

Sample Syllabus

[Jump to Today](#)

 Edit

ME 459: Machine Learning in Engineering

Professor: Dr. Xiang Yang

Email: xzy48@psu.edu

Office: Research East, Room 132

Office Hours: 9:00 am to 5:00 pm, Monday through Friday by Appointment

About the Instructor:

Dr. Xiang Yang is an Assistant Professor of Mechanical Engineering at Penn State University. He received my Ph.D. in Mechanical Engineering from Johns Hopkins University in 2016. He held a postdoctoral appointment at the Center for Turbulence Research (CTR) at Stanford University for one and half years after my Ph.D. and joined Penn State in 2018. Yang is the director of the [Flow Physics and Computational Research Lab](#). <https://sites.psu.edu/fpcrl/> Yang's field of expertise lies in high-fidelity numerical simulation of fluid flows, turbulence modeling, and machine learning. A list of his work could be found on [his google scholar page](#). <https://scholar.google.com/citations?user=XJqpcBkAAAAJ&hl=en>

Course Description

This course serves as an introduction to machine learning and its diverse applications in engineering, emphasizing hands-on experience with MATLAB. Through a carefully structured curriculum, students will gain a solid understanding of the underlying mathematical concepts while developing practical skills to implement and analyze machine learning algorithms.

Course Topics

An overview of MATLAB

Linear regression

Logistic regression

Artificial neural network

Genetic algorithm

Support vector machine

K-means algorithm

Principle component analysis

Anomaly detection

Bayesian optimization

Recommender system

Decision tree

Course Learning Objectives

Course Goals:

The goals of this course are to:

1. Provide an introductory understanding of machine learning concepts and their mathematical underpinnings.
2. Explore the application of machine learning techniques within various engineering disciplines.
3. Develop proficiency in using MATLAB for implementing machine learning algorithms.
4. Cultivate analytical skills necessary to interpret data-driven models and results in engineering contexts.
5. Foster critical thinking about the limitations and ethical considerations of machine learning in engineering.

Course Objectives:

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

1. Explain the core concepts of machine learning and articulate their relevance in engineering.
2. Perform data analysis and implement linear and logistic regression models using MATLAB.
3. Apply gradient descent algorithms to train machine learning models.
4. Design and train artificial neural networks for regression and data classification tasks.
5. Utilize the K-means algorithm for clustering analysis and genetic algorithms for optimization problems.
6. Conduct principal component analysis to reduce the dimensionality of engineering datasets.
7. Implement anomaly detection techniques to identify outliers in engineering data.

8. Employ Bayesian optimization methods to fine-tune engineering models.
9. Build recommender systems to assist in engineering decision-making processes.
10. Create decision trees for predictive analysis and interpret the outcomes for engineering applications.
11. Critically evaluate the results of machine learning models and their implications for engineering problems.

Assessment Methods:

Students' understanding and application of course material will be evaluated through:

1. Assignments requiring the implementation of machine learning algorithms in MATLAB.
2. In-class quizzes testing conceptual knowledge and problem-solving abilities.
3. A class project that applies machine learning methods to a real-world engineering problem.
4. Online participation and discussions to reinforce learning objectives.

Grading

HW 60%: There are 9 HWs. They are generally due on Sundays, but deadlines may fluctuate based on our pace in class.

In-class quiz 20%: We will have one quick one-question quiz every class on the content in that class.

Final Project 20%.

Schedule of the class (subject to change)

Week (approx.)	Topic
1	Introduction to machine learning, Review of MATLAB
2	Linear regression
3	Logistic regression
4, 5, 6	Neural network
7	Genetic algorithm

8	Support vector machine
9	K means algorithm
10	Principal component analysis
11	Anomaly detection
12	Recommender systems
13	Bayesian optimization

ACADEMIC INTEGRITY STATEMENT

Academic dishonesty will not be tolerated **at all**. I hope that everyone can develop enough pride in his or her own work and abilities that this will never be a problem. When you earn an Engineering degree from Penn State, the University certifies that you are capable of performing engineering duties at a professional level. Course grades are the sole basis on which the College of Engineering certifies your degree with the assumption that your course grades are a valid assessment of your own knowledge and abilities. If you have cheated, you have falsified that credential. Therefore, we must have academic integrity expectations to ensure the validity of your grade and your degree. Detailed information on this topic can be found at <https://www.engr.psu.edu/faculty-staff/academic-integrity.aspx>. Some examples are given below:

COPYING ON TEST: Copying in a complicit manner with another student; passing answers via text or email; discussing answers in exam; having someone else complete your exam, etc.

PLAGIARISM: The fabrication of information and citations; submitting others work from professional journals, books, articles and papers; submission of other student's papers or lab results or project reports and representing the work as one's own; fabricating in part or total, submissions and citing them falsely, etc.

ACTS OF AIDING OR ABEADING: Facilitating acts by others; unauthorized collaboration of work; permitting another to copy from exam; writing a paper for another; inappropriately collaborating on home assignment or exam without permission or when prohibited, etc.

UNAUTHORIZED POSSESSION: Of examinations, through purchase or supply; stealing exams; failing to return exams on file; selling exams; photocopying exams; buying exams; any possession of an exam without the custodian's permission, etc.

SUBMITTING PREVIOUS WORK: Submitting a paper, case study, lab report or any assignment that had been submitted for credit in a prior class without the knowledge and permission of the instructor.

TAMPERING WITH WORK: Changing own or another student's work product such as lab results, papers, or test answers; tampering with work either as a prank or in order to sabotage another work, etc.

GHOSTING: Taking a quiz, an exam, performing a laboratory exercise or similar evaluation in place of another; having another take a quiz, an exam, or perform an exercise or similar evaluation in place of the student, etc.

STATEMENT ON ACCOMODATIONS FOR STUDENTS WITH DISABILITIES: Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Student Disability Resources (SDR) website provides contact information for every Penn State campus: <http://equity.psu.edu/sdr/campus-contacts>  (<http://equity.psu.edu/sdr/campus-contacts>). For further information, please visit Student Disability Resources: <http://equity.psu.edu/sdr>  (<http://equity.psu.edu/sdr>).

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: <http://equity.psu.edu/sdr/guidelines>  (<http://equity.psu.edu/sdr/guidelines>). If the documentation supports your request for reasonable accommodation, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodation with them as early in your courses as possible. You must follow this process for every semester that you request accommodation.

EDUCATIONAL EQUITY AND REPORTING BIAS: Consistent with University Policy AD29, students who believe they have experienced or observed a hate crime, an act of intolerance, discrimination, or harassment that occurs at Penn State are urged to report these incidents as outlined on the University's Report Bias webpage (<http://equity.psu.edu/reportbias/>)

COUNSELING AND PSYCHOLOGICAL SERVICES: Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. The university offers a variety of confidential services to help you through difficult times, including individual and group counseling, crisis intervention, consultations, online chats, and mental health screenings. These services are provided by staff who welcome all students and

embrace a philosophy respectful of clients' cultural and religious backgrounds, and sensitive to differences in race, ability, gender identity and sexual orientation.

- [Counseling and Psychological Services at University Park \(CAPS\)](http://studentaffairs.psu.edu/counseling/) 
(<http://studentaffairs.psu.edu/counseling/>): 814-863-0395
- Counseling and Psychological Services at [Commonwealth Campuses](http://senate.psu.edu/faculty/counseling-services-at-commonwealth-campuses/)
 (<http://senate.psu.edu/faculty/counseling-services-at-commonwealth-campuses/>)
- Penn State Crisis Line (24 hours/7 days/week): 877-229-6400
Crisis Text Line (24 hours/7 days/week): Text LIONS to 741741

INSTRUCTIONS FOR A CAMPUS CLOSURE

In the event of a campus closure, our class will transition to a virtual format using ZOOM. The students are expected to turn in their assignments on time through Canvas.

Course Summary:

Date	Details	Due
Fri Aug 29, 2025	 Why are you here?	to do: 11:59pm
Fri Sep 19, 2025	 HW 1 (https://psu.instructure.com/courses/2402501/assignments/17401698)	due by 11:59pm
Fri Sep 26, 2025	 HW 2 (https://psu.instructure.com/courses/2402501/assignments/17401700)	due by 11:59pm
Fri Oct 3, 2025	 HW 3 (https://psu.instructure.com/courses/2402501/assignments/17648415)	due by 11:59pm
Fri Oct 10, 2025	 HW3 (https://psu.instructure.com/courses/2402501/assignments/17401707)	due by 11:59pm
	 HW 4 (https://psu.instructure.com/courses/2402501/assignments/17648416)	due by 11:59pm

Date	Details	Due
Fri Oct 17, 2025	 HW4 (https://psu.instructure.com/courses/2402501/assignments/17401701)	due by 11:59pm
Mon Oct 27, 2025	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401688)	due by 1:59pm
Wed Oct 29, 2025	 In class quiz (https://psu.instructure.com/courses/2402501/assignments/17401674)	due by 1pm
Fri Oct 31, 2025	 HW 5 (https://psu.instructure.com/courses/2402501/assignments/17401702)	due by 11:59pm
Wed Nov 5, 2025	 In class quiz (https://psu.instructure.com/courses/2402501/assignments/17401692)	due by 1:59pm
Sun Nov 9, 2025	 HW 6 (https://psu.instructure.com/courses/2402501/assignments/17401703)	due by 11:59pm
Fri Nov 14, 2025	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401678)	due by 1:20pm
	 HW 7 (https://psu.instructure.com/courses/2402501/assignments/17401704)	due by 11:59pm
Fri Nov 21, 2025	 HW 8 (https://psu.instructure.com/courses/2402501/assignments/17401705)	due by 11:59pm
	 In class Quiz (https://psu.instructure.com/courses/2402501/assignments/17401677)	due by 11:59pm
Fri Dec 5, 2025	 In class quiz Acquisition Function (https://psu.instructure.com/courses/2402501/assignments/17401670)	due by 1:20pm
	 In class Quiz Map reduce (https://psu.instructure.com/courses/2402501/assignments/17401691)	due by 11:59pm
Mon Dec 8, 2025	 In class Quiz Bayesian (https://psu.instructure.com/courses/2402501/assignments/17401683)	due by 1pm

Date	Details	Due
Fri Dec 12, 2025	 In class quiz SGD (https://psu.instructure.com/courses/2402501/assignments/17401685)	due by 1pm
	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401684)	due by 1pm
	 Class Project (https://psu.instructure.com/courses/2402501/assignments/17401695)	due by 11:59pm
	 HW 9 (https://psu.instructure.com/courses/2402501/assignments/17401706)	due by 11:59pm
Fri Dec 19, 2025	 HW 10 (https://psu.instructure.com/courses/2402501/assignments/17401699)	due by 11:59pm
	 In class quiz (https://psu.instructure.com/courses/2402501/assignments/17401681)	
	 In class quiz (https://psu.instructure.com/courses/2402501/assignments/17401689)	
	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401667)	
	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401669)	
	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401671)	
	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401672)	
	 In-class Quiz (https://psu.instructure.com/courses/2402501/assignments/17401675)	
	 In-class quiz (https://psu.instructure.com/courses/2402501/assignments/17401676)	
	 In-class Quiz (https://psu.instructure.com/courses/2402501/assignments/17401679)	

Date	Details	Due
	 <u>In-class quiz</u> https://psu.instructure.com/courses/2402501/assignments/17401687	
	 <u>In-class Quiz</u> https://psu.instructure.com/courses/2402501/assignments/17401690	
	 <u>In-class Quiz</u> https://psu.instructure.com/courses/2402501/assignments/17401693	
	 <u>In-class quiz class 1</u> https://psu.instructure.com/courses/2402501/assignments/17401682	
	 <u>In-class Quiz Class 2</u> https://psu.instructure.com/courses/2402501/assignments/17401680	
	 <u>In-class Quiz Class 3</u> https://psu.instructure.com/courses/2402501/assignments/17401686	
	 <u>Quick Quiz Aug 29th</u> https://psu.instructure.com/courses/2402501/assignments/17401668	