

# CSE-8990-01-202210 Special Topic in CS (Spring 2022)

[Jump to Today](#)

**CSE 8990 - Advanced AI Robotics**

**Thursday 5:00 – 7:30pm**

**Swalm 145**

## Instructor

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## Office Hours

Thursday 3:30 pm - 4:45 pm. Other times by email appointment.

## Course Description

Advanced Robotics deals with the underlying technology in modern, autonomous, artificially intelligent robots for applications including autonomous vehicles, drones, planetary rovers, as well as their broader impacts in related computer science fields such as artificial intelligence and machine learning. The primary topics covered in the class include real-time localization and mapping, deep learning for perception, deep reinforcement learning, and advanced planning. This class is designed to help graduate students learn and understand the latest trends in software frameworks, sensor technologies and data-driven algorithms in the field of robotics. Students will also learn about how these robotic and automation technologies can be applied to a broad range of industries include agriculture and forestry, construction and mining, field exploration, and search and rescue.

## Prerequisites

CSE 4643/6643 (AI Robotics) or CSE 4633 (Artificial Intelligence) or CSE 8673 (Machine Learning) or equivalent courses

## Class Schedule

Date	Topic	Reading	Assignment
01/20	0. Intro & ROS Tutorial	<a href="#">Linux Tutorial (Links to an external site.)</a> <a href="#">ROS Tutorial (Links to an external site.)</a> ( <b>Links to an external site.</b> )	<a href="#">Paper presentation signup (Links to an external site.)</a>
01/27	1. Localization and Mapping	<a href="#">SLAM (Links to an external site.)</a>	Lab #1 released
02/03	2. Feature Descriptors	<a href="#">SIFT (Links to an external site.)</a> <a href="#">3D Descriptors (Links to an external site.)</a> <a href="#">ORB-SLAM (Links to an external site.)</a> <a href="#">code (Links to an external site.)</a>	Paper selections due
02/10	3. Visual vs Lidar SLAM	<a href="#">Hector SLAM (Links to an external site.)</a> <a href="#">code (Links to an external site.)</a> <a href="#">LeGO-LOAM (Links to an external site.)</a> <a href="#">code (Links to an external site.)</a>	
02/17	4. Structure from Motion	<a href="#">Structure from Motion (Links to an external site.)</a>	

		<a href="#">code (Links to an external site.)</a>	
02/24	5. Object Recognition Benchmarks	<a href="#">KITTI Vision Benchmark (Links to an external site.)</a>	Lab #1 due. Lab #2 released
		<a href="#">dataset (Links to an external site.)</a>	
		<a href="#">ResNet (Links to an external site.)</a>	
03/03	6. Deep Learning for Object Recognition	<a href="#">PointNet (Links to an external site.)</a>	<a href="#">Project groups signup (Links to an external site.)</a>
		<a href="#">code (Links to an external site.)</a>	
03/10	7. Semantic & Instance Segmentation	<a href="#">Panoptic Segmentation (Links to an external site.)</a>	
03/17	8. Deep Reinforcement Learning	<a href="#">Deep Q-Network (Links to an external site.)</a>	Project Proposal due
		<a href="#">BADGR (Links to an external site.)</a>	
03/24	9. Self-supervised Learning	<a href="#">code (Links to an external site.)</a>	
03/31	10. Exploration		Lab #2 due
04/07	Open Topic		
04/14	Open Topic		Interim Project Report due
04/21	Open Topic		
04/28	CAVS Lab Tour		

The instructor reserves the right to change the course policies and/or schedule in order to facilitate instruction. Any such changes will be updated on Canvas and distributed to students via Announcements on Canvas or through the course email list. Additionally, all changes will be discussed in class.

## Learning Objectives

The learning outcomes for students in this course will be as follows: (1) be familiarized with the state-of-the-art algorithms and software frameworks in robotics (2) understand the metrics for robotics algorithms including computational efficiency, accuracy, and real-world applicability (3) implement a robotics project that incorporates multiple algorithms related to sensing, planning, control, and learning (4) develop critical reading skills to understand the strengths and weaknesses of current approaches to research problems and identify interesting open questions and future research directions (5) develop the background and skills necessary to perform research in robotics and related fields such as artificial intelligence and machine learning.

### Textbooks

- Probabilistic Robotics - Sebastian Thrun, Wolfram Burgard, Dieter Fox

<https://mitpress.mit.edu/books/probabilistic-robotics> (Links to an external site.)

- Principles of Robot Motion - Choset et al.

<https://mitpress.mit.edu/books/principles-robot-motion> (Links to an external site.)

Additional online readings will be posted on the class schedule on a regular basis.

### Individual Lab Assignments

Two lab assignments will be given throughout the semester and is an essential part of understanding the lecture materials. The assignment should be submitted by the specified due date by the end of the day. Assignments will be graded and returned. Students are responsible for assignments turned in on time; even for days when the student has an excused absence. Unless otherwise specified, assignments will be done individually and each student must hand in their

own assignment. It is acceptable, however, for students to collaborate in figuring out solutions and helping each other understand the underlying concepts. When collaborating, the "whiteboard policy" is in effect: You may discuss assignments on a whiteboard, but, at the end of a discussion the whiteboard must be erased, and you must not transcribe or take with you anything that has been written on the board during your discussion. You must be able to reproduce the results solely on your own after any such discussion. Finally, you must report the names of the students you collaborated with on each assignment.

## **Research Paper Presentations**

This class will feature in-class discussion of landmark robotics research papers and provide an opportunity to critique and evaluate the merits of each paper. The paper discussions will also provide an opportunity to examine recent challenges and potential future directions in robotics. Each student will individually make a presentation and lead the discussion of one research paper during the semester. After the paper presentation, all students are expected to take part in class discussions and should contribute at least one question or discussion point. The presentation should make use of one of the topics / papers listed in the syllabus above. Other topics / papers may be allowable (e.g. papers related to your own research or thesis) but will require prior approval from the instructor.

## **Final Group Project**

The course project is an opportunity to explore some of the techniques covered in class and apply them to solve a robotics problem that is of interest. The project topic may be anything related to AI and robotics including navigation, localization, mapping, planning, control, machine learning, etc. Each final project group should consist of 1-3 students. As part of the project deliverables, each group will need to submit a project proposal, interim project report, final project report and make a final presentation.

# **Grading**

5% Class participation

30% Individual lab assignments

15% Research paper presentation

50% Final group project:

- 10% Project proposal
- 15% Interim project report
- 25% Final project report and presentation

**Grading Scale:**

A = 90 – 100 %

B = 80 – 89.9 %

C = 70 – 70.9 %

D = 60 – 69.9 %

F = Below 60 %

**Late assignments:** Late assignments will lose 10% per day late, up to a maximum of 50% off.

**Add/drop policy:** See the Mississippi State University Add/Drop Policy  
<https://www.uaac.msstate.edu/faq/how-and-when-can-i-adddrop-class/Links to an external site.>

**Attendance Policy:** This section is a face-to-face instructional class. Students are expected to attend class regularly and to arrive on time. Although class attendance is mandatory, up to **two** absences are allowed during the semester. Sleeping in class, being late, or leaving early without prior notice may result in an unexcused absence. Each student is responsible for all material and administrative instructions given during the lecture period. Each unexcused absence will result in one percentage point deducted from your final grade up to a maximum of 10%. Please refer to [Academic Operating Policy 12.09](#), regarding detailed attendance expectations and accommodations.

**Continuity of Instruction:** In the event that face-to-face classes are suspended due to extenuating circumstances, such as weather, the instructor will continue instruction in a manner that best supports the course content and student engagement. In this event, all instructors will notify students of the change via their university email address (the official vehicle for communication with students). At that time, they will provide details about how instruction and communication will continue, how academic integrity will be ensured, and what students may

expect during the time that face-to-face classes are suspended. If a student becomes unable to continue class participation due to extenuating circumstances, (e.g., health and safety, loss of power, etc.) the student should contact their instructor and advisor for guidance. For additional guidance, please refer to [Academic Operating Policy 12.09](#).

## **Student Honor Code**

Mississippi State has an approved Honor Code that applies to all students. The code is as follows: “As a Mississippi State University student, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do.” Upon accepting admission to Mississippi State University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor Code. Student will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the MSU community from the requirements or the processes of the Honor Code. For additional information, please visit: <http://honorcode.msstate.edu/policyLinks> [to an external site.](#) [Links to an external site.](#)

## **Academic Misconduct**

Academic misconduct (cheating, plagiarism, forgery, etc) of any form can result in serious consequences. Penalties may be as severe as receiving a grade of “F” in this course, suspension, and/or possible expulsion. Faculty members and students are responsible for reporting cases of academic misconduct. See: [http://students.msstate.edu/honorcode/Links to an external site.](http://students.msstate.edu/honorcode/Links to an external site)

## **Title IX**

MSU is committed to complying with Title IX, a federal law that prohibits discrimination, including violence and harassment, based on sex. This means that MSU’s educational programs and activities must be free from sex discrimination, sexual harassment, and other forms of sexual misconduct. If you or someone you know has experienced sex discrimination, sexual violence and/or harassment by any member of the university community, you are encouraged to report the conduct to MSU’s Director of Title IX/EEO Programs at 325-8124 or by e-mail to [titleix@msstate.edu](mailto:titleix@msstate.edu). Additional resources are available at [Dean of Students Sexual Misconduct and Sexual Assault](#).

## **Disability Resource Center**

Mississippi State University is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (01 Montgomery Hall) collaborates with

students who have disabilities to arrange reasonable accommodations. If you have, or think you may have, a disability, please contact [drc@saffairs.msstate.edu](mailto:drc@saffairs.msstate.edu) or 662-325-3335 to arrange a confidential discussion regarding equitable access and reasonable accommodations. Disabilities may include, but are not limited to, conditions related to mental health, chronic health, attention, learning, autism, brain injury, vision, hearing, mobility, speech, or intellectual disabilities. In the case of short-term disabilities (e.g., broken arm), students and instructors can often work to minimize barriers. If additional assistance is needed, please contact the Disability Resource Center.

***University Safety Statement.*** *Mississippi State University values the safety of all campus community members. Students are encouraged to register for Maroon Alert texts and to download the Everbridge App. Visit the Personal Information section in Banner on your mystate portal to register. To report suspicious activity or to request a courtesy escort via Safe Walk, call University Police at 662-325-2121, or in case of emergency, call 911. For more information regarding safety and to view available training resources, including helpful videos, visit <https://ready.msstate.edu/Links to an external site.> .*