ECE 425/525: Introduction to Deep Learning: An Engineering Perspective
FALL 2025 | Course Syllabus
MWF 10:00-10:50am | AME S338

Instructor: Jyotikrishna Dass, PhD
Contact Information: Message on MS Teams group for the course (*no email please unless necessary*)
Office Hours: *Mondays: 1pm-2pm and Thursdays: 10am-11am*
Office: *ECE Rm. 456T*

Teaching Assistant: Hariharan Ramesh
TA Office Hours: *(Starts Sept 2 onwards) Tuesdays: 4pm-5pm and Thursdays: 1pm-2pm*
TA Office Venue: *ECE Rm. 430 (exception: Tue, Sept 23, 4-5pm, venue will be ECE Rm. 330)*

Course D2L: https://d2l.arizona.edu/d2l/home/1615086 (course materials, submissions, announcements)
Course MS Teams: General | ECE 425 525 FA25 001 | Microsoft Teams (**Download MS Teams app on your desktop and phone** for announcements, discussion channels, messaging teaching staff):

Deep Learning is revolutionizing artificial intelligence tasks such as language understanding, speech and image recognition, machine translation, autonomous driving, etc. This transformative impact of deep learning, which tries to model the neural networks in brains, was recognized with Nobel Prizes in 2024 and Turing Award in 2018. This course provides a comprehensive introduction to deep neural networks with a focus on underlying principles and engineering applications. Students will explore the fundamental concepts, optimization techniques, and software tools of deep learning starting from the basics of perceptron and progressing to advanced neural network models with convolutions and attentions. The course emphasizes an engineering perspective, hands-on learning, and integrating theory with practice. The course also introduces latest methods to enhance the efficiency of training and inference in deep learning models and systems. Designed for students from diverse engineering disciplines, this course aims to equip them with the skills and knowledge to effectively apply deep learning in their respective fields.

Learning Outcomes
This course aims to develop a comprehensive understanding of deep learning principles and their applications, enabling students to:
- Define the underlying principles of neural networks and deep learning.
- Analyze the mechanisms, applications, and limitations of techniques commonly used in training and inference of deep neural networks.
- Develop the skills to design, implement, and evaluate deep learning models.
- Gain hands-on programming experience with deep learning frameworks and software tools in PyTorch.

THE UNIVERSITY OF ARIZONA

- For graduate students (ECE 525): Apply deep learning techniques to solve engineering problems in computer vision, natural language processing, and broader engineering disciplines like mechanical engineering or biomedical engineering.

Course Objectives

Welcome to the exhilarating world of Deep Learning from an engineering perspective! In this course, we will embark on an exciting journey to uncover the engineering principles behind the design and training of intelligent systems. Engineering is all about applying scientific and mathematical principles to solve real-world problems, and in this course, we'll dive into fundamentals of neural networks and explore advanced architectures that drive today's cutting-edge AI applications. Together, we'll learn how to build, optimize, and deploy AI systems, ensuring they are efficient, scalable, and impactful.

- **Fundamentals and Implementation:** Students will understand the foundational concepts of deep learning, including neural networks, loss functions, backpropagation, and optimization algorithms, and will implement these using frameworks like PyTorch.
- **Modern Architectures and Efficient Techniques**: Students will explore and apply modern neural network architectures such as CNNs, RNNs, and Transformers, as well as efficient deep learning techniques like pruning, sparsity, quantization, and distributed/federated learning.
- **Applications and Computational Performance:** Students will explore applications of deep learning to real-world problems in various engineering domains, understand computational performance and hardware systems, and engage in hands-on programming assignments and case study/project to demonstrate their skills.
- **Advanced Machine Learning:** Students will get acquainted with advanced machine learning techniques such as Graph Neural Networks, Deep Reinforcement Learning, Contrastive Learning, etc.
- **Ethics and Responsible AI:** Students will examine ethical considerations and societal impacts of advanced AI technologies, ensuring models are fair, secure, interpretable, and responsible.

Course Prerequisites

Advanced standing is required. We expect students to have the necessary object-oriented programming experience (preferably Python; we will be using Numpy and PyTorch in this class), and be familiar with linear algebra, basic calculus (differentiation, chain rule), and probability. Understanding of data science, and machine learning concepts is beneficial but not required. Prerequisites: ECE 201, ECE 310, MATH 125 or MATH 122b, or equivalent experiences.

Textbook

Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola. *Dive into deep learning*. Cambridge University Press, 2023, https://d2l.ai.

References

1. Christopher M. Bishop and Hugh Bishop, *Deep Learning: Foundations and Concepts*, 2024, ISBN: 978-3-031-45467-7, https://www.bishopbook.com/.
2. Simon J.D. Prince, *Understanding deep learning*, MIT press, 2023, https://udlbook.github.io/udlbook/.
3. Python, Jupyter notebook, and PyTorch documentations at https://docs.python.org/ https://jupyter.org/, and https://pytorch.org/docs/.

Additional supplemental materials will be referenced and made available to students through D2L.

Course Schedule*

[Subject to change] Since this is the first edition of this introductory course taught to students with diverse skills and backgrounds, we will adjust the course schedule as we make progress!

Module	Topic	Textbook Chapter
1	Introduction to Deep Learning + Preliminaries	Chapters 1-2
2	Linear Neural Networks + Loss Functions + Softmax	Chapters 3-4
3	Multilayer Perceptron+ Backpropagation	Chapter 5
4	Optimization Algorithms	Chapter 12
5	Convolutional Neural Networks	Chapters 7-8
6	Recurrent Neural Networks	Chapters 9-10
7	Attentions and Transformers	Chapter 11
8	Generative AI: LLMs and Image Generation	Additional resources (link)
9	Computational Performance + H/W Systems	Chapter 13
10	Efficient Deep Learning Techniques: *Pruning, Sparsity, Quantization, Knowledge Distillation, Transfer Learning, Parameter Efficient Fine Tuning, Distributed Machine Learning*	Additional resources *[Subject to change]*
11	Selected Applied topics in AI + **X**, where **sample X** = {"*Security and Privacy*", "*Fairness, Interpretability, and Explainability*", "*Hardware Accelerator*", "*Edge Computing*", "*Engineering*"}	Additional resources Guest lectures, survey papers, etc. *[Subject to change]*

12	Selected Advanced Topics **(optional)**: *Graph Neural Networks, Contrastive Learning, Automated ML, Deep Reinforcement Learning*	Additional resources *[Subject to change]*
13-16	Applied Deep Learning (Case study/Project)	

Course Assignments, Projects, and Exams

Undergraduate section (ECE 425):
- *five* **homework assignments** comprising both written and programming components,
- *one* **midterm exam** and
- *one* **case study (literature view) or project** on applications of deep learning leading to a final presentation in class, and report.

Graded Activities (ECE 425)	Week N*: Due Date** Final deadline (11:30pm MST)	Incentive Date** 10% Bonus (11:30pm MST)
Labor Day – no classes/office hours	**Week 2: Mon, 09/01/2025**	
Homework Assignment 1 *(Modules 1-2)*	Week 3: Sun, 09/14/2025	Week 3: Sat, 09/13/2025
Homework Assignment 2 *(Modules 3-4)*	Week 5: Sun, 09/28/2025	Week 5: Sat, 09/27/2025
Homework Assignment 3 *(Modules 4-5)*	Week 7: Sun, 10/12/2025	Week 7: Sat, 10/11/2025
Homework Assignment 4 *(Modules 6- 7)*	Week 9: Sun, 10/26/2025	Week 9: Sat, 10/25/2025
Midterm Exam *(Modules 1-7)*	**Week 10: Fri, 10/31/2025 (during class lecture)**	**Not Applicable**
Veterans Day – no classes/office hours	**Week 12: Tue, 11/11/2025**	
Homework Assignment 5 *(Modules 8-9)*	Week 12: Sun, 11/16/2025	Week 12: Sat, 11/15/2025
Thanksgiving – no classes/office hours	**Week 14: 11/27/2025 – 11/30/2025**	
Case Study/Project Class Presentation	**Week 16: Mon, 12/08/2025 and Wed, 12/10/2025 (during class lecture)**	**Not Applicable**
Reading day – no classes/office hours	**Week 16: Thu, 12/11/2025**	
Case Study/Project Online Deliverable	**Week 16: Fri, 12/12/2025 (due 12:30pm MST)**	**Not Applicable**

* Week "N" begins Mondays and ends Sundays

** *Subject to change* with advance notice, as deemed appropriate by the instructor

All dates and times mentioned in this course are in Mountain Standard Time (Arizona), which is UTC-7 hours. Arizona does not observe Daylight Saving Time.

Graduate section (ECE 525):

- *six* **homework assignments** (i.e. an additional 6th assignment)
- **additional problems** in the homework assignments 1-5
- **extra question** in the midterm,
- **one project** (no case study) applying deep learning principles in practice with programming leading to a final presentation in class, and report

Graded Activities (ECE 525)	Week N*: Due Date** Final deadline (due 11:30pm MST)	Incentive Date** 10% Bonus (before 11:30pm MST)
Labor Day – no classes/office hours	**Week 2: Mon, 09/01/2025**	
Homework Assignment 1 *(Modules 1-2)*	Week 3: Sun, 09/14/2025	Week 3: Sat, 09/13/2025
Homework Assignment 2 *(Modules 3-4)*	Week 5: Sun, 09/28/2025	Week 5: Sat, 09/27/2025
Homework Assignment 3 *(Modules 4-5)*	Week 7: Sun, 10/12/2025	Week 7: Sat, 10/11/2025
Homework Assignment 4 *(Modules 6- 7)*	Week 9: Sun, 10/26/2025	Week 9: Sat, 10/25/2025
Midterm Exam *(Modules 1-7)*	**Week 10: Fri, 10/31/2025 (during class lecture)**	**Not Applicable**
Veterans Day – no classes/office hours	**Week 12: Tue, 11/11/2025**	
Homework Assignment 5 *(Modules 8-9)*	Week 12: Sun, 11/16/2025	Week 12: Sat, 11/15/2025
Thanksgiving – no classes/office hours	**Week 14: 11/27/2025 – 11/30/2025**	
Homework Assignment 6 (Module 10)	Week 15: Wed, 12/03/2025	Week 15: Tue, 12/02/2025
Project Class Presentation	**Week 16: Mon, 12/08/2025 and Wed, 12/10/2025 (during class lecture)**	**Not Applicable**
Reading day – no classes/office hours	**Week 16: Thu, 12/11/2025**	
Project Online Deliverable	**Week 16: Fri, 12/12/2025 (due 12:30pm MST)**	**Not Applicable**

* Week "N" begins Mondays and ends Sundays

** *Subject to change* with advance notice, as deemed appropriate by the instructor

All dates and times mentioned in this course are in Mountain Standard Time (Arizona), which is UTC-7 hours. Arizona does not observe Daylight Saving Time.

Grading

** *Subject to change* with advance notice, as deemed appropriate by the instructor

Undergraduate section (ECE 425): The grading distribution for the undergraduate section will be determined based on the following criteria:

5 Homework Assignments	*55%*
Mid-Term Exam	*25%*
Case study/Project presentation	*10%*
Case study/Project report and deliverables	*10%*
Total	***100%***

Graduate section (ECE 525): The grading distribution for the graduate section will be determined based on the following criteria. Graduate students in ECE 525 are required to complete an *additional homework assignment* and an *applied deep learning project* (in lieu of case study). They will also solve extra problems in each of the first five homework assignments and the midterm exam. with Each assignment features additional comprehensive question(s) requiring detailed theoretical/programming elements, and midterm exam will include an additional question.

6 Homework Assignments	*60%*
Mid-Term Exam	*20%*
Project presentation	*10%*
Project report and deliverables	*10%*
Total	***100%***

Final Examination

There is **no written final examination**. Instead, we will have **class presentation for the case study/project (for ECE 425) and project (for ECE 525) and deliverables** as per our schedule. The registrar-allocated final exam date (**12/12/2025**) will be the due date for submission of deliverables for the case study and project. These deliverables could comprise written report, software code repository, slides, any graphics/recordings, etc. More information on the final exam schedule is available at https://registrar.arizona.edu/faculty-staff-resources/room-class-scheduling/schedule-classes/final-exams

Grading Scale and Policies

The following scale will be used to award the final grades:

Percentage	Letter Grade
90% – 100%	A
80% – 89%	B
70% – 79%	C
60% – 69%	D
<60%	E

Late Policy:
- Homework assignment is **"Due (final deadline)"** at the time specified in the course schedule **beyond which the submission is considered as late**.
- **Late homework** (after final due date)**, midterm exam, case study/project (ECE 425), and project (ECE 525) will not be accepted and will receive 0 points.**

Note that in case of multiple submissions, the most recent submission is considered as the final submission and accordingly late penalty, or bonus (for assignments) will be applied.

Incentive Submission Bonus:

Each homework assignment **also has an "Incentive Date"** to encourage students to submit their homework early and earn a *10% bonus* on that assignment. For example, if you submit the assignment to meet the incentive date and score 70/100, your final score will be 70 + (0.1 x 70) = 77/100. If you submit after the incentive date and before the final deadline (due date), your final score will remain 70/100.

Two Late-waiver tickets for homework assignments:

We understand that academic life can be challenging sometimes - with students juggling multiple courses and personal commitments – and one may fall off-track from the submission deadlines. To help you manage the demands of your personal and academic life and to facilitate your continued interest in our course, we are offering 2 late-waiver tickets to be used for homework assignments without any late penalty! (Note: *waiver ticket does not apply towards incentive date!*

- **Each ticket** can be used to submit a homework assignment **up to 24 hours late** from the "due date (final deadline)".
  - Either apply both tickets to a single assignment for a total extension of 48 hours,
  - Or use those for two separate assignments, granting a 24-hour extension for each.

- **(How to use the waiver ticket?)**
  - When you realize you may not be able to meet the upcoming "due date", **notify the instructor as soon as possible to use your waiver ticket(s)** **before the final deadline**.

- o **You must submit instructor's acknowledgement of your request as a part of your submission to ensure you are not graded as late!**

- **(May still earn 0 points– how?)**
  - o **CASE 1:** Once the assignment's **final deadline has passed** and you **had not notified** the instructor earlier, you can no longer use the late waiver ticket for that assignment, and it will be **assigned 0 points** according to our late submission policy. However, you will **still retain** that quota of your ticket.
  - o **CASE 2:** If you opted for this waiver ticket(s) on-time and were still **not** able to meet the extended deadline, **0 points will be assigned** and you would **lose the ticket(s)** quota for future assignments.

Therefore, we recommend using these waiver tickets judiciously and for reasons beyond personal emergency or documented illness (for which we have following make up policy).

Make-up Policy

A make-up homework assignment and exam (in our case, **midterm** and **case study or project**) may only be granted under extraordinary circumstances. Students requesting a make-up exam should

- **contact the instructor well in advance (before the due date)** and
- **provide written documentation with supporting letter/email from medical officer, dean, etc., for the reason they cannot attend the regularly scheduled homework or exam or case study/project.**

The acceptance of the justification provided by the student is at the discretion of the instructor.

Requests for incompletes (I) and withdrawal (W) must adhere to the University policies.

Grading Policy for Graduate Students

There will be specific distinctions of graduate vs. undergraduate material on the mid-term exam and homework. In addition, the graduate students will have a project (report and presentation) in lieu of the case study (literature view or project + deliverables) option for undergraduate students.
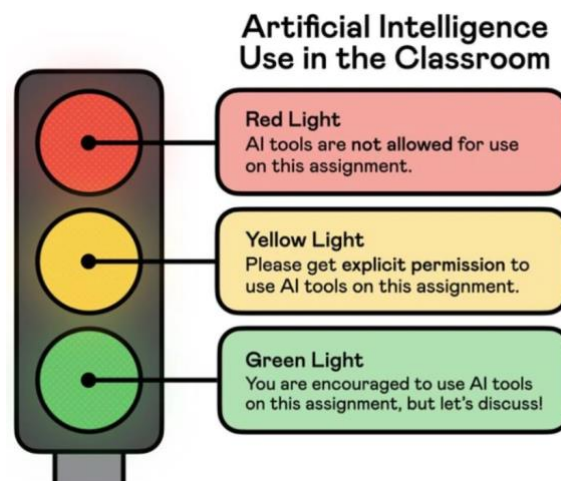
Course Communications

This course utilizes the University of Arizona's D2L course management system for assignments, exams, content distribution, and important announcements (which will be relayed on MS Teams as well). Please log in regularly to check for new announcements, reminders, and course-related information. Throughout the semester, you are encouraged to communicate with your instructor via in-person lectures, MS Teams messages, office hours, or by scheduling an in-person or Zoom meeting.

Artificial Intelligence in Teaching and Learning

We are in a unique situation on campus where the course you are enrolled in is the very topic of study and current technological advancement which has resulted in this unprecedented situation - where we need to clearly communicate about fair use of AI tools in teaching and learning, especially pertaining to this course! **The fundamental question around this policy we have to navigate together in our course is "*Could we use AI to teach/learn about AI?*" How fascinating!!!**

I am encouraging open communication throughout the course so that we clearly distinguish cases where use of such generative AI tools could be allowed and cases where we will not allow!

Additional information can be found at this web site covering academic integrity and ethics, privacy issues, AI detection, teaching and learning with AI, talking to students about AI, and assignment/teaching strategies. https://ucatt.arizona.edu/teaching/artificial-intelligence-teaching-learning.

Artificial Intelligence Use in the Classroom

Red Light
AI tools are not allowed for use on this assignment.

Yellow Light
Please get explicit permission to use AI tools on this assignment.

Green Light
You are encouraged to use AI tools on this assignment, but let's discuss!

Course Policies
As a University of Arizona student, it is expected that you become familiar with and adhere to university-wide policies and procedures. Complete and up-to-date information can be found in the UA General Catalog. https://catalog.arizona.edu/syllabus-policies

Incomplete (I) or Withdrawal (W)
Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal, respectively.

Dispute of Grade Policy

You can dispute any grade that you receive within one week that the grade has been awarded.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students.

Accessibility and Accommodations

At the University of Arizona, we strive to make learning experiences as accessible as possible. If you anticipate or experience barriers based on disability or pregnancy, please contact the Disability Resource Center (520-621-3268, https://drc.arizona.edu/) to establish reasonable accommodations.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. However, graded work/exercises must be the product of independent effort unless otherwise instructed. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog.
See: http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity.

The University Libraries have some excellent tips for avoiding plagiarism, available at http://new.library.arizona.edu/research/citing/plagiarism.
Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations of this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

Nondiscrimination and Anti-harassment Policy

The University of Arizona is committed to creating and maintaining an environment free of discrimination. In support of this commitment, the University prohibits discrimination, including harassment and retaliation, based on a protected classification, including race, color, religion, sex,

national origin, age, disability, veteran status, sexual orientation, gender identity, or genetic information. For more information, including how to report a concern, please see http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy

Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Additional Resources for Students

UA Academic policies and procedures are available at http://catalog.arizona.edu/policies

Campus Health

http://www.health.arizona.edu/

Campus Health provides quality medical and mental health care services through virtual and in-person care. Phone: 520-621-9202

Counseling and Psych Services (CAPS)

https://health.arizona.edu/counseling-psych-services

CAPS provides mental health care, including short-term counseling services, Phone: 520-621-3334

The Dean of Students Office's Student Assistance Program

http://deanofstudents.arizona.edu/student-assistance/students/student-assistance

Student Assistance helps students manage crises, life traumas, and other barriers that impede success. The staff addresses the needs of students who experience issues related to social adjustment, academic challenges, psychological health, physical health, victimization, and relationship issues, through a variety of interventions, referrals, and follow-up services.

Email: DOS-deanofstudents@email.arizona.edu

Phone: 520-621-7057

Survivor Advocacy Program

https://survivoradvocacy.arizona.edu/

The Survivor Advocacy Program provides confidential support and advocacy services to student survivors of sexual and gender-based violence. The Program can also advise students about relevant non-UA resources available within the local community for support.

Email: survivoradvocacy@email.arizona.edu

Phone: 520-621-5767

Campus Pantry

Any student who has difficulty affording groceries or accessing sufficient food to eat every day, or who lacks a safe and stable place to live and believes this may affect their performance in the course, is urged to contact the Dean of Students for support. In addition, the University of Arizona Campus Pantry is open for students to receive supplemental groceries at no cost. Please see their website at: *campuspantry.arizona.edu* for open times.

Furthermore, please notify the instructor if you are comfortable in doing so. This will enable the instructor to provide any resources they may possess.

Safety on Campus and in the Classroom
For a list of emergency procedures for all types of incidents, please visit the website of the Critical Incident Response Team (CIRT): https://cirt.arizona.edu/case-emergency/overview
Also, watch the video available at
https://arizona.sabacloud.com/Saba/Web_spf/NA7P1PRD161/common/learningeventdetail/crtfy000000000003560

Confidentiality of Student Records
http://www.registrar.arizona.edu/ferpa

Subject to Change Statement

Information contained in the course syllabus may be subject to change with advance notice, as deemed appropriate by the instructor.