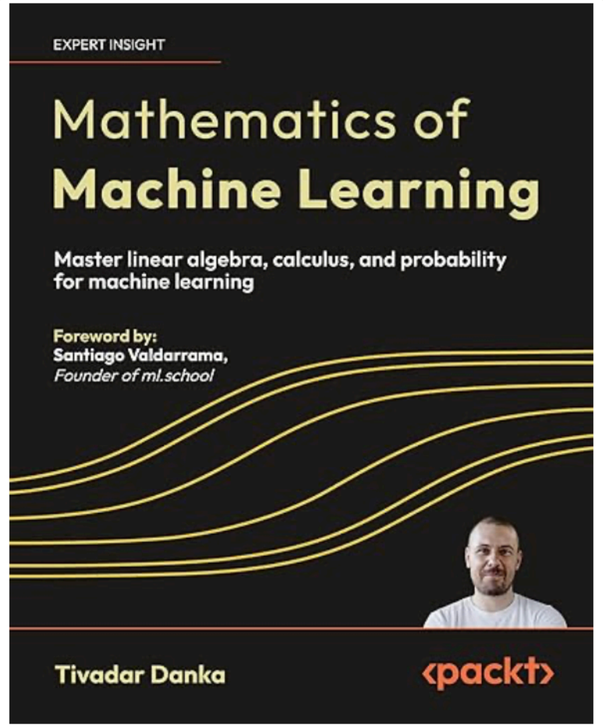
Week	Tuesday	Thursday	Topic	Source
1	—	**Jan 8**	**Course Introduction + Motivation; What is Math for ML?**	Syllabus
2	Jan 13	Jan 15	**The Geometry of Data**	Ch 1–2
3	Jan 20	Jan 22	**Computational Linear Algebra**	Ch 3–4
4	Jan 27	Jan 29	**Systems & Eigen-Geometry**	Ch 5–6
5	Feb 3	Feb 5	**Dimensionality Reduction & Factorization**	Ch 7
6	Feb 10	Feb 12	**Graphs & Stochastic Systems**	Ch 8 + Supp.
7	Feb 17	Feb 19	**Calculus Foundations for ML**	Ch 9–11
8	**Feb 24 (Q&A)**	**Feb 26 (Midterm)**	**Midterm Review & Exam**	—
9	Mar 3	Mar 5	**The Engine of Learning (Derivatives)**	Ch 12
10	Mar 10	Mar 12	**Single-Variable Optimization & Integration**	Ch 13–14
—	**Mar 17**	**Mar 19**	**Spring Break – No Class**	—
11	Mar 24	Mar 26	**Multivariable Calculus**	Ch 15–16
12	Mar 31	Apr 2	**High-Dimensional Optimization**	Ch 17
13	Apr 7	Apr 9	**Probability Spaces**	Ch 18
14	Apr 14	Apr 16	**Random Variables & Distributions**	Ch 19
15	Apr 21	**Apr 23 (Last Class)**	**Expectation & Information Theory**	Ch 20 + Supp.

** Timeline and content are subject to change depending on the pace of the class.**

TABLE OF CONTENTS

Resources and Python Help

- **Recommended Books (No book required):**
  - *Mathematics of Machine Learning* (Tivadar Danka). *Master linear algebra, calculus, and probability for machine learning.*
  - *Mathematics for Machine Learning* (Deisenroth, Faisal, Ong).
- **Visual Learning:**
  - 3Blue1Brown (Linear Algebra, Calculus, Neural Networks).
- **Python Libraries:**
  - **Core:** NumPy, SciPy, Matplotlib.
  - **Autodiff & DL:** PyTorch, JAX.



What you need to know?

- **Some Machine Learning Knowledge**
  - This is *not* a pure ML/Programming/Math course.
- **Knowledge of Python**
  - Preferably Python for ML.
  - Experience with Jupyter Notebooks or Google Colab is helpful.
- **Knowledge of statistics and probability is strongly recommended!**

Class Expectations

- **Emphasis on interaction — lots of it!**
- I encourage questions from you throughout the class.
- Don’t hesitate — ask immediately whenever something isn’t clear.
- You might get a bonus point for your questions!
- Please stay engaged: avoid chatting with friends, working on other courses, or distracting others during class.

TABLE OF CONTENTS

Assessments and Course Resources

Component	CS 466	CS 566
Labs / Programming Assignments	45%	45%
Quizzes & Homework	15%	15%
Midterm Exam	15%	10%
Final Exam	25%	15%
Graduate Project	—	15%
Total	**100%**	**100%**

Course Resources

- All papers available per lecture.
- All lecture notes available per lecture.
- **No required book but recommended resources are available.**

Programming Assignments

- **4–5 assignments throughout the semester covering:**
  - Linear Algebra
  - Calculus
  - Probability
  - Optimization
- **All submissions via Blackboard.**
- **Assignments are individual.**
- **Programming + Report.**
- **Google Colab recommended.**

Quizzes & Homework

- Weekly homework assignments.
- **All submissions via Blackboard.**
- **Assignments are individual.**
- Math style questions.

- **Due at specified deadlines.**
- **10% penalty per day late.**
- **Max 3 days late.**
- **>3 days = Zero.**
- **No extensions** except emergencies.

Class Contributions (+5%)

- **Pop Attendance (1 point)**
  - > 50: **1 pt** | > 25: **0.5 pts** | < 25: **0 pts**
- **Knowledge Quiz (1 point)**
  - Short quizzes to check understanding.
- **Participation (3 points)**
  - Active discussion.
  - Ask/answer questions.
  - Sticky note for contributions.

Grading Scheme

CS 466

Grade	Description
A+	95-100
A	90-94
A-	88-90
B+	85-87
B	83-84
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	Below 60

CS 566

Grade	Description
A	90-100
B	80-89
C	70-79
D	60-69
F	Below 60

TABLE OF CONTENTS

Midterm and Final Exams

Overview

- The **midterm and final exams** together are worth **40%** (CS 466) / **25%** (CS 566) of your final grade.
- Exams will feature **“old style” questions**—expect clear, direct problems that test your understanding, not tricky or ambiguous items.

Expected Dates

- **Midterm Exam:** *Week 7* (exact date to be announced)
- **Final Exam:** *During the official final exam period* (date set by the university)

Grading Policy

- If needed, the **highest mark achieved on the exam will be considered the full mark**.
- All students’ scores may be **scaled relative to the top score** to ensure fairness.

What to Expect

- Questions will focus on core concepts, problem-solving, and your ability to apply what you’ve learned.

TABLE OF CONTENTS

Project Expectations (15%) and Due Dates

Project Overview

- Projects are individual.
- **Project Theme:** Choose a core mathematical concept (e.g., Optimization, Matrix Factorization, Probability) applied to AI, provide a proposal, implement the concept from scratch (or a novel variation), and write a research paper.

Key Milestones & Deadlines

- **Project Presentations:** (Most likely Video Recording)
  - Short in-class presentations with peer feedback.
- **Final Deliverables Due:** End of Week 16 (Dec 5)
  - Written report/paper (5–8 pages) and code submission.

Expectations

- Clear problem statement and motivation.
- Demonstration of understanding of course concepts.
- Well-documented code and reproducible experiments.
- Insightful analysis and discussion of results.
- Proper citation of all sources and related work.

TABLE OF CONTENTS

Academic Integrity - Collaboration Guidelines

- **Collaboration is encouraged!**
- **Over the line**
  - Showing your work to a friend – **OK**
  - Sending your work to a friend – **Not OK**
  - Finding sources, ideas, examples – **OK**
  - Copying text, ideas, code – **Not OK**
  - Using ChatGPT/LLM to help with part of the code – **OK** (In most cases)
  - Copying all code from ChatGPT/LLM – **Not OK**
  - Using whatever ML/DL/AI library in Python – **OK**
- **Sometimes, you will be asked to explain your code**

Academic Integrity - Zero Tolerance Policy

- **Zero tolerance!**
  - Immediate failure for the assignment
  - If repeated: failure of the course and referral to the Office of Academic Integrity
  - **I do what I say. So don’t do it!**
- **Random search**
  - Testing code for statistical similarity; renaming variable names is not going to fool us!
  - Other technologies

Academic Integrity - Final Warning

- **Reports/assignments/other tasks are your work, so never ever copy from others**
  - Or do not give it to others
  - If detected, you will get a zero
  - No exceptions
- **PLEASE don’t violate**
- **No exception will be provided**

Thank You!