CSC 422: MACHINE AND DEEP LEARNING

Instructor

Robert Moseley, MS
Email**:** **rmoseley@calbaptist.edu**
Office: **EGR333**
Office Phone: **(951) 552–8851**
Office Hours: **Monday / Wednesday 10:30am-12:00pm, 1:00pm–3:00pm**

Course Meeting Times and Locations:

- Section A Lecture: **MWF 8:15 AM – 9:15 AM** Location: **Engineering 104** (Moseley)

Course Description

This course covers machine learning topics including supervised and unsupervised learning, linear and logistic regression, support vector machines, as well as deep learning topics like neural networks (MLPs, CNNs, RNNs, GANs, Transformers), LLMs, and more. Coursework includes instruction and programming assignments in algorithmic implementations and high-level library usage. Students also apply machine learning techniques to a unique research project.

Due to the living nature of artificial intelligence research, topics in this course will continually shift and might not exactly reflect content listed below.

Pre-requisites (Required)

- EGR121 (Intro to Computer Programming in C++) **OR** CIS268 (Computer Programming Languages (Python))
- STA310 (Mathematical Statistics I) **OR** EGR305 (Engineering Stats) **OR** MAT353 (Probability & Statistics) **OR** STA144 – Intro to Statistics **OR** Other Suitable Stats Course (BEH350 – Stats for the Behavioral Sciences, MAT154 – Stats for Nursing and Healthcare)

Co-requisites

None

Mandatory Text and Resources

The following online web courses are required to be taken/purchased:

1.) [Zybook]: Machine Learning and Deep Learning - https://learn.zybooks.com/library
   - Code: **CALBAPTISTCSC422MoseleyFall2025**
2.) IDE for coding assignments
   - https://code.visualstudio.com/
3.) Python
   - https://www.python.org/downloads/
   - Download Python 3.11 (it has greater library support for DL)

Extra Text and Resources

1.) Understanding Deep Learning
   - https://udlbook.github.io/udlbook/?utm_source=chatgpt.com
2.) Machine Learning Resources

- https://github.com/azminewasi/online-ml-university?utm_source=chatgpt.com

3.) 3Blue1Brown Math Videos
- https://www.3blue1brown.com/

Course Learning Outcomes

Course Objectives

By the end of this course, students should be able to demonstrate mastery of the following learning student/course outcomes; the Program Objectives being implemented by this course and the classroom assignments are below:

Course Learning Objectives			
#	**Description**	**Program Objectives**	**Assignments**
1	Demonstrate a high-level understanding of classification and clustering algorithms by solving basic mathematical problems (e.g., entropy, distance, etc.)	1-Analysis	• HW
2	Use data wrangling methods to make datasets more accessible to machine learning models.	1-Analysis, 2-Design, 6-Applied Knowledge	• HW/Projects
3	Create shallow learning models (e.g., linear regression, logistic regression, etc.) using modern ML packages and libraries to solve simple/linear problems.	1-Analysis, 2-Design, 6-Applied Knowledge	• HW/Projects
4	Utilize modern ML packages and libraries to build deep learning models via basic and advanced neural networks (e.g., MLPs, CNNs, RNNs, GANs, etc.).	1-Analysis, 2-Design, 6-Applied Knowledge	• HW/Projects
5	Research, analyze and present cutting-edge machine learning topics.	3-Communication	• Research Project
6	Articulate the potential moral implications of AI/ML advancements	4-Ethics, 7-Workd View	• Research Project

Program Objectives

The CBU College of Engineering (CoE) has the following outcomes that are assessed throughout the program in various courses:

CBU CoE Program Objectives			
#	**Source**	**Title**	**Description**
1	ABET	Analysis	Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2	ABET	Design	Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3	ABET	Communication	Communicate effectively in a variety of professional contexts.
4	ABET	Ethics	Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5	ABET	Teamwork	Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

6	ABET	Applied Knowledge	Apply computer science theory and software development fundamentals to produce computing-based solutions.
7	CoE	Christian World View	Demonstrate an ability to articulate a Christian worldview on personal, professional, technical, and societal issues
8	CoE	Leadership	Demonstrate an understanding of the basic concepts in leadership

Assignment and Lecture Overview

Week	Discussion Topic	Assignment & CLO Mapping
1	ML/SL: Introduction to ML & High-Level Theoretical Overview	Zybooks Ch. 1 Coding Assignment 1 - CLO5
2		
3	ML: Classification Models, Regression Models, Model Evaluation, Model Validation, Supervised vs Unsupervised Learning	Zybooks Ch. 2 Coding Assignment 2 – CLO 1
4		Zybooks Ch. 3 Coding Assignment 3 – CLOs 2, 3
5		Zybooks Ch. 4 & 5 Coding Assignment 4 – CLOs 2, 3
6	DL: Neural Networks (MLPs), Perceptrons, Weights and Biases, Shallow Networks	Zybooks Ch. 6 Coding Assignment 5 Midterm Project – CLOs 2,4
7	DL: Convolutional Neural Networks (CNNs), Image Classification, Image Segmentation	Zybooks Ch. 7 Coding Assignment 6 – CLO 4
8	DL: Recurrent Neural Networks (RNNs), LSTMs, temporal networks	Zybooks Ch. 8 Coding Assignment 7 – CLO 4
9	DL: Generative Adversarial Networks (GANs), Diffusion Models, Image Generation	Zybooks Ch. 9 Coding Assignment 8 – CLO 4
10	DL: Transformers and LLMs, Training Stages, Finetuning, LoRA / QLoRA	Zybooks Ch. 10 – CLO 4
11	DL: Reinforcement Learning, RLHF, Reasoning, and Alignment	Zybooks Ch. 11 Coding Assignment 9 – CLO 4
12	Extra Topics, Project / Lab Time & Final Presentations	Zybooks Ch. 12 Coding Assignment 10 – CLOs 2-5
13		
14	Finals Week	Final Project Deliverables – CLOs 2-5

***Note on Zybooks, during week 6 Zybook material will diverge from lecture content.** This is to cover maximum number of topics possible. At times this course will feel like drinking from a firehose, that is okay! Exposure to these topics is important and we will go through them together!

Asynchronous Lecture Days

Due to the instructor being a first-year faculty member, there will be bi-monthly asynchronous lectures. On these days, students will watch a recorded video and do a short write-up on the video.

Here are the dates of the asynchronous lectures:

Date (All Wednesdays)
September 10th
September 24th
October 8th
October 22nd
November 12th
December 3rd

Assignment Overview

Learning

The first 5 weeks of the course will be dedicated to building a foundation in machine learning and providing practical learning experiences as described in the following sub-sections.

Zybook Information

Students will track through the primary Required Textbook (via Zybook) and supplement their primary course curriculum via Zybook lab assignments. Students will submit a written or video summary summarizing the main concepts learned from the materials. Specific schedule will be provided in class.

Lecture Attendance

While Zybook and external material will be used for instruction in lower-level concepts, lectures will be a primary delivery method of practical (high-level) concepts and ML examples. Thus, attendance will be required.

We will have 3 types of lectures in this course: 1) theory based lectures where we discuss motivating mathematics, theory, and high level concepts, 2) programming based lectures where we apply learned theory in a classroom setting to understand what this looks like hands on, and 3) research based lectures where we will read research and discuss / present the chosen paper for that session.

Advanced Topic Presentation

Machine learning is an ever-evolving field, and thus, it is not possible to cover every modern machine learning topic. It is important to learn how to research, comprehend and convey concepts about new machine learning topics, and thus, various cutting-edge topics will be assigned for students to research and present to fellow class members during lecture.

Final Research Project

The last 4–6 weeks of the course will be dedicated to a **challenging, research-oriented project** where you will apply machine learning and deep learning techniques to a substantial problem. Projects should go beyond toy examples and aim to either:

- **Modify or extend** an existing method to explore a novel idea.
- **Tackle a challenging open-ended problem** (e.g., unsolved reinforcement learning tasks, robustness, bias/fairness, interpretability).
- **Reproduce and analyze** a recent research paper implementation (replication study).

You will work in pairs (or small groups with instructor approval) to research, implement, extent, and present your findings.

1. Planning & Background Presentation

The first two weeks of the project will focus on background research and scoping your idea. Each team must:

- Select a research direction (replication, extension, or open-ended challenge).
- Survey related work and summarize key prior approaches.
- Develop a clear plan of action for experiments.

Deliverable: **8–10 minute in-class presentation** with slides covering your chosen problem, background research, and proposed methodology.

2. Development Progress Updates

Each week, submit a **5-minute video update** summarizing your progress. Updates should:

- Demo new code, experiments, or results.
- Reflect on challenges and adjustments to the plan.
- Show cumulative growth from the previous week.

3. Final Report

Each group will submit a **6–12 page report** formatted like a scholarly paper (conference/journal style). Required sections:

- Abstract
- Introduction
- Background & Related Work
- Methods / Experimental Setup
- Results & Analysis
- Conclusion & Future Work
- References

The report should demonstrate **deep understanding of the problem, critical evaluation of results, and thoughtful discussion of limitations.**

4. Final Presentation & Results

In the last week, each group will give an **8–10 minute final presentation** with slides. Presentations should include:

- The original problem and motivation
- Background and prior work
- Your methodology and experiments
- Results and key insights
- Discussion of what worked, what didn't, and what you would try next

Grading will emphasize **creativity, rigor, clarity of communication, and depth of understanding.**

Assessment Policies

Assignment Evaluation Plan

An assessment instrument (checklist, rubric, etc.) will accompany each major graded assignment. See the course website for specific assignment criteria and the accompanying grading instruments.

Course Point Distribution

Graded assignments will be weighted as follows:

Attendance	0%
Participation (Presentations / zyBooks Participation/Challenge Activities)	10%
Homework (zyLabs / Blackboard-based labs)	10%
Coding Assignments	30%
Project I (Midterm)	10%
Project II (Final)	30%
Research Presentation	10%

Final Grades
The following scale will be used when calculating final grades:

A	93%-100%	A-	90%-92.9%	B+	87%-89.9%
B	83%-86.9%	B-	80%-82.9%	C+	77%-79.9%
C	73%-76.9%	C-	70%-72.9%	D+	67%-69.9%
D	63%-66.9%	D-	60%-62.9%	F	< 59.95%

Checking Grades
Be sure to check your grades often via Blackboard.

Artificial Intelligence Tools

AI tools (such as ChatGPT, Copilot, or other coding assistants) are welcome and encouraged in this course as a way to **accelerate learning, explore creative ideas, and build ambitious projects**. Part of becoming a skilled machine learning practitioner is learning how to effectively collaborate with advanced tools.

However, AI-generated work **must be critically evaluated, verified, and understood by you**. Submitting code or writing that you cannot explain or reproduce will be treated the same as not doing the work yourself. Think of AI as a partner: it can help you get started, debug, or brainstorm—but you are ultimately responsible for the accuracy, originality, and depth of your work.

The goal is not just to finish assignments, but to **deepen your understanding** of machine learning and deep learning. Use AI tools wisely to push your projects further, while ensuring that what you submit reflects your own learning and comprehension.

Appeals Policy
To appeal a grade, send an e-mail to your instructor's e-mail address within two weeks of the grade having been received. Overdue appeals will not be considered. For the final course grade use the normal CBU appeals process.

Incomplete Policy
Students will not be given an incomplete grade in the course without sound reason and documented evidence as described in the Student Handbook. In any case, for a student to receive an incomplete, he or she must be passing and must have completed a significant portion of the course.

Disabilities Policy

In compliance with the Americans with Disabilities Act (ADA), all qualified students enrolled in this course are entitled to "reasonable accommodations." Please notify the instructor during the first week of class of any accommodations needed for the course.

SEXUAL HARASSMENT & TITLE IX POLICY

Review the Sex Discrimination, Sexual Violence & Sexual Harassment section of the Student Handbook. All offenses will be reported.

InsideCBU: https://insidecbu.calbaptist.edu

Academic Catalog: **http://www.calbaptist.edu/explore-cbu/offices/office-registrar/academic-catalogs/undergraduate/**

Calendar: https://insidecbu.calbaptist.edu/ICS/Academics/Academic_Calendars.jnz