UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, January 14, 2025

Attending: Varun Agrawal, Achilleas Anastasopoulos, Yavuz Bozer, Xudong Fan, Chris Fidkowski, Anouck Girard, Saadet Albayrak Guralp, Robert Hovden, Amir Kamil, Leena Lalwani, Xiaogan Liang, Radoslaw Michalowski, Nolgi Oquendo-Colon, Anchal Sareen, Rachael Schmedlen, Stephanie Sheffield, Won Sik Yang

Support Staff: Mercedes Carmona, Betsy Dodge, Matthew Faunce

Call to Order: 1:34 PM

Adjourned: 3:06 PM

Agenda:

1. Approval of 12.10.2024 Meeting Minutes – Page 4 - **APPROVED**
2. ECE PhD Program Modification – Action Item – Page 6 - **APPROVED**
    a. The ECE department requests a modification to the ECE PhD degree requirements to make ECE 590 a required course for Fall 2025. If the proposal is not approved for the term listed, then the change will be implemented for Winter 2026 and later. The requirement will not impact current students, only by incoming students, but current students will be encouraged to take the course as an elective if not taken yet. The course does not add any additional credits but replaces an optional 1 credit course of Satisfactory/Unsatisfactory coursework that had previously been permitted to meet the total credit requirement. This course has been offered for four years as EECS 598 and students learn about different resources available at the university as well as meet with leaders within CoE and Rackham. Ultimately, this course helps students build the foundation for their doctoral and better prepares the student for their degree program.
    b. EECS - CSE asks if a senior undergraduate student can take this course. CEE also questions if there should be any credit exclusion for the course.
        i. The course is currently only for Rackham and Non-Rackham Graduate students. The intention is for graduate students to take this course to better prepare the student for their graduate program studies. Some advising would help encourage students to take this course, if not a credit exclusion. If needed, a credit exclusion for the course should be discussed further with the department.
            1. EECS - CSE mentions that CSE 601 is a similar course compared to ECE 590, which has been very successful and eases students into their program.
    c. IOE inquires about the seminars as well as the course numbering being used for Special Topics within other departments.
        i. The seminar information is listed within the course syllabus, which lists the topic and speaker within the weekly topic schedule. There are many departments that are involved with this course that cover various topics the student may come across while completing their degree. Special Topic course numbers vary per department and there is not a specific numbering system used for engineering special topic courses.
    d. CoE CC members voted unanimously to approve this proposal. The proposal will appear at the next CoE Faculty meeting for Winter 2025.

CARF SUMMARIES

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	Is Course on LSA Course Guide?	APPROVED	NOTES & REVISIONS	TABLED
19	BIOMEDE	311	MOD	Changes to Enforced Prerequisite and Course Components.	FT 2025	C-	YES	APPROVED	Department needs to review Advisory Prerequisite as Linear Algebra is not a required course for BIOMEDE students.	
22	BIOMEDE	519	MOD	Changes to Enforced Prerequisite and Course Components.	FT 2025	NO	YES	CONDITIONAL APPROVED	Cross-listed with PHYSIOL 519. Department should review Course Description, Advisory Prerequisite (add topics), Course Credit Type to add Non-Rackham Graduate student.	
25	CSE	596	NEW		FT 2025	C	NO	APPROVED		
38	ECE	590	NEW		FT 2025	NO	NO	APPROVED		
47	EECS	390	MOD	Changes to Enforced Prerequisite and Terms Typically Offered.	FT 2025	C	YES	APPROVED		
50	EECS	408	NEW		FT 2025	NO	NO	APPROVED		
66	EECS	474	NEW		FT 2025	C	NO	APPROVED		
77	EECS	475	MOD	Changes to Course Credit Type, Advisory and Enforced Prerequisites, Course Components, and Terms Typically Offered.	FT 2025	C	YES	APPROVED		
80	EECS	477	MOD	Changes to Advisory and Enforced Prerequisites.	FT 2025	C	YES	APPROVED		
83	EECS	490	MOD	Change to Enforced Prerequisite.	FT 2025	C	YES	APPROVED		
86	ENGR	110	MOD	Changes to Course Description, Advisory and Enforced Prerequisites.	FT 2025	NO	YES	APPROVED	Suggestion for department to review Course Description for “near-peer”.	

90	**MECHENG**	**524**	**MOD**	Changes to Cross-listed Departments, Course Description, Full Term Credit Hours, Course Credit Type, and Advisory Prerequisite.	**FT 2025**	**NO**	**YES**		Adding Cross-Listing with BIOMEDE 524. Supporting Statement must include both reasons for cross-listing, plans for teaching/advising from both departments. Course Description needs to be reviewed for BIOMEDE Students.	**TABLED**
93	**ROB**	**415**	**NEW**		**FT 2025**	**C-**	**NO**	**CONDITIONAL APPROVAL**	Supporting statement should expand how and why this is helpful for students/program. Suggestion for department to review Course Credit Type to add Non-Rackham Graduate students.	
104	**ROB**	**416**	**NEW**		**FT 2025**	**C-**	**NO**	**CONDITIONAL APPROVED**	Department to review Course Credit Type to add Non-Rackham Graduate students and Course Description.	
115	**ROB**	**472**	**NEW**		**FT 2025**	**NO**	**NO**	**APPROVED**	Suggestion for department to review Course Credit Type to add Non-Rackham Graduate students.	
124	**ROB**	**516**	**NEW**		**FT 2025**	**C-**	**NO**	**CONDITIONAL APPROVED**	Department to review Course Title (adding Advanced), and Course Description.	
135	**ROB**	**560**	**MOD**	Changes to Cross-listed Departments.	**FT 2025**	**NO**	**YES**	**APPROVED**	Adding Cross-Listing with MECHENG 547. Suggestion for department to review Abbreviated Title, keep consistent with course title.	
139	**ROB**	**572**	**MOD**	Changes to Course Description and Credit Exclusions.	**FT 2025**	**NO**	**YES**	**APPROVED**	Cross-listed with NAVARCH 569. Suggestion for department to review Course Title (adding Advanced).	

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, December 10, 2024

Attending: Varun Agrawal, Achilleas Anastasopoulos, Yavuz Bozer, Xudong Fan, Chris Fidkowski, Anouck Girard, Saadet Albayrak Guralp, Elizabeth Holm, Amir Kamil, Leena Lalwani, Ryan Latimer, Xiaogan Liang, Frank Marsik, Carol Menassa, Radoslaw Michalowski, Nolgi Oquendo-Colon, Yulin Pan, Eric Rutherford, Elyse Vigiletti, Won Sik Yang

Support Staff: Mercedes Carmona, Matthew Faunce

Call to Order: 1:35 PM

Adjourned: 2:18 PM

Agenda:

1. Approval of 11.26.2024 Meeting Minutes – Page 2 - **APPROVED**
2. BSE in AEROSP Program Modification – Action Item – Page 5 - **APPROVED**
    a. The Aerospace Engineering department are making changes to the BSE curriculum of removing AEROSP 405, 4 credits as a required Aerospace Engineering Subject and increasing the Technical Electives from 9 to 13 credits. The department found that AEROSP 405 was an excessive laboratory requirement and adding the credits to technical electives allows students more course selection freedom. Also, a constant decline in students registering for AEROSP 405 over the past few years. Overall, the BSE credit total will still stay the same at 128 credits with changes implemented for Fall 2025 with current students choosing to graduate under the current or new requirements and admitted Fall 2025 students will graduate under the new requirement.
    b. CEE asks if AEROSP 405 is still to be offered and is not being deleted by the department.
        i. AEROSP confirms that the course will still be offered, but in the future the course may only be offered for Fall or Winter, but not both terms. Discussions to be continued by the AEROSP department.
    c. MECHENG department is concerned with the removal of the course due to the dual degree program with AEROSP and the course replacement AEROSP 405 has for MECHENG 495. Does this concern dual degree students? What about other AEROSP and MECHENG course replacements between programs?
        i. AEROSP will honor course replacements with MECHENG courses for dual degree students. There will not be any issues as the credits are staying the same for the degree requirement. AEROSP 405 being removed and moving credits to technical electives will give students other options to take courses and still satisfy degree requirements. The department will discuss overlapping courses with dual degree programs.
    d. IOE questions if there are an ABET implications due to this program modification.
        i. AEROSP states there are no implications as the ABET coordinator for the department did the mapping for the program and the modification for the program satisfies the requirements and more for the program.
    e. CoE CC members voted to approve this proposal. The proposal will appear at the next CoE Faculty meeting for Winter 2025.
3. CEE MEng in CEM Program Modification – Action Item – Page 8 – **APPROVED**
    a. The CEE MEng in CEM degree is moving from residential to online to be more accessible for students and hopes of gaining more students, international audience. There is no change in degree requirements between the residential and online program with the degree still requiring 26 credits between 2 semesters, there is an option for part-time students as well. There are several competitive institutions listed, University of Illinois at Urbana-Champaign, Purdue Polytechnic, Iowa State, and Lawrence Technology, that also contain Master's programs in construction engineering online, suggesting that there is a market opportunity for a new online program from the University of Michigan – College of Engineering. Data is included in the proposal that supports the increased preference for graduate online education, which gives students flexibility with jobs and families as well as using the Certificate in CEM with

stackable credits towards the MEng CEM degree reducing degree costs. Faculty will not teach more than 2 courses for the curriculum and deliver the courses above and beyond their regular teaching load. This change to be an online degree is to be implemented in Fall 2026. Once the program begins, there will be one admission cycle per year and then a move to two or three intakes a year in the future.

b. IOE suggests adding information regarding the Certificate in CEM that states that each course is worth 1 credit each, so 6 credits overall for the 6 courses taken.
c. CoE CC members voted to approve this proposal. The proposal will appear at the next CoE Faculty meeting for Winter 2025.

ECE ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY OF MICHIGAN

TO: College Curriculum Committee

FROM: Jeff Fessler, Interim Chair of Electrical and Computer Engineering

DATE: 2024-12-18

SUBJECT: Modification of PhD degree program

As Interim Chair of the Electrical and Computer Engineering (ECE) division within the CoE, I request approval for a modification to the ECE PhD program. The modification requested is to make ECE 590 Skills for Success in Graduate Studies a required course for the ECE PhD program.

Purpose of Course

The purpose of ECE 590 Skills for Success in Graduate Studies is to assist our incoming class with the transition to graduate school. The course consists of a series of seminars by faculty and staff from the ECE department, the College of Engineering, and the Rackham graduate school. These seminars will introduce students to the resources available as graduate students at the University of Michigan and provide insights into how to succeed as a graduate student.

Background

The course has been offered for four years as EECS 598 and, more recently, ECE 598. This course introduces incoming graduate students to available resources at Michigan. It also presents skills to be successful both in the classroom and research. Since the introduction of the Special Topics 598 course, over 200 first-year ECE graduate students have enrolled. The faculty discussed making this a required course for Ph.D. students at the May 9, 2024 ECE faculty retreat. The faculty voted to make this a required course (78% in favor) at the retreat.

After the initial vote, ECE faculty then re-reviewed this course with the Graduate Academic Affairs Committee on November 10, 2024. This committee, made up of a selection of faculty members and the Graduate Program Manager, discussed the requirement and were in agreement to present the requirement to the faculty at large.

Following the discussion and the approval of the Graduate Academic Affairs Committee, the proposal for this addition of this requirement was discussed at multiple faculty meetings on

November 1, November 15, and finally on December 6, 2024. These meetings allowed for faculty to have the opportunity to voice their thoughts on making the course a requirement, receive answers on questions they may have had, and be able to fully think through the requirement in a thorough manner. After the discussion, followed by an email vote, the decision to make ECE 590 a required course for PhD students stood with faculty approving the degree requirement.

Rationale

In the piloting of this course since Fall 2021, students have had an opportunity to learn about different resources available at University of Michigan. In addition, throughout the course, students have met with different leaders of the College of Engineering and Rackham Graduate School. These opportunities help students to build the foundation for their doctoral studies. With sessions on how to write a NSF/Grant proposal, how to communicate effectively in the US, and how to handle imposter syndrome, this course has offered students a way to start their graduate studies on the right foot.

Proposed Implementation

ECE 590 will be required as part of the PhD program requirements for graduation for students who enter in Fall 2025. (If approval is not received in time for Fall 2025, the change will be implemented for PhD students starting in Winter 2026 or later.) This requirement will not impact current students, and will be required only by incoming students, though we will encourage current students to take the course as an elective if they have not already done so.

The course will not add any additional credits to the degree program, but instead will replace an optional 1 credit of Satisfactory/Unsatisfactory coursework, that had been previously permitted to meet the total credit requirement.

Sincerely,

Jeffrey A. Fessler

Jeff Fessler
William L. Root Distinguished University Professor of EECS
Interim Chair of Electrical and Computer Engineering

Proposed New Language – Changes in Red

PhD Degree Credit Distribution/Coursework

1) Without a relevant Master's degree, a student must complete a minimum of 36 graduate level credit hours with the following distribution:

- ≥ 36 graduate level credit hours
  - ≥ 30 credits of technical graded courses
    - ≥ 12 credits of ECE courses 500 level or higher
    - ≥ 9 credits in an ECE major area
      - ≥ 6 of these credits at 500 level or higher (will count toward your 12 cr. of ECE 500 level or higher requirement)
  - ≥ 3 credits of graded cognate area (may count toward your technical course requirement)
  - 1 Credit of ECE 590 Skills for Success in Graduate Studies
  - **Optional**
    - ≤ 5 credits of S/U graded courses
      - ≤ 2 credit of seminars/courses that are not directed study
      - ≤ 5 credits of directed study

2) With a relevant Master's degree, a student must complete a minimum of 18 graduate level credit hours with the following distribution:

- ≥ 18 graduate level credit hours taken at UM Ann Arbor
  - ≥ 6 credits of graded technical courses
  - ≥ 3 credits of graded cognate courses (can be satisfied with course equivalency but will not count toward the 18 cr. requirement)
  - 1 Credit of ECE 590 Skills for Success in Graduate Studies
  - ≤ 5 additional credits of graduate level courses approved by the research advisor (including directed study)

Current Language

1) Without a relevant Master's degree, a student must complete a minimum of 36 graduate level credit hours with the following distribution:

- ≥ 36 graduate level credit hours
    - ≥ 30 credits of technical graded courses
        - ≥ 12 credits of ECE courses 500 level or higher
        - ≥ 9 credits in an ECE major area
            - ≥ 6 of these credits at 500 level or higher (will count toward your 12 cr. of ECE 500 level or higher requirement)
    - ≥ 3 credits of graded cognate area (may count toward your technical course requirement)
    - **Optional in addition to the above**
        - ≤ 6 credits of S/U graded courses
            - ≤ 3 credit of seminars/courses that are not directed study
            - ≤ 6 credits of directed study

2) With a relevant Master's degree, a student must complete a minimum of 18 graduate level credit hours with the following distribution:

- ≥ 18 graduate level credit hours taken at UM Ann Arbor
    - ≥ 6 credits of graded technical courses
    - ≥ 3 credits of graded cognate courses (can be satisfied with course equivalency but will not count toward the 18 cr. requirement)
    - ≤ 6 additional credits of graduate level courses approved by the research advisor (including directed study)

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-11-06
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 590
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐		
☑	Course Title (full title)	Course Title (full title) Skills for Success in Graduate Studies
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Grad Skills
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Seminars by faculty and staff from EECS, the College of Engineering, and the Rackham graduate school to assist incoming graduate students with the transition to graduate school. Provides introductions to various campus resources, as well as insights on how to succeed in graduate school.	
☑	Full Term Credit Hours Undergraduate Min: Graduate Min: 1 Undergraduate Max: Graduate Max: 1	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject:	Catalog:

☑	Grading Basis ☐ Graded (A – E) ☐ Credit/No Credit ☑ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☐ Lecture ☑ Seminar ☐ Recitation ☐ Lab ☐ Discussion ☐ Independent Study	Graded Component ☐ ☑ ☐ ☐ ☐ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Peter Seiler	Cognizant Faculty Member Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Nancy Slowey Email: nslowey@umich.edu Phone: 734-763-2305

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 11/7/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Peter Seiler	Date: 11/6/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Assist incoming graduate students with the transition to graduate school. The course consists of seminars by faculty and staff from EECS, the College of Engineering, and the Rackham graduate school. These lectures will introduce students to various campus resources and provide insight on how to succeed in graduate school.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture/seminar): 1
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
Assist incoming graduate students with the transition to graduate school. The course consists of seminars by faculty and staff from EECS, the College of Engineering, and the Rackham graduate school. These lectures will introduce students to various campus resources and provide insight on how to succeed in graduate school.

ECE 598-008: Skills for Success in Graduate Studies
Fall 2024

1. **Prerequisites**: Graduate standing

2. **Seminar Time:** Wednesdays from 4:30pm-5:30pm, 1311 EECS

3. **Purpose:** The purpose of this course is to assist our incoming class with the transition to graduate school. The course consists of a series of seminars by faculty and staff from the EECS department, the College of Engineering, and the Rackham graduate school. These seminars will introduce you to the resources available to you as graduate students here at the University of Michigan and provide insights into how to succeed as a graduate student.

4. **Topics (Note: schedule and speakers subject to change)**

Week #	Date	Topic	Speaker
1	8/28	Overview of Semester Life On/Off Campus	Peter Seiler ECE Grad Chair Kristen Thornton ECE Graduate Program Manager
2	9/4	Engineering Honor Code	Peter Seiler
3	9/11	How to Write a Proposal + Discussion on NSF GRFP (https://www.nsfgrfp.org/)	Peter Seiler
4	9/18	Research: Computational/Analytical	Mingyan Liu Assoc. Dean for Academic Affairs Alice L. Hunt Collegiate Professor of Engineering Professor, Electrical Engineering and Computer Science
5	9/25	Conflict Resolution	Peter Seiler
6	10/2	Mental Health & Managing Stress	Angela Farrehi Director Michigan Engineering C.A.R.E Center

7	10/9	Cultural Norms	Laure Bordas-Isner International Student & Scholar Advisor International Center
8	10/16	Research: Empirical	Becky Peterson Associate Professor, ECE Director, Lurie Nanofab. Facility
9	10/23	How to Give a Good Presentation	Manos Kapritsos Associate Professor Computer Science & Engineering
10	10/30	Research-Based Strategies for Managing Imposter Phenomenon	Maggie (Evans) Gardner Senior Program Manager for STEM Professional Development Rackham Graduate School
11	11/6	Research Ethics/Lab Safety	Peter Seiler
12	11/13	Navigating Difficult Conversations	Mallory Martin-Ferguson, M.Ed. Director Grad Student and Program Consultation Services Rackham Graduate School
13	11/20	Group Presentations	Students
14	11/27	Thanksgiving break	No lecture
15	12/4	Wrap-up/Student Feedback + Any remaining group presentations	Peter Seiler

5. **Required Text:** None.

6. **Course Instructor:**

Prof. Peter Seiler
4223 EECS
(734) 763-6204
pseiler@umich.edu

Office hours: Wednesdays 1-2pm
(Office hours will be in person but zoom meetings available by appointment.)
Pronouns: he/him/his

7. **Attendance:** The course will consist of 14 weeks of seminars. All seminars will be recorded and posted on Canvas. However, attendance will be taken at the seminars. **You should attend at least 10 seminars in person and watch the recording for any seminar that you did not attend in person. Physical attendance is required for the group presentations (Weeks 13 and 15).** Students are expected to put away all electronic devices and pay respectful attention to the speakers during the seminar.

8. **Group Presentations:** You will form small groups and give a short presentation (10 min) in the last two weeks of the course. Your presentation will be on a topic of your choosing related to graduate skills. You could revisit one of the topics presented during the semester. Alternatively, you could present on a new topic, e.g.: Engineering Ethics; Time Management; Career Planning (Industry, Academia, National Labs); Effective Mentorship; How to write technical papers; How to read/review technical papers; or Strategies for effective teaching. Additional details will be given in the course.

9. **Grading:** Students much attend at least 10 seminars in person and participate in the group presentations to receive a satisfactory grade in the course.

10. **Web Page:** Important files and announcements will be posted on the course's Canvas site. All seminars will be recorded and posted on Canvas.

11. **Honor Code:** Students in the College of Engineering at the University of Michigan are expected to be intimately familiar with its Honor Code. Details of the Honor Code are available online at:

    https://ecas.engin.umich.edu/honor-council/honor-code/

12. DEI Statement: We consider this classroom to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability, and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for the speaker and every other member of the class. We are dedicated to helping each of you achieve all that you can in this class. We may, either in lecture or smaller interactions, accidentally use language that creates offense or discomfort. Should we do this, we invite you to contact us and help us understand and avoid making the same mistake again. If you do not feel comfortable contacting us in person, anonymous feedback is also fine (such as a note in our faculty mailbox or left at our offices). Please also contact us (in person, e-mail, or anonymously) if other members of the teaching staff or fellow students are detracting from our class climate.

University of Michigan
Fall 2023 Instructor Report
EECS 598-013: Special Topics
Heath Hofmann

26 out of 60 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	14	7	4	0	0	1	4.6	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	15	4	5	1	0	1	4.7	4.2	4.2
I knew what was expected of me in this course.(Q1633)	16	7	2	0	0	1	4.7	4.4	4.5
I had a strong desire to take this course.(Q4)	14	5	4	1	1	0	4.6	4.1	4.0
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	16	5	4	0	0	1	4.7	2.8	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Heath Hofmann seemed well prepared for class meetings.(Q230)	22	1	3	0	0	0	4.9	4.7	4.8
Heath Hofmann explained material clearly.(Q199)	20	3	1	0	1	1	4.9	4.6	4.7
Heath Hofmann treated students with respect.(Q217)	22	3	0	1	0	0	4.9	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	17	5	3	0	0	1	4.8
The textbook made a valuable contribution to the course. (Q64)	10	3	3	1	0	9	4.7
Prerequisites provided adequate preparation for this course. (Q61)	13	3	4	0	1	5	4.7
I developed confidence in my abilities as an engineer. (Q1769)	14	8	3	0	1	0	4.6
I developed the ability to solve real world engineering problems. (Q1770)	14	7	3	1	1	0	4.6

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Heath Hofmann was an excellent teacher. (Q2)	21	4	0	0	0	1	4.9

The medians are calculated from Fall 2023 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2022 Instructor Report
EECS 598-013: Special Topics
Mingyan Liu

30 out of 52 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	17	10	2	0	0	1	4.6	4.5	4.7
My interest in the subject has increased because of this course. (Q1632)	18	7	4	0	0	1	4.7	4.2	4.5
I knew what was expected of me in this course.(Q1633)	20	7	3	0	0	0	4.8	4.6	4.6
I had a strong desire to take this course.(Q4)	17	7	6	0	0	0	4.6	4.0	4.5
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	16	6	7	0	0	1	4.6	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Mingyan Liu seemed well prepared for class meetings.(Q230)	20	3	2	0	0	5	4.9	4.8	4.8
Mingyan Liu explained material clearly.(Q199)	19	5	1	0	0	5	4.8	4.7	4.7
Mingyan Liu treated students with respect.(Q217)	22	2	1	0	0	5	4.9	4.8	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	23	5	2	0	0	0	4.8
The textbook made a valuable contribution to the course. (Q64)	15	3	4	1	0	7	4.7
Prerequisites provided adequate preparation for this course. (Q61)	16	3	4	1	0	6	4.8
I developed confidence in my abilities as an engineer. (Q1769)	18	8	3	0	0	1	4.7
I developed the ability to solve real world engineering problems. (Q1770)	17	5	6	0	0	2	4.7

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Mingyan Liu was an excellent teacher. (Q2)	20	4	1	0	0	5	4.9

The medians are calculated from Fall 2022 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2022 Instructor Report
EECS 598-013: Special Topics
Heath Hofmann

30 out of 52 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	17	10	2	0	0	1	4.6	4.5	4.7
My interest in the subject has increased because of this course. (Q1632)	18	7	4	0	0	1	4.7	4.2	4.5
I knew what was expected of me in this course.(Q1633)	20	7	3	0	0	0	4.8	4.6	4.6
I had a strong desire to take this course.(Q4)	17	7	6	0	0	0	4.6	4.0	4.5
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	16	6	7	0	0	1	4.6	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Heath Hofmann seemed well prepared for class meetings.(Q230)	23	6	1	0	0	0	4.8	4.8	4.8
Heath Hofmann explained material clearly.(Q199)	22	7	1	0	0	0	4.8	4.7	4.7
Heath Hofmann treated students with respect.(Q217)	23	6	1	0	0	0	4.8	4.8	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	23	5	2	0	0	0	4.8
The textbook made a valuable contribution to the course. (Q64)	15	3	4	1	0	7	4.7
Prerequisites provided adequate preparation for this course. (Q61)	16	3	4	1	0	6	4.8
I developed confidence in my abilities as an engineer. (Q1769)	18	8	3	0	0	1	4.7
I developed the ability to solve real world engineering problems. (Q1770)	17	5	6	0	0	2	4.7

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Heath Hofmann was an excellent teacher. (Q2)	23	6	1	0	0	0	4.8

The medians are calculated from Fall 2022 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2025-01-02
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Biomedical Engineering Subject: BIOMEDE Catalog: 311	Dept (Home): Biomedical Engineering Subject: BIOMEDE Catalog: 311
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐		
☐	Course Title (full title) Biomedical Signals and Systems	Course Title (full title) Biomedical Signals and Systems
☐	Abbreviated Title (20 char) Bio Signals & Syst	Abbreviated Title (20 char) Bio Signals & Syst
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Theory and practice of signals and systems in both continuous and discrete time domains with examples from biomedical signal processing and control. Continuous-time linear systems convolution, steady-state responses, Fourier and Laplace transforms, transfer functions, poles and zeros, stability, sampling, feedback. Discrete-time linear systems: Z transform, filters, Fourier transform, signal processing.	
☐	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: Undergraduate Max: 4 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Biomedical Engineering Catalog: 311

☐

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char) MATH 217	Advisory Prerequisite (254 char) MATH 217
☑	Enforced Prerequisite (254 char) BIOMEDE 231 and (MATH 215 or MATH 285) and (MATH 216 or MATH 286) Minimum grade requirement: C-	Enforced Prerequisite (254 char) BIOMEDE 211 and BIOMEDE 231 and BIOMEDE 241 and (MATH 215 or MATH 285) Minimum grade requirement: C-
☐	Credit Exclusions	Credit Exclusions

☑

Course Components
- ☑ Lecture
- ☐ Seminar
- ☐ Recitation
- ☐ Lab
- ☑ Discussion
- ☐ Independent Study

Graded Component
- ☑
- ☐
- ☐
- ☐
- ☐
- ☐

Terms Typically Offered
- ☑ Fall
- ☐ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Kathleen Panagis Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Email: Phone:

CoE Curriculum Committee Representative:	Zhongming Liu	Print: Zhongming Liu	Date: 12/21/2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Ariella Shikanov	Print: Ariella Shikanov	Date: 12/23/2024
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Theory and practice of signals and systems in both continuous and discrete time domains with examples from biomedical signal processing and control. Continuous-time linear systems convolution, steady-state responses, Fourier and Laplace transforms, transfer functions, poles and zeros, stability, sampling, feedback. Discrete-time linear systems: Z transform, filters, Fourier transform, signal processing.	Course Description Theory and practice of signals and systems in both continuous and discrete time domains with examples from biomedical signal processing and control. Continuous-time linear systems convolution, steady-state responses, Fourier and Laplace transforms, transfer functions, poles and zeros, stability, sampling, feedback. Discrete-time linear systems: Z transform, filters, Fourier transform, signal processing.
Class Length Full term	Class Length Full term
Contact hours (lecture): 4	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation) 1
Contact hours (lab) 0	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Engineering Expertise (UGrad)

Special resources of facilities required for this course:

Supporting statement:
This course has not been offered in several years, so we are updating the required prerequisite courses. The 200-level BIOMEDE courses were reconfigured about five years ago and the content has changed. This course will draw upon bioelectrical and biomechanical concepts, so BIOMEDE 211 is added to the list of prerequisites in addition to BIOMEDE 231. Furthermore, BIOMEDE 241 now consists of statistics and programming content, which is also important foundational knowledge for this course. Furthermore, (MATH 216 or MATH 286) has been removed as a required prerequisite because it is a required prerequisite for BIOMEDE 211, so it will automatically be fulfilled with the BIOMEDE 211 prerequisite.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2025-01-02
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Biomedical Engineering Subject: BIOMEDE Catalog: 519	Dept (Home): Biomedical Engineering Subject: BIOMEDE Catalog: 519
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Medicine - PHYSIOL - 519	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Medicine - PHYSIOL - 519
☐	Course Title (full title) Quantitative Physiology	Course Title (full title) Quantitative Physiology
☐	Abbreviated Title (20 char) Quantitative Physiol	Abbreviated Title (20 char) Quantitative Physiol
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) This course provides learning opportunities for graduate students to understand and develop competencies in a quantitative, research oriented, systems and approach to physiology. Systems examined include: musculoskeletal; cardiovascular; respiratory, endocrine; gastrointestinal; and renal. Mathematical models and engineering analyses are used to describe system performance where applicable.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 4 Undergraduate Max: Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Biomedical Engineering Catalog: 519

☐	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char) BIOLCHEM 310	Advisory Prerequisite (254 char) BIOLCHEM 310
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Graduate Standing Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☐ Discussion ☐ Independent Study	Graded Component ☑ ☐ ☐ ☐ ☐ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Ariella Shikanov Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Email: Phone:

CoE Curriculum Committee Representative:	Zhongming Liu	Print: Zhongming Liu	Date: 12/21/2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Ariella Shikanov	Print: Ariella Shikanov	Date: 12/23/2024
Cross-Listed Department Chair:	Daniel E Michele	Print: Daniel E Michele	Date: 1/2/2025
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description This course provides learning opportunities for graduate students to understand and develop competencies in a quantitative, research oriented, systems and approach to physiology. Systems examined include: musculoskeletal; cardiovascular; respiratory, endocrine; gastrointestinal; and renal. Mathematical models and engineering analyses are used to describe system performance where applicable.	Course Description This course provides learning opportunities for graduate students to understand and develop competencies in a quantitative, research oriented, systems and approach to physiology. Systems examined include: musculoskeletal; cardiovascular; respiratory, endocrine; gastrointestinal; and renal. Mathematical models and engineering analyses are used to describe system performance where applicable.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 4
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab) 2	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
519 is required for a number of our graduate students. This course is often set up as a meet-together with BIOMEDE 419, which is required for all of our undergraduate students.

Special resources of facilities required for this course:

Supporting statement:
Adding graduate standing as a prerequisite. Removing Lab component to better reflect the course structure. Updating terms typically offered

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2025-01-05
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Computer Science and Engineering Subject: CSE Catalog: 596
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Engineering Interactive Systems
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Eng Interactive Sys
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Engineering Interactive Systems, encompassing research areas in Human-Computer Interaction, Ubiquitous Computing, and Mobile Systems. Covers principles of designing, prototyping, and evaluating interactive computing systems, focusing on practical applications in the Internet of Things, health, wearables, and smart environments.	
☑	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject:	Catalog:

☑	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

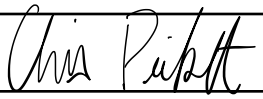
	CURRENT LISTING	**REQUESTED LISTING**
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) EECS 281 or EECS 373; (C or better, No OP/F) or Graduate Standing Minimum grade requirement: C
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☑ Lab ☐ Discussion ☐ Independent Study	Graded Component ☑ ☐ ☐ ☐ ☐ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Alanson Sample	Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ariana Powell Email: powellar@umich.edu Phone:

CoE Curriculum Committee Representative: 	Print: Amir Kamil	Date: 12/23/24
CoE Curriculum Committee Chair:	Print:	Date:
Home Department Chair: 	Print: Christopher Peikert	Date: 12/23/24
Cross-Listed Department Chair:	Print:	Date:
Cross-Listed Department Chair:	Print:	Date:
Cross-Listed Department Chair:	Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Engineering Interactive Systems, encompassing research areas in Human-Computer Interaction, Ubiquitous Computing, and Mobile Systems. Covers principles of designing, prototyping, and evaluating interactive computing systems, focusing on practical applications in the Internet of Things, health, wearables, and smart environments.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab) 2

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
HCC breadth course for CSE graduate programs

Special resources of facilities required for this course:

Supporting statement:
This course covers a wide range of technical topics in Human-Computer Interaction (HCI), Ubiquitous Computing, and Mobile Systems. Lectures and readings focus on Ubiquitous Computing, Mobile Computing, Digital Fabrication, Haptic Interfaces, Mixed Reality, Tangible User Interfaces, Natural User Interfaces, Brain-Computer Interfaces, and User Studies. Labs emphasize hands-on skills such as digital fabrication (3D printing and laser cutting), prototyping electronics (Arduino), applied machine learning, and user evaluation techniques. A semester-long group project challenges students to design, prototype, and evaluate interactive sensing systems. Originally offered as a seminar in 2018, the course underwent significant revisions in Winter 2020 and Fall 2021, with the current curriculum established by Winter 2023 and Winter 2024. Enrollment has grown and remained strong, with participation from PhD, Master's, and undergraduate students. Numbers include Fall 2018 (7 students), Winter 2020 (48 students), Fall 2021 (26 students), Winter 2023 (43 students), and Winter 2024 (31 students). With its HCC breadth designation, enrollment priority will be given to CSE PhD and Master's students looking to fulfill their graduate breadth course requirements.

EECS 598 Engineering Interactive Systems

Lecture: MW 1:30-3:00 - 1017 DOW

Lab Sections: Tu 3-6PM, Tu 6-9PM, Th 12-3PM, & Th 3-6PM

Course Description:

The rapid advancement of consumer electronics, mobile devices, and the Internet of Things (IoT) has opened up new possibilities for creating affordable, interactive devices. These technologies allow users to access information in mobile and diverse environments, enable sensors to monitor both the user and their surroundings and build meaningful models of user context, behavior, and state. This course will equip students with the foundational concepts and practical skills needed to design, prototype, and evaluate interactive computing systems.

Through a blend of hands-on labs and critical discussions, students will explore cutting-edge research in Human-Computer Interaction (HCI) and mobile systems. The course will focus on emerging technological trends and teach the tools necessary to design, building, and evaluate these systems. In the second half of the semester, student teams will propose, design, and evaluate an interactive system with the flexibility to choose from a range of project areas. Suggested domains include health, wearables, smart communities, and IoT, though Ph.D. students may tailor projects to align with their research interests in consultation with the instructor.

This course accommodates students from diverse technical and non-technical backgrounds, with project difficulty calibrated to each student's experience and effort. As a combined graduate and upper-level undergraduate course, it assumes a high level of maturity and self-motivation. Students are expected to define and pursue projects that challenge them, fostering personal growth and expanding their skills in interactive systems design.

Topics Covered in the Course

Lecture	Lab
Ubiquitous Computing	Laser Cutting
Mobile Computing	3D Printing
Digital Fabrication	Mobile Interfaces
Haptics Interfaces	Tangaible Interfaces
Mixed Reality and Environments	User Evaluation
Tangaible User Interfaces	Microcontrollers & Sensors
Natural User Interfaces	Machine Learning for Interactive Interfaces
Brain-Computer Interfaces	Final Project
User Studies	

Learning Objectives and Outcomes

This course provides students with a comprehensive overview and foundation in Human-Computer Interaction (HCI) in the context of the third generation of computing and beyond. Through active, hands-on exploration, students will gain an appreciation for the practical applications of interactive systems for both research and industry. Upon successful completion of the course, students will be able to:

- **Understand the Evolution of Computing Paradigms**
  Articulate the key concepts of ubiquitous computing, mobile systems, and the evolution into the third generation of computing and beyond

- A**nalyze Advanced Human-Computer Interfaces**
  Evaluate and design interactive systems that go beyond traditional keyboard and mouse interfaces, such as gesture-based, voice-activated, and tangible user interfaces.

- **Apply Design and Evaluation Methods**
  Employ established methods for designing, prototyping, and evaluating user-facing hardware and software systems, focusing on user-centered design principles.

- **Develop Skills in Digital Fabrication**
  Utilize digital fabrication tools such as 3D printing and laser cutting to create physical prototypes that support interactive systems.

- **Design Responsive Systems**
  Design hardware and software systems capable of sensing user behavior and environmental conditions, and dynamically responding to them.

- **Create Practical, Real-World User Interfaces**
  Build functional hardware/software systems that integrate seamlessly into everyday environments and provide intuitive user interactions.

- **Evaluate System and User Performance**
  Apply appropriate methodologies for assessing both system performance and user experience, ensuring the usability and effectiveness of the interactive system.

Course Details

Prerequisites:

Graduate standing; or permission from the instructor

Enrollment:

Because of the hands-on nature of this course, we have a capacity limit of ~50 students, depending on lab space. All students are initially placed on the waitlist.

Lecture:

Lecture content will primarily focus on an introduction to core Human-Computer Interaction concepts and topics such as Ubiquitous Computing and Mobile HCI, interface beyond the keyboard and mouse. This will primarily take the form of instructor-led lectures and in-class group discussions based on reading assignments of research papers. Additionally, the lecture will provide background on key concepts such as digital fabrication (3D modeling, laser cutting, 3D printing) as well as core skills for building interactive systems such as embedded systems (Arduino) and real-time machine learning.

Homework:

Readings will consist of academic papers, literature surveys, and editorially articles related to lecture material for a given week. Students must finish their assigned papers and fill out the online article review form before the beginning of class on the dates assigned. On occasion groups of students will be assigned different papers and explore a topic from different points of view. Readings are designed to prepare students to participate in the class discussions where we will explore and debate the merits of the topics. Several traditional written homework assignments along will also be assigned through the semester. These assignments are designed to give students practice topics that fall outside of lab content. All homework assignments must be completed individually without direct help from other students in accordance with our course policy on individual and group work.

Labs:

This course is heavily focused on labs and projects. Labs will focus on developing practical hands-on experience in rapid prototyping of interactive systems and evaluating their performance. Two *Skills Labs* are designed to teach students how to use 3D printers and laser cutters. *Skills Labs* are to be completed individually. There will also be three larger *Interaction Labs* which are to be completed in assigned groups. *Interaction Labs* are designed to give students hands-on experience creating hardware devices that sense user input, interpret their actions, and respond accordingly.

Class Project:

A major portion of this class focuses on an open-ended design project, where teams of students will pitch, design, build, and evaluate an interactive prototype of their own creation. An emphasis is placed on evaluation methods either through technical evaluations (i.e. can the students project sense and classify an event with sufficient accuracy) and/or user studies (i.e. can people use the interface effectively). Students are encouraged to bring their own unique backgrounds and experiences to the project and are encouraged to seek out team members from other disciplines. Project themes and requirements will be announced 2 weeks before the start of the project as indicated on the class schedule. The project deliverables include progress milestones, user evaluation interaction and testing and a final report written in a conference or journal format.

Grading:

Class Participation	5%
Reading Assignments	20%
Skills Labs	5%
Interaction Lab	30%
Design Project	40%

Course Policies:

Extenuating Circumstances & Getting Help

We fully understand that sometimes events outside of students' control can impact their ability to learn and thrive in class. We are committed to making sure everyone can be successful in EECS 598 Engineering Interactive Systems. Students that are experiencing difficulties are encouraged to reach out to the instructors as early as possible. The earlier you make us aware of a problem, the easier it is for us to help. We are happy to work with and accommodate students who are making a good-faith effort to resolve issues early on. In contrast, it is much more difficult to make accommodations for an issue after an assignment is due.

Late Policy for Homeworks, Reading Assignments & Labs

Homework and reading assignments are to be submitted to Canvas on the due dates indicated. Homework & reading assignments can be submitted up to 24 hours after the due date but will receive a 10% penalty. No homework or reading assignments will be accepted after the “late” deadline. Students with extenuating circumstances should contact the instructors before the homework is due.

Lab assignments will be submitted to Canvas on the due dates indicated. It is important that labs are completed on time to ensure students keep up with the class. Labs submitted up to 24 hours late will receive a 5% penalty. This reduced penalty in the first 24 hours is intended to accommodate minor errors and lapses that can cause students to be “a little late”. After 24 hours the late penalty is 10% per day up to a maximum of 5 days late in total. For example, id there is a deliverable on Tuesday at 11:59, will receive a 5% penalty if submitted at or before 11:59 on Wednesday, the same lab submitted on or before Thursday at 11:59 will receive a total late penalty of 15%, submitted on Friday will receive a total of 25%, and submitted on Saturday will receive a 35% penalty. Students with extenuating circumstances should contact the instructors before the lab is due.

Student Mental Health and Wellbeing:

The University of Michigan is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, contact Counseling and Psychological Services (CAPS) at (734) 764-8312 and https://caps.umich.edu during and after hours, on weekends and holidays, or through its counselors physically located in schools on both North and Central Campus. You may also consult University Health Service (UHS) at (734) 764-8320 and https://www.uhs.umich.edu/mentalhealthsvcs, or for alcohol or drug concerns, see www.uhs.umich.edu/aodresources.

For a listing of other mental health resources available on and off campus, visit http://umich.edu/~mhealth/

Tentative Course Schedule:

Week	Data	Day	Lecture Monday	Labs & Project	Assignments
1	1/10/2024	Wednesday	Course Overview / Trends in Technology / laser cutting	(no lab on Wednesday or Thursday)	Intake Survey (due)
2	1/15/2024	Monday	MLK Day (No Class)		
	1/17/2024	Wednesday	Ubiquitous Computing & Laser Cutting Intro	Laser Cutting - Skills Lab 1	HW - Reading #1
3	1/22/2024	Monday	3D Printing Technology	3D Printing - Skills Lab 2	
	1/24/2024	Wednesday	Multi-Touch Technology		
4	1/29/2024	Monday	Input Devices & Typing Interface	Lab 1: Tiny Typing Challenge	HW - Reading #2
	1/31/2024	Wednesday	Tangible Computing		
5	2/5/2024	Monday	Natural User Interfaces	Lab 2: Adrunio	HW - Reading #3
	2/7/2024	Wednesday	Usability Principles / Haptics		
6	2/12/2024	Monday	Tiny Typing Competition	Lab 3-Part 1: MLBasics	HW - Reading #4
	2/14/2024	Wednesday	Brain Computer Interfaces		
7	2/19/2024	Monday	Project Overview & Innovation	Lab 3-Part 2: Arduino + T4Train	HW - Reading #5
	2/21/2024	Wednesday	Project Ideation and Team Formation		HW - Project Pitch Slides
8	2/26/2024	Monday	No Classes	No Classes	
	2/28/2024	Wednesday	No Classes	No Classes	
9	3/4/2024	Monday	Project Ideation and Team Formation		HW - Reading #6
	3/6/2024	Wednesday	Virtual & Augmented Reality		
10	3/11/2024	Monday	Project Pitches		HW - Reading #7
	3/13/2024	Wednesday	Project Pitches		Project Proposal
11	3/18/2024	Monday	No Class -- Project Meetings		
	3/20/2024	Wednesday	No Class -- Project Meetings		Milestone 1
12	3/25/2024	Monday	No Class -- Project Meetings		
	3/27/2024	Wednesday	No Class -- Project Meetings		Milestone 2
13	4/1/2024	Monday	No Class -- Project Meetings		
	4/3/2024	Wednesday	No Class -- Project Meetings		System Integration & Preliminary Test
14	4/8/2024	Monday	No Class -- Project Meetings		
	4/10/2024	Wednesday	Design Expo Logistics and Posters		Evaluation Round 1 - Due
15	4/15/2024	Monday	No class -- Project Meetings		
	4/17/2024	Tuesday	No class -- Project Meetings		Evaluation Round 2 - Due
16	4/22/2024	Monday	Expo	Expo	Expo

Example Reading Assignments:

The exact reading list for the course is still being selected. The following papers have been provided to give students an example of the type of work that will be covered in the class.

- Ways of Knowing in HCI
    - Experimental Research in HCI
    - Concepts, Values, and Methods for Technical Human–Computer Interaction Research
- Fiberio: A Touchscreen that Senses Fingerprints
- Fingertip Tactile Devices for Virtual Object Manipulation and Exploration
- DextrES: Wearable Haptic Feedback for Grasping in VR via a Thin Form-Factor Electrostatic Brake
- Trigeminal-based Temperature Illusions
- ShapeShift: 2D Spatial Manipulation and Self-Actuation of Tabletop Shape Displays for Tangible and Haptic Interaction
- Project Zanzibar: A Portable and Flexible Tangible Interaction Platform
- Photo-Chromeleon: Re-Programmable Multi-Color Textures Using Photochromic Dyes
- PrintScreen: fabricating highly customizable thin-film touch-displays
- Project Jacquard: Interactive Digital Textiles at Scale
- Metamaterial Mechanisms
- Thermorph: Democratizing 4D Printing of Self-Folding Materials and Interfaces
- SATURN: A Thin and Flexible Self-powered Microphone Leveraging Triboelectric Nanogenerator
- LaserOrigami: laser-cutting 3D objects
- RoMA: Interactive Fabrication with Augmented Reality and a Robotic 3D Printer
- A Layered Fabric 3D Printer for Soft Interactive Objects
- Printed optics: 3D printing of embedded optical elements for interactive devices
- Shape-Aware Material: Interactive Fabrication with ShapeMe
- The Toastboard: Ubiquitous Instrumentation and Automated Checking of Breadboarded Circuits
- EM-Sense: Touch Recognition of Uninstrumented, Electrical and Electromechanical Objects
- Synthetic Sensors: Towards General-Purpose Sensing
- Wall++: Room-Scale Interactive and Context-Aware Sensing
- HyperCam: hyperspectral imaging for ubiquitous computing applications
- Finexus: Tracking Precise Motions of Multiple Fingertips Using Magnetic Sensing
- PrivacyMic: Utilizing Inaudible Frequencies for Privacy Preserving Daily Activity Recognition
- PaperID: A Technique for Drawing Functional Battery-Free Wireless Interfaces on Paper
- Sozu: Self-Powered Radio Tags for Building-Scale Activity Sensing
- Picking Pockets on the Lawn: The Development of Tactics and Strategies in a Mobile Game
- Principles of Mixed-Initiative User Interfaces

University of Michigan
Winter 2024 Instructor Report
EECS 498 008 - EECS 598 008
Alanson Sample

11 out of 31 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	6	4	0	1	0	0	4.6	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	6	2	2	1	0	0	4.6	4.2	4.2
I knew what was expected of me in this course.(Q1633)	3	3	2	3	0	0	3.7	4.4	4.6
I had a strong desire to take this course.(Q4)	7	1	1	2	0	0	4.7	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	4	4	2	1	0	3.1	2.9	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Alanson Sample seemed well prepared for class meetings.(Q230)	7	4	0	0	0	0	4.7	4.7	4.8
Alanson Sample explained material clearly.(Q199)	6	5	0	0	0	0	4.6	4.6	4.7
Alanson Sample treated students with respect.(Q217)	7	3	1	0	0	0	4.7	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	6	2	1	2	0	0	4.6
I felt included and valued when working with other students. (Q253)	8	1	2	0	0	0	4.8

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Alanson Sample was an excellent teacher. (Q2)	7	2	2	0	0	0	4.7

The medians are calculated from Winter 2024 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Winter 2023 Instructor Report
EECS 498 008 - EECS 598 008
Alanson Sample

8 out of 42 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	7	1	0	0	0	0	4.9	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	7	1	0	0	0	0	4.9	4.1	4.2
I knew what was expected of me in this course.(Q1633)	5	0	2	0	0	0	4.8	4.3	4.6
I had a strong desire to take this course.(Q4)	6	1	0	0	0	0	4.9	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	1	4	2	0	0	3.0	2.8	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Alanson Sample seemed well prepared for class meetings.(Q230)	7	1	0	0	0	0	4.9	4.7	4.8
Alanson Sample explained material clearly.(Q199)	7	1	0	0	0	0	4.9	4.6	4.7
Alanson Sample treated students with respect.(Q217)	7	1	0	0	0	0	4.9	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	6	2	0	0	0	0	4.8
The textbook made a valuable contribution to the course. (Q64)	3	0	2	0	0	3	4.7
Prerequisites provided adequate preparation for this course. (Q61)	6	2	0	0	0	0	4.8
The laboratory was a valuable part of this course. (Q331)	6	1	1	0	0	0	4.8
Laboratory assignments were relevant to what was presented in class. (Q337)	6	2	0	0	0	0	4.8
I developed confidence in my abilities as an engineer. (Q1769)	8	0	0	0	0	0	5.0
I developed the ability to solve real world engineering problems. (Q1770)	7	1	0	0	0	0	4.9
Laboratory assignments required a reasonable amount of time and effort. (Q336)	4	3	0	1	0	0	4.5

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Alanson Sample was an excellent teacher. (Q2)	6	2	0	0	0	0	4.8

University of Michigan
Fall 2021 Instructor Report With Comments
EECS 498 013 - EECS 598 009
Alanson Sample

11 out of 26 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	6	3	0	0	0	0	4.8	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	6	3	0	0	0	0	4.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	6	2	1	0	0	0	4.8	4.5	4.4
I had a strong desire to take this course.(Q4)	7	2	0	0	0	0	4.9	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	2	0	5	2	0	0	3.0	3.0	2.9

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Alanson Sample seemed well prepared for class meetings.(Q230)	8	1	0	0	0	0	4.9	4.8	4.7
Alanson Sample explained material clearly.(Q199)	7	1	0	0	0	0	4.9	4.7	4.7
Alanson Sample treated students with respect.(Q217)	7	2	0	0	0	0	4.9	4.9	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	5	4	0	0	0	0	4.6
Prerequisites provided adequate preparation for this course. (Q61)	5	3	0	0	0	1	4.7
The textbook made a valuable contribution to the course. (Q64)	4	1	2	0	0	2	4.6
I felt included and valued when working with other students. (Q253)	6	3	0	0	0	0	4.8
I felt comfortable asking questions in class. (Q521)	8	1	0	0	0	0	4.9
I developed confidence in my abilities as an engineer. (Q1769)	6	3	0	0	0	0	4.8
I developed the ability to solve real world engineering problems. (Q1770)	7	2	0	0	0	0	4.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Alanson Sample was an excellent teacher. (Q2)	7	2	0	0	0	0	4.9

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-11-06
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING			**REQUESTED LISTING**		
☑	Dept (Home): Subject: Catalog:			Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 590		
☐	☐ Course is Cross-Listed with Other Departments			☐ Course is Cross-Listed with Other Departments		
	Department	Subject	Catalog Number	Department	Subject	Catalog Number
☑	Course Title (full title)			Course Title (full title) Skills for Success in Graduate Studies		
☑	Abbreviated Title (20 char)			Abbreviated Title (20 char) Grad Skills		
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Seminars by faculty and staff from EECS, the College of Engineering, and the Rackham graduate school to assist incoming graduate students with the transition to graduate school. Provides introductions to various campus resources, as well as insights on how to succeed in graduate school.					
☑	Full Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: 1 Graduate Max: 1		Half Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: Graduate Max:	
☑	Course Credit Type Rackham Graduate Student, Non-Rackham Graduate Student					
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:			☐ Course is Y graded ☐ Can be taken more than once in the same term		

Subject:	Catalog:

☑	Grading Basis ☐ Graded (A – E) ☐ Credit/No Credit ☑ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☐ Lecture ☑ Seminar ☐ Recitation ☐ Lab ☐ Discussion ☐ Independent Study	Graded Component ☐ ☑ ☐ ☐ ☐ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Peter Seiler	Cognizant Faculty Member Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Nancy Slowey Email: nslowey@umich.edu Phone: 734-763-2305

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 11/7/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Peter Seiler	Date: 11/6/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Assist incoming graduate students with the transition to graduate school. The course consists of seminars by faculty and staff from EECS, the College of Engineering, and the Rackham graduate school. These lectures will introduce students to various campus resources and provide insight on how to succeed in graduate school.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture/seminar): 1
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
Assist incoming graduate students with the transition to graduate school. The course consists of seminars by faculty and staff from EECS, the College of Engineering, and the Rackham graduate school. These lectures will introduce students to various campus resources and provide insight on how to succeed in graduate school.

ECE 598-008: Skills for Success in Graduate Studies
Fall 2024

1. **Prerequisites**: Graduate standing

2. **Seminar Time:** Wednesdays from 4:30pm-5:30pm, 1311 EECS

3. **Purpose:** The purpose of this course is to assist our incoming class with the transition to graduate school. The course consists of a series of seminars by faculty and staff from the EECS department, the College of Engineering, and the Rackham graduate school. These seminars will introduce you to the resources available to you as graduate students here at the University of Michigan and provide insights into how to succeed as a graduate student.

4. **Topics (Note: schedule and speakers subject to change)**

Week #	Date	Topic	Speaker
1	8/28	Overview of Semester Life On/Off Campus	Peter Seiler ECE Grad Chair Kristen Thornton ECE Graduate Program Manager
2	9/4	Engineering Honor Code	Peter Seiler
3	9/11	How to Write a Proposal + Discussion on NSF GRFP (https://www.nsfgrfp.org/)	Peter Seiler
4	9/18	Research: Computational/Analytical	Mingyan Liu Assoc. Dean for Academic Affairs Alice L. Hunt Collegiate Professor of Engineering Professor, Electrical Engineering and Computer Science
5	9/25	Conflict Resolution	Peter Seiler
6	10/2	Mental Health & Managing Stress	Angela Farrehi Director Michigan Engineering C.A.R.E Center

7	10/9	Cultural Norms	Laure Bordas-Isner International Student & Scholar Advisor International Center
8	10/16	Research: Empirical	Becky Peterson Associate Professor, ECE Director, Lurie Nanofab. Facility
9	10/23	How to Give a Good Presentation	Manos Kapritsos Associate Professor Computer Science & Engineering
10	10/30	Research-Based Strategies for Managing Imposter Phenomenon	Maggie (Evans) Gardner Senior Program Manager for STEM Professional Development Rackham Graduate School
11	11/6	Research Ethics/Lab Safety	Peter Seiler
12	11/13	Navigating Difficult Conversations	Mallory Martin-Ferguson, M.Ed. Director Grad Student and Program Consultation Services Rackham Graduate School
13	11/20	Group Presentations	Students
14	11/27	Thanksgiving break	No lecture
15	12/4	Wrap-up/Student Feedback + Any remaining group presentations	Peter Seiler

5. **Required Text:** None.

6. **Course Instructor:**

Prof. Peter Seiler
4223 EECS
(734) 763-6204
pseiler@umich.edu

Office hours: Wednesdays 1-2pm
(Office hours will be in person but zoom meetings available by appointment.)
Pronouns: he/him/his

7. **Attendance:** The course will consist of 14 weeks of seminars. All seminars will be recorded and posted on Canvas. However, attendance will be taken at the seminars. **You should attend at least 10 seminars in person and watch the recording for any seminar that you did not attend in person. Physical attendance is required for the group presentations (Weeks 13 and 15).** Students are expected to put away all electronic devices and pay respectful attention to the speakers during the seminar.

8. **Group Presentations:** You will form small groups and give a short presentation (10 min) in the last two weeks of the course. Your presentation will be on a topic of your choosing related to graduate skills. You could revisit one of the topics presented during the semester. Alternatively, you could present on a new topic, e.g.: Engineering Ethics; Time Management; Career Planning (Industry, Academia, National Labs); Effective Mentorship; How to write technical papers; How to read/review technical papers; or Strategies for effective teaching. Additional details will be given in the course.

9. **Grading:** Students much attend at least 10 seminars in person and participate in the group presentations to receive a satisfactory grade in the course.

10. **Web Page:** Important files and announcements will be posted on the course's Canvas site. All seminars will be recorded and posted on Canvas.

11. **Honor Code:** Students in the College of Engineering at the University of Michigan are expected to be intimately familiar with its Honor Code. Details of the Honor Code are available online at:

    https://ecas.engin.umich.edu/honor-council/honor-code/

12. DEI Statement: We consider this classroom to be a place where you will be treated with respect, and we welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability, and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for the speaker and every other member of the class. We are dedicated to helping each of you achieve all that you can in this class. We may, either in lecture or smaller interactions, accidentally use language that creates offense or discomfort. Should we do this, we invite you to contact us and help us understand and avoid making the same mistake again. If you do not feel comfortable contacting us in person, anonymous feedback is also fine (such as a note in our faculty mailbox or left at our offices). Please also contact us (in person, e-mail, or anonymously) if other members of the teaching staff or fellow students are detracting from our class climate.

University of Michigan
Fall 2023 Instructor Report
EECS 598-013: Special Topics
Heath Hofmann

26 out of 60 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	14	7	4	0	0	1	4.6	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	15	4	5	1	0	1	4.7	4.2	4.2
I knew what was expected of me in this course.(Q1633)	16	7	2	0	0	1	4.7	4.4	4.5
I had a strong desire to take this course.(Q4)	14	5	4	1	1	0	4.6	4.1	4.0
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	16	5	4	0	0	1	4.7	2.8	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Heath Hofmann seemed well prepared for class meetings.(Q230)	22	1	3	0	0	0	4.9	4.7	4.8
Heath Hofmann explained material clearly.(Q199)	20	3	1	0	1	1	4.9	4.6	4.7
Heath Hofmann treated students with respect.(Q217)	22	3	0	1	0	0	4.9	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	17	5	3	0	0	1	4.8
The textbook made a valuable contribution to the course. (Q64)	10	3	3	1	0	9	4.7
Prerequisites provided adequate preparation for this course. (Q61)	13	3	4	0	1	5	4.7
I developed confidence in my abilities as an engineer. (Q1769)	14	8	3	0	1	0	4.6
I developed the ability to solve real world engineering problems. (Q1770)	14	7	3	1	1	0	4.6

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Heath Hofmann was an excellent teacher. (Q2)	21	4	0	0	0	1	4.9

The medians are calculated from Fall 2023 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2022 Instructor Report
EECS 598-013: Special Topics
Mingyan Liu

30 out of 52 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	17	10	2	0	0	1	4.6	4.5	4.7
My interest in the subject has increased because of this course. (Q1632)	18	7	4	0	0	1	4.7	4.2	4.5
I knew what was expected of me in this course.(Q1633)	20	7	3	0	0	0	4.8	4.6	4.6
I had a strong desire to take this course.(Q4)	17	7	6	0	0	0	4.6	4.0	4.5
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	16	6	7	0	0	1	4.6	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Mingyan Liu seemed well prepared for class meetings.(Q230)	20	3	2	0	0	5	4.9	4.8	4.8
Mingyan Liu explained material clearly.(Q199)	19	5	1	0	0	5	4.8	4.7	4.7
Mingyan Liu treated students with respect.(Q217)	22	2	1	0	0	5	4.9	4.8	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	23	5	2	0	0	0	4.8
The textbook made a valuable contribution to the course. (Q64)	15	3	4	1	0	7	4.7
Prerequisites provided adequate preparation for this course. (Q61)	16	3	4	1	0	6	4.8
I developed confidence in my abilities as an engineer. (Q1769)	18	8	3	0	0	1	4.7
I developed the ability to solve real world engineering problems. (Q1770)	17	5	6	0	0	2	4.7

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Mingyan Liu was an excellent teacher. (Q2)	20	4	1	0	0	5	4.9

The medians are calculated from Fall 2022 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2022 Instructor Report
EECS 598-013: Special Topics
Heath Hofmann

30 out of 52 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	17	10	2	0	0	1	4.6	4.5	4.7
My interest in the subject has increased because of this course. (Q1632)	18	7	4	0	0	1	4.7	4.2	4.5
I knew what was expected of me in this course.(Q1633)	20	7	3	0	0	0	4.8	4.6	4.6
I had a strong desire to take this course.(Q4)	17	7	6	0	0	0	4.6	4.0	4.5
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	16	6	7	0	0	1	4.6	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Heath Hofmann seemed well prepared for class meetings.(Q230)	23	6	1	0	0	0	4.8	4.8	4.8
Heath Hofmann explained material clearly.(Q199)	22	7	1	0	0	0	4.8	4.7	4.7
Heath Hofmann treated students with respect.(Q217)	23	6	1	0	0	0	4.8	4.8	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	23	5	2	0	0	0	4.8
The textbook made a valuable contribution to the course. (Q64)	15	3	4	1	0	7	4.7
Prerequisites provided adequate preparation for this course. (Q61)	16	3	4	1	0	6	4.8
I developed confidence in my abilities as an engineer. (Q1769)	18	8	3	0	0	1	4.7
I developed the ability to solve real world engineering problems. (Q1770)	17	5	6	0	0	2	4.7

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Heath Hofmann was an excellent teacher. (Q2)	23	6	1	0	0	0	4.8

The medians are calculated from Fall 2022 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 16 to 74 in College of Engineering.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-21
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 390	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 390
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) Programming Paradigms	Course Title (full title) Programming Paradigms
☐	Abbreviated Title (20 char) Prog Paradigms	Abbreviated Title (20 char) Prog Paradigms
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Survey of programming language features and paradigms and how to effectively use them. Introduces common features for program execution, data, and resource management. Exploration of paradigms including imperative, functional, object-oriented, and declarative programming, as well as advanced programming techniques. Students will gain experience in large projects that incorporate these paradigms.	
☐	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: Undergraduate Max: 4 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 390

☐

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) EECS 281; (C or better, No OP/F). Enrollment in one minor elective allowed for Computer Science Minors. Minimum grade requirement: C	Enforced Prerequisite (254 char) EECS 281; (C or better, No OP/F). Minimum grade requirement: C
☐	Credit Exclusions	Credit Exclusions

☑

Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☑ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

Terms Typically Offered
- ☑ Fall
- ☑ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Amir Kamil Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ariana Powell Email: powellar@umich.edu Phone:

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 12/21/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Andrew DeOrio	Date: 12/27/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Survey of programming language features and paradigms and how to effectively use them. Introduces common features for program execution, data, and resource management. Exploration of paradigms including imperative, functional, object-oriented, and declarative programming, as well as advanced programming techniques. Students will gain experience in large projects that incorporate these paradigms.	Course Description Survey of programming language features and paradigms and how to effectively use them. Introduces common features for program execution, data, and resource management. Exploration of paradigms including imperative, functional, object-oriented, and declarative programming, as well as advanced programming techniques. Students will gain experience in large projects that incorporate these paradigms.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab) 2	Contact hours (lab) 2

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
We have enough capacity in this course that we no longer need to restrict CS minors from taking it in addition to another elective.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-10-11
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 408
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Advanced Operating Systems Projects
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Advanced OS Projects
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Hands-on experience with advanced operating systems concepts. Includes topics such as managing multiprocessors, building and using spinlocks, suspending and waking processors with interprocessor interrupts, inheriting address spaces, sharing data through copy-on-write, managing locks dynamically, and enabling increased concurrency in multithreaded systems.	
☑	Full Term Credit Hours Undergraduate Min: 2 Graduate Min: 2 Undergraduate Max: 2 Graduate Max: 2	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Catalog:

☑	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

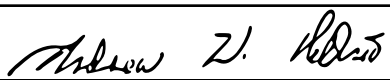
	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Concurrent enrollment in EECS 482 Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☐ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☑ Discussion ☐ Independent Study	Graded Component ☐ ☐ ☐ ☐ ☑ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Peter Chen Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Punam Vyas Email: vyas@umich.edu Phone: 647-175

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 12/04/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: **Andrew DeOrio**	Date: **12/04/2024**
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Hands-on experience with advanced operating systems concepts. Includes topics such as managing multiprocessors, building and using spinlocks, suspending and waking processors with interprocessor interrupts, inheriting address spaces, sharing data through copy-on-write, managing locks dynamically, and enabling increased concurrency in multithreaded systems.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture):
Contact hours (recitation)	Contact hours (recitation) 2
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Flexible technical elective for CS majors

Special resources of facilities required for this course:

Supporting statement:
This course is an optional companion course available to students who are concurrently enrolled in EECS 482. Students implement advanced versions of the EECS 482 course projects, which will give students more experience with concepts such as multiprocessors, spinlocks, inter-processor interrupts, address space inheritance, copy-on-write memory sharing, dynamic lock management, and advanced locking techniques. These are not covered elsewhere in the undergraduate CS curriculum, and they provide a strong foundation for students who wish to specialize in systems programming or become more familiar with how computing systems work.

Since Fall 2018, the EECS 482 instructors have been offering this course as a special-topics section, with about half the students in EECS 482 electing to take the additional section. The following are enrollment and evaluation numbers from the offerings:

Semester	Enrollment	Q1	Q2	Q4
Fall 2018	139	4.9	5	4.8
Winter 2019	173	4.8	4.9	4.6
Fall 2019	153	4.8	5	4.6
Winter 2020	153	4.7	4.8	4.7
Fall 2020	196	4.8	4.9	4.7

Winter 2021	200	4.7	4.9	4.7
Fall 2021	123	N/A	N/A	N/A
Winter 2022	111	4.9	4.9	4.8
Fall 2022	98	N/A	N/A	N/A
Winter 2023	110	4.9	4.9	4.8
SpSu 2023	9	5	5	5
Fall 2023	189	4.9	4.9	4.8
Winter 2024	188	4.7	4.8	4.6
SpSu 2024	15	4.9	5	4.9
Fall 2024	164	N/A	N/A	N/A

Introduction to Operating Systems
EECS 482 / 4xx (Fall 2025 -- draft)

1. Course overview

EECS 482 is an introductory course on operating systems at the senior undergraduate or first-year graduate level. The objective of the course is to teach the issues involved in the design and implementation of modern operating systems. The concepts in this course are applicable to many operating systems and hardware platforms. We will discuss examples that are drawn from historically significant and modern operating systems including MULTICS, Unix, and Windows. We will cover topics such as processes and threads, concurrency and synchronization, CPU scheduling, virtual memory management, communication in distributed systems, secondary-storage management, and file systems.

To help you understand operating systems, you will implement several modules that form much of the core functionality in modern operating systems. These projects will give you practical exposure to topics such as threads, virtual memory management, client-server systems, and file systems. We will also assign homework questions that will be covered in the lab sections.

We offer an optional supplemental course (EECS 4xx) for students concurrently enrolled in EECS 482. Students in EECS 4xx will complete advanced versions of the EECS 482 course projects, which will give students more experience with concepts such as multiprocessors, spinlocks, inter-processor interrupts, address space inheritance, copy-on-write memory sharing, dynamic lock management, and advanced locking techniques. Class meeting times for EECS 4xx will be structured as discussion section times for students enrolled in EECS 4xx, which will largely be used to provide one-on-one help to teams working on the advanced projects.

2. Prerequisites

Students must have completed EECS 281 and EECS 370. Students should understand data structures and computer architecture, have extensive C/C++ programming experience, and be familiar with UNIX.

3. Course materials and information

The recommended textbook for the course is Operating Systems: Principles and Practice (2nd edition), by Thomas Anderson and Michael Dahlin (ISBN 0985673524). There will also be lecture slides and supplementary readings posted on the course web page. Course announcements and project help will be posted on piazza.

4. Course projects

Four projects will be assigned during the semester. Each project will require a substantial time commitment on your part.

4.1 Group work

Three of the four projects in this course will be done in groups of 2-3 students (Project 1 is done individually). Groups may be drawn from the entire EECS 482 population; members of a group need not all be in the same lecture or lab section. Declare your group's membership by xxx. After this date, we will form groups from the remaining students. Choose your group members carefully. You should discuss topics such as prior experience, course background, goals for this course, workload and schedule for this semester, and preferred project management and work style. Make sure you can find several blocks of time during the week to meet to discuss or carry out the project. Students who have worked on any EECS 482 project in a past semester should talk with an instructor before joining a group.

Students are expected to work diligently in their group for the benefit of the entire group. All group members should be familiar with all aspects of each project, irrespective of their role on the project. We expect all group members to contribute their fair share, and we expect to assign the same project grade to all members of a group. To help ensure this, group members will evaluate the contributions of other group members after each project. Members who contribute less than their share may receive a lower grade on the project; non-contributing members will receive a zero. In case of disputes regarding contribution, an instructor may examine the commit log or interview group members.

Students may be fired from a group by the majority vote of the remaining members. The recommended procedure for this is as follows: (1) documented "gentle warning" of risk of firing in e-mail, with cc to all group members and eecs482-fac@umich.edu with cause and specific work required to remain in group; (2) allow at least 72 hours for compliance; (3) if the problems persist, e-mail statement of firing to the group and eecs482-fac@umich.edu. Fired group members may join another group; students who cannot find a group must complete the remaining projects by themselves.

Managing group dynamics and using each group member's time and talents effectively can be difficult. If there are problems with your group, please see an instructor as soon as possible. Be open and candid with your group about potential problems early on so your group can plan around those problems and not fall behind. A sure way to make your group upset at you is not finishing your work at an agreed-upon deadline and not informing them about the problems early enough for them to help.

All projects will be hosted at github. Please sign up for a free github account if you don't already have one, then register your github username with us. The eecs482 organization at github will provide a private repository for each group for each project. Commits to the repository should reflect the proportion of work performed by each group memer. If you use pair programming, take turns at the keyboard so that the commit log reflects the contributions of both members.

4.2 Turning in projects

Projects are due at the end of the day (11:59:59 pm Eastern time) specified in the project handout. Your initial project score will be the highest autograder score [0,80] you have achieved by the due date, multiplied by a hand-grading score [1,1.25] based on a human grader's evaluation of your highest-scoring submission.

After the due date, you may continue to submit to the autograder and earn more autograder points, but these extra points will not be multiplied by the hand-grading score. For example, if your autograder score at the project due date is 60, your hand-grading score is 1.20, and your autograder score at the end of the semester is 80, then your final project score will be 60*1.20 + (80-60) = 92. The last day to submit to the autograder is December 13, 2024.

If a family/personal emergency causes you to miss a significant number of days, please see an instructor to decide the best course of action. If you are having trouble understanding the material or starting a project, please come to office hours for help right away.

4.3 Honor code

All projects in this course are to be done by your own group and in accordance with the College of Engineering Honor Code. Violation will result in a zero on the project in question and initiation of the formal procedures of the Engineering Honor Council.

At the same time, we encourage students to help each other learn the course material. As in most courses, there is a boundary separating these two situations. You may give or receive help on concepts covered in lecture or lab and on the specifics of C++ syntax. You may consult with other students to help you understand the project specification (i.e., the problem definition). However, you may not collaborate in any way when constructing your solution--the solution to the project must be generated by your group working alone. Any misrepresentation of another person's work as your

own is unacceptable and is a violation of the honor code. You are not allowed to work out the[57] programming details of the problems with anyone or to collaborate to the extent that your programs are identifiably similar. You are not allowed to look at or in any way derive advantage from solutions or code that you did not write. If you worked on the projects in the past (e.g., if you are repeating EECS 482), you are not allowed to re-use code that your group wrote from the prior semester.

We encourage students to use online resources such as cppreference, Stack Overflow, and ChatGPT. However, you may only use these types of resources for general programming help (such as how to use a particular C++ feature); you may not use them to get help that is specific to the EECS 482 projects. Be wary of using AI pair programmers (e.g., Copilot), as it may provide code that causes you to violate the honor code.

Please talk with an instructor if you have any questions as to what constitutes unacceptable collaboration or use of online resources. You are expected to take reasonable precautions to protect your work. You may not post your work in a publically accessible location, such as public code repositories. Don't let other students borrow your account or computer; don't leave your program in a publicly accessible directory; and don't discard printouts in a public place.

4.4 Tips for success on the projects

The most common reason for doing poorly on the projects is starting them late. You will be given plenty of time to complete each project. However, if you wait several days to start a project, you may not be able to finish. Start early, and plan to have it finished a few days ahead of the due date. Expect to spend *much more* time debugging the code than you did writing it.

A common reason for spending too much time on a project is coding before thinking through the entire project. Resist the urge to start writing code as your first step; you are likely to code yourself into a corner. Meet with your group and plan out the architecture of your solution. Expect to revise this architecture several times before settling on a plan. Read the project description carefully, and list the behaviors the specifications require of your solution. The more you think through and understand what needs to be programmed before you write code, the better. Design your project with independently and incrementally testable subsystems rather than saving all testing for the end. If your project has an error, try to recreate the error with the simplest possible test. Another common reason for spending too much time on a project is debugging by trying things at random, just to see if they work. If you find a workaround without understanding why it fixes the problem, you may be masking the problem rather than fixing it, and it will probably cause more problems later and be harder to fix. If you find yourself in this position, step away from the computer and think about what is happening, or come see an instructor in office hours.

There are many sources of help on which you can draw. Most questions can be submitted to the teaching staff and your fellow classmates via piazza. These will typically be answered within the day, often more quickly during working hours. However, some types of questions cannot be

answered without seeing your project. If you have detailed questions about your program, speak to an instructor during office hours. Students are also encouraged to help one another on the course concepts (but not the implementation of the projects). One of the best ways for you to make sure that you understand a concept is to explain it to someone else. Keep in mind, however, that you should not expect anyone else to do any part of your project for you. The project that you turn in must be your own.

5. Exams

There will be two exams during the semester: a midterm exam and the final exam. You are expected to take both exams in-person at the scheduled times.

If you miss an exam for reasons other than a documented medical or personal emergency, you will receive a zero for that exam. If you anticipate a conflict with an exam time, talk to the instructor at least one month before the exam date. Exam dates are given at the beginning of the semester so you can avoid scheduling job interviews or other commitments on those days. Outside commitments are not considered a valid reason for missing an exam.

Exam answers will be collected via a web form. You will need a laptop with sufficient battery power for the exam period. If you do not have access to such a laptop, you may be able to borrow one from the North Campus Technology Checkout.

After you receive your exam back, you may discover it was graded incorrectly. We encourage you to ask for a regrade to correct clear errors in grading. However, please make sure you understand the question and solution fully before asking for a regrade, because it is always a bit risky asking a grader to examine your solution more closely -- the grader may notice a new error, which could result in a lower score.

You may have one regrade request in-progress at a time. If (and only if) your regrade is successful, you may submit your next request. This policy is meant to reduce spurious regrade requests, and to make sure you understand the solution and your answer fully before asking for the regrade. Regrades will be open for one week, starting shortly after the exam solution is covered in class.

6. Delivery of instruction

This semester's class will be delivered via in-person/online/recorded lectures, in-person/online/recorded labs, in-person/online office hours, and **in-person only** exams. To participate effectively in class, students will need consistent and reliable access to a computer that supports project development.

Lectures and lab sections will be interactive and geared for students who are attending synchronously. To accomodate students who cannot attend lectures or labs synchronously, lectures

and labs will be recorded and made available afterwards to students in this class. As part of your participation in this course, you may be recorded. If you do not wish to be recorded, please contact the instructors in the first week of class to discuss alternative arrangements. Students may not record or distribute any class activity without written permission from the instructor, except as necessary as part of approved accommodations for students with disabilities. Any approved recordings may only be used for the student's own private use.

Office hours will be managed via an online queue. Please post your location when you join the office hour queue; if you are joining online, post the URL for an online meeting (e.g., Zoom or Google Meet); an instructor will join your meeting when it is your turn.

7. Grading

Final grades for EECS 482 will be based on a weighted average of the points earned on the core projects and exams. Final grades for EECS 4xx will be based on the same weighted average of the points earned on the advanced projects and exams. See weights below. Factors such as class participation may be used to adjust your final grade, especially if it falls on a borderline.

Project 1: 5%
Project 2: 15%
Project 3: 15%
Project 4: 15%
Midterm exam: 25%
Final exam: 25%

8. Computers

The standard computing platform for this course is x86-64 PCs with Linux (RHEL 8) and g++ version 12.2.1, which are available via ssh at login.engin.umich.edu .

The project libraries and executables we provide should also work on other versions of Linux (e.g., Ubuntu 22.04) and on Windows Subsystem for Linux (WSL 2, e.g., running Ubuntu 22.04). We also provide files that should work on MacOS 13. These systems are not officially supported but have been used successfully by prior students.

9. Contacting the instructors

For questions on course material, please use piazza.

To contact the instructors about a personal concern, e-mail eecs482-fac@umich.edu .

10. Semester schedule

Week of	Topic	Readings
Aug 26 - Aug 30	Introduction	Ch. 1-1.1, 1.3, 2-2.1, 4-4.2, 4.9
Sep 2 - Sep 6	Threads and concurrency	Ch. 5-5.4
Sep 9 - Sep 13	Threads and concurrency	Ch. 5.5-5.6, 5.8
Sep 16 - Sep 20	Threads and concurrency	Ch. 4.3-4.8
Sep 23 - Sep 27	Threads and concurrency	Ch. 5.7, 6.4-6.5, 7
Sep 30 - Oct 4	Threads and concurrency	
Oct 7 - Oct 11	Address spaces	Ch. 8, 9-9.5, 9.7
Oct 14 - Oct 18	Address spaces	
Oct 21 - Oct 25	Midterm exam (Oct 21, 7-8:50 pm)	Ch. 2.2-2.9, 3-3.3
Oct 28 - Nov 1	Address spaces	
Nov 4 - Nov 8	CPU scheduling; File systems	Ch. 11-12
Nov 11 - Nov 15	File systems	Ch. 13-14, 3.4-3.5
Nov 18 - Nov 22	File systems; networking	
Nov 25 - Nov 29	Distributed systems	
Dec 2 - Dec 6	Case studies	
Dec 9 - Dec 13	Review	
Dec 16 - Dec 20	Final exam (Dec 17, 8-9:50 am)	

University of Michigan
Winter 2022 Instructor Report With Comments
EECS 498-002: Special Topics
Manos Kapritsos

37 out of 98 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	28	4	1	0	0	0	4.9	4.6	4.4
My interest in the subject has increased because of this course. (Q1632)	24	7	1	1	0	0	4.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	29	3	1	0	0	0	4.9	4.6	4.4
I had a strong desire to take this course.(Q4)	22	7	4	0	0	0	4.8	4.1	4.0
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	9	1	4	6	13	0	2.1	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Manos Kapritsos seemed well prepared for class meetings.(Q230)	28	2	1	0	0	2	4.9	4.8	4.7
Manos Kapritsos explained material clearly.(Q199)	27	3	1	0	0	2	4.9	4.7	4.6
Manos Kapritsos treated students with respect.(Q217)	25	5	1	0	0	2	4.9	4.8	4.7

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	27	5	1	0	0	0	4.9
Prerequisites provided adequate preparation for this course. (Q61)	25	4	2	0	0	1	4.9
The textbook made a valuable contribution to the course. (Q64)	17	6	5	1	1	3	4.6
I felt included and valued when working with other students. (Q253)	24	7	1	1	0	0	4.8
I felt comfortable asking questions in class. (Q521)	24	5	2	0	0	2	4.9
I developed confidence in my abilities as an engineer. (Q1769)	25	6	2	0	0	0	4.8
I developed the ability to solve real world engineering problems. (Q1770)	26	5	2	0	0	0	4.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Manos Kapritsos was an excellent teacher. (Q2)	28	3	2	0	0	0	4.9

University of Michigan
Winter 2023 Instructor Report
EECS 498-002: Special Topics
Manos Kapritsos

35 out of 110 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	28	3	3	0	0	0	4.9	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	25	7	2	0	0	0	4.8	4.1	4.2
I knew what was expected of me in this course.(Q1633)	27	4	3	0	0	0	4.9	4.3	4.6
I had a strong desire to take this course.(Q4)	25	6	3	0	0	0	4.8	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	4	1	6	7	16	0	1.6	2.8	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Manos Kapritsos seemed well prepared for class meetings.(Q230)	28	2	2	0	0	2	4.9	4.7	4.8
Manos Kapritsos explained material clearly.(Q199)	29	1	2	0	0	2	4.9	4.6	4.7
Manos Kapritsos treated students with respect.(Q217)	28	2	2	0	0	2	4.9	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	28	3	2	1	0	0	4.9
The textbook made a valuable contribution to the course. (Q64)	15	7	6	0	1	5	4.5
Prerequisites provided adequate preparation for this course. (Q61)	25	6	3	0	0	0	4.8
I felt comfortable asking questions in class. (Q521)	26	5	3	0	0	0	4.8
I developed confidence in my abilities as an engineer. (Q1769)	26	6	2	0	0	0	4.8
I developed the ability to solve real world engineering problems. (Q1770)	24	7	3	0	0	0	4.8
I felt included and valued when working with other students. (Q253)	28	2	2	0	0	2	4.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Manos Kapritsos was an excellent teacher. (Q2)	29	2	2	0	0	1	4.9

University of Michigan
Spring/Summer 2023 Instructor Report
EECS 498-100: Special Topics
Peter Chen

7 out of 8 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	7	0	0	0	0	0	5.0	4.7	4.6
My interest in the subject has increased because of this course. (Q1632)	6	1	0	0	0	0	4.9	4.4	4.4
I knew what was expected of me in this course.(Q1633)	6	1	0	0	0	0	4.9	4.6	4.6
I had a strong desire to take this course.(Q4)	7	0	0	0	0	0	5.0	4.1	4.2
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	0	0	1	5	0	1.2	2.8	2.9

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Peter Chen seemed well prepared for class meetings.(Q230)	7	0	0	0	0	0	5.0	4.8	4.8
Peter Chen explained material clearly.(Q199)	7	0	0	0	0	0	5.0	4.7	4.8
Peter Chen treated students with respect.(Q217)	7	0	0	0	0	0	5.0	4.9	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	7	0	0	0	0	0	5.0
The textbook made a valuable contribution to the course. (Q64)	0	2	3	0	0	2	3.3
Prerequisites provided adequate preparation for this course. (Q61)	5	1	1	0	0	0	4.8
I developed confidence in my abilities as an engineer. (Q1769)	3	3	0	0	0	0	4.5
I developed the ability to solve real world engineering problems. (Q1770)	6	1	0	0	0	0	4.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Peter Chen was an excellent teacher. (Q2)	7	0	0	0	0	0	5.0

The medians are calculated from Spring/Summer 2023 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 1 to 15 in College of Engineering.

University of Michigan
Fall 2023 Instructor Report
EECS 498-002: Special Topics
Peter Chen

108 out of 181 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	76	19	3	0	1	1	4.8	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	67	26	4	1	0	1	4.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	64	29	4	0	0	1	4.7	4.4	4.5
I had a strong desire to take this course.(Q4)	65	27	3	2	0	1	4.8	4.1	4.0
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	7	4	12	21	54	0	1.4	2.8	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Peter Chen seemed well prepared for class meetings.(Q230)	87	10	0	0	0	0	4.9	4.7	4.8
Peter Chen explained material clearly.(Q199)	86	11	2	0	0	0	4.9	4.6	4.7
Peter Chen treated students with respect.(Q217)	88	10	1	0	0	0	4.9	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	77	18	2	0	0	1	4.9
The textbook made a valuable contribution to the course. (Q64)	22	14	17	7	3	32	3.8
Prerequisites provided adequate preparation for this course. (Q61)	48	40	6	0	0	1	4.5
I felt comfortable asking questions in class. (Q521)	51	35	5	0	0	3	4.6
I developed confidence in my abilities as an engineer. (Q1769)	55	37	1	1	0	1	4.6
I developed the ability to solve real world engineering problems. (Q1770)	54	36	1	0	0	1	4.7
I felt included and valued when working with other students. (Q253)	63	23	2	2	0	3	4.8

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Peter Chen was an excellent teacher. (Q2)	81	16	0	0	0	0	4.9

University of Michigan
Spring/Summer 2024 Instructor Report
EECS 498-002: Special Topics
Peter Chen

9 out of 12 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	8	1	0	0	0	0	4.9	4.7	4.6
My interest in the subject has increased because of this course. (Q1632)	8	1	0	0	0	0	4.9	4.6	4.4
I knew what was expected of me in this course.(Q1633)	8	1	0	0	0	0	4.9	4.7	4.6
I had a strong desire to take this course.(Q4)	8	1	0	0	0	0	4.9	4.3	4.2
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	0	1	4	3	0	1.9	2.7	2.9

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Peter Chen seemed well prepared for class meetings.(Q230)	9	0	0	0	0	0	5.0	4.8	4.9
Peter Chen explained material clearly.(Q199)	9	0	0	0	0	0	5.0	4.8	4.8
Peter Chen treated students with respect.(Q217)	9	0	0	0	0	0	5.0	4.9	4.9

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	8	1	0	0	0	0	4.9
I felt included and valued when working with other students. (Q253)	9	0	0	0	0	0	5.0

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Peter Chen was an excellent teacher. (Q2)	9	0	0	0	0	0	5.0

The medians are calculated from Spring/Summer 2024 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 1 to 15 in College of Engineering.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-11-18
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 474
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐		
☑	Course Title (full title)	Course Title (full title) Algorithms for Data Science
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Data Sci Algorithms
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Fundamental techniques and mathematical methods for designing and analyzing algorithms used in data science and machine learning. Topics include randomized algorithms (sketching), streaming algorithms (frequent items), dimensionality reduction (Johnson-Lindenstrauss embeddings), matrix approximation (randomized singular value decomposition), optimization (stochastic gradient descent, Newton's method), and graph algorithms (spectral clustering).	
☑	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject:	Catalog:

☑	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

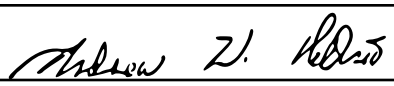
	CURRENT LISTING	**REQUESTED LISTING**
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) EECS 376 or a proof-based math course
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) (MATH 214 or 217 or 296 or 417 or 419 or ROB 101) and (STATS 250 or 280 or 412 or 425 or MATH 425 or EECS 301 or IOE 265 or DATASCI 101); (C or better, No OP/F) or Graduate Standing Minimum grade requirement: C
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☑ Discussion ☐ Independent Study	Graded Component ☑ ☐ ☐ ☐ ☐ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Michał Dereziński	Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ariana Powell Email: powellar@umich.edu Phone:

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 12/04/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: **Andrew DeOrio**	Date: **12/04/2024**
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Fundamental techniques and mathematical methods for designing and analyzing algorithms used in data science and machine learning. Topics include randomized algorithms (sketching), streaming algorithms (frequent items), dimensionality reduction (Johnson-Lindenstrauss embeddings), matrix approximation (randomized singular value decomposition), optimization (stochastic gradient descent, Newton's method), and graph algorithms (spectral clustering).
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
ULCS elective for undergrad CS programs

Special resources of facilities required for this course:

Supporting statement:
This course introduces algorithmic and theoretical foundations of data science, with a focus on applications to machine learning. With the ever-increasing data sizes, providing theoretical foundations for the design and analysis of algorithms used in data science is becoming increasingly important. The course covers several important algorithms which use randomization, linear algebra, and optimization to construct compressed representations of data and to efficiently perform large-scale data processing and prediction tasks. This knowledge is relevant both for students interested in algorithms, but also those who seek a strong foundation for applying algorithmic tools in data science domains. The course is intended as an Upper-Level CS elective and will complement existing courses such as EECS 477 (Introduction to Algorithms) and EECS 445 (Introduction to Machine Learning).

Enrollment:

Winter 2022 (Euiwoong Lee): 14
Winter 2023 (Michał Dereziński): 20
Winter 2024 (Michał Dereziński): 24
Fall 2024 (Michał Dereziński): 26

Algorithms for Data Science

Instructor: ***Michał Dereziński*** (derezin@umich.edu) **EECS 498-005, Winter 2024**

Lectures: Mondays and Wednesdays, 3-4:30pm, IOE 1680
Instructor office hours: Mondays 4:30-6pm, and Wednesdays 4:30-5:30pm, BBB 2649

GSI: Sachin Garg (sachg@umich.edu)
Discussion sections: Fridays, 1:30-2:30pm, EECS 1005
GSI office hours: Fridays, 4-6pm, BBB 4941

Prerequisites: EECS 376 (advisory), Linear Algebra (MATH 214, 217, 296, 417, or 419), solid backgroud in probability

Overview: This course will introduce algorithmic and theoretical foundations of data science. With the emergence of machine learning and data science, as well as the ever-increasing data sizes, providing theoretical foundations for the computational complexity of data manipulation algorithms is becoming increasingly important. The course will cover several important algorithms in data science and demonstrate how their performances can be analyzed. While fundamental ideas covered in EECS 376 (e.g., design and analysis of algorithms) will be important, some topics will introduce new concepts and ideas, including randomized dimensionality reduction, sketching algorithms, and optimization algorithms (e.g., for training machine learning models). The course will delve into concepts in linear algebra, such as matrix multiplication and singular value decomposition, as well as in probability theory, such as expectation, independence and concentration of random variables.

Evaluation: The evaluation will be based on a midterm, a final, and homework assignments: homework 40%, midterm 30%, and final 30% (extra credit may be awarded for participation in class and on piazza). The final grade will be based on a standard 90/80/70 scale (e.g., if you get 90, you will get at least A-, if you get 80, you will get at least B-, etc), with the possibility of curving up.

Homework: There will be roughly 4 homeworks (spaced out by about two/three weeks). Working in groups of 2 is allowed, but each person must submit their own write-up and write the names of all group members on your solutions. Using Generative AI tools is not allowed.

Exams: Both the midterm and the final will be take-home exams designed for a 24 hour period (although more than 24 hours may be given for completing each exam). These will be open-note and open-internet tests, but each student should submit their own solution (no groups) and may not communicate/consult answers with any other humans (or Generative AI tools) in real life or on the internet.

- Take-home midterm: Thursday, March 7, 5pm ET - Saturday, March 9, 5pm ET.
- Take-home final: Monday, April 29, 10am ET - Wednesday, May 1, 5pm ET.

Honor policy: You are expected to practice the highest possible standards of academic integrity, including personal responsibility, honesty, fairness, respect, and mutual trust. Deviations from this expectation will result in a minimum academic penalty of your failing the assignment, and may result in additional disciplinary measures. This includes, but is not limited to, cheating, using unauthorized material during exams, using or copying another student's work, and any other form of academic misrepresentation or misconduct. In particular, any course materials that are found on coursehero, chegg, etc will be immediately reported to the honor council. To review the current Engineering Honor Code, refer to the Honor Council page https://ecas.engin.umich.edu/honor-council/.

Commitment to equal opportunity: The Faculty of the College of Engineering are committed to a policy of equal opportunity for all persons and do not discriminate on the basis of race, color, national origin, age, marital status, sex, sexual orientation, gender identity, gender expression, disability, religion, height, weight, or veteran status. Please feel free to contact your instructor with any problem, concern, or suggestion. We ask that all students treat each other with respect.

Diversity, Equity, and Inclusion: This classroom is a place where you should expect to be treated with respect, and where we celebrate individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability, and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. If I accidentally use language that creates offense or discomfort, either in a lecture or in a smaller interaction, please reach out to me to help me understand and avoid making the same mistake again.

Accommodations for Students with Disabilities: If you think you need an accommodation for a disability, please let your instructor know at your earliest convenience. Some aspects of this course may be modified to facilitate your participation and progress. As soon as you make us aware of your needs, we can work with the Services for Students with Disabilities (SSD, http://ssd.umich.edu) office to help us determine appropriate academic accommodations. SSD typically recommends accommodations through a Verified Individualized Services and Accommodations (VISA) form. Any information you provide is private and confidential and will be treated as such.

Student Mental Health and Wellbeing: University of Michigan is committed to advancing the mental health and wellbeing of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, contact Counseling and Psychological Services (CAPS) at (734) 764-8312 and https://caps.umich.edu/.

Lecture plan (subject to change)

Course overview and logistics	Wed, Jan 10
Linear algebra and probability review 1	Wed, Jan 17
Sketching data streams	Mon, Jan 22
Sketching data streams	Wed, Jan 24
Fast matrix multiplication 1	Mon, Jan 29
Fast matrix multiplication 2	Wed, Jan 31
Concentration inequalities 1	Mon, Feb 5
Concentration inequalities 2	Wed, Feb 7
Dimensionality reduction 1	Mon, Feb 12
Dimensionality reduction 2	Wed, Feb 14
Subspace embeddings	Mon, Feb 19
Subspace embeddings	Wed, Feb 21
Fast sketching operators 1	Mon, Mar 4
Fast sketching operators 1	Wed, Mar 6
Least squares regression 1	Mon, Mar 11
Least squares regression 2	Wed, Mar 13
Low-rank approximation 1	Mon, Mar 18
Low-rank approximation 2	Wed, Mar 20
Convex optimization 1	Mon, Mar 25
Convex optimization 2	Wed, Mar 27
Stochastic optimization 1	Mon, Apr 1
Stochastic optimization 2	Wed, Apr 3
Constrained optimization 1	Mon, Apr 8
Constrained optimization 2	Wed, Apr 10
Spectral graph algorithms 1	Mon, Apr 15
Spectral graph algorithms 2	Wed, Apr 17
Spectral graph algorithms 3	Mon, Apr 22

Textbooks

There is no official textbook for the course. However, the following materials will be helpful, all of which are available in the "Useful bonus materials" folder on the canvas page:

- David Woodruff. *Sketching as a Tool for Numerical Linear Algebra* (2015) [6]
- Michael Mahoney. *Lecture notes on randomized linear algebra* (2016) [4]
- Petros Drineas and Michael Mahoney. *Lectures on Randomized Numerical Linear Algebra* (2018) [3]
- Per-Gunnar Martinsson and Joel Tropp. *Randomized numerical linear algebra: Foundations and algorithms* (2020) [5]
- Stephen Boyd and Lieven Vandenberghe. *Convex optimization* (2004) [2]
- Léon Bottou, Frank Curtis and Jorge Nocedal. *Optimization methods for large-scale machine learning* (2018) [1]

References

[1] Léon Bottou, Frank E Curtis, and Jorge Nocedal. Optimization methods for large-scale machine learning. *Siam Review*, 60(2):223–311, 2018.

[2] Stephen P Boyd and Lieven Vandenberghe. *Convex optimization*. Cambridge university press, 2004.

[3] P. Drineas and M. W. Mahoney. Lectures on randomized numerical linear algebra. In *The Mathematics of Data*, IAS/Park City Mathematics Series, pages 1–48. AMS/IAS/SIAM, 2018.

[4] Michael W Mahoney. Lecture notes on randomized linear algebra. *arXiv preprint arXiv:1608.04481*, 2016.

[5] Per-Gunnar Martinsson and Joel A Tropp. Randomized numerical linear algebra: Foundations and algorithms. *Acta Numerica*, 29:403–572, 2020.

[6] D. P. Woodruff. *Sketching as a Tool for Numerical Linear Algebra*. Foundations and Trends in Theoretical Computer Science. NOW Publishers, Boston, 2014.

University of Michigan
Winter 2023 Instructor Report
EECS 498-005: Special Topics
Michal Derezinski

8 out of 18 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	5	2	0	0	1	0	4.7	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	3	3	1	0	1	0	4.2	4.1	4.2
I knew what was expected of me in this course.(Q1633)	5	1	1	1	0	0	4.7	4.3	4.6
I had a strong desire to take this course.(Q4)	3	3	1	1	0	0	4.2	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	0	4	1	2	0	2.8	2.8	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Michal Derezinski seemed well prepared for class meetings.(Q230)	5	2	1	0	0	0	4.7	4.7	4.8
Michal Derezinski explained material clearly.(Q199)	4	2	1	1	0	0	4.5	4.6	4.7
Michal Derezinski treated students with respect.(Q217)	5	3	0	0	0	0	4.7	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	2	2	1	0	2	0	3.8
The textbook made a valuable contribution to the course. (Q64)	3	0	1	0	2	2	4.0
Prerequisites provided adequate preparation for this course. (Q61)	3	0	1	1	3	0	2.5
I felt comfortable asking questions in class. (Q521)	3	4	1	0	0	0	4.3
I developed confidence in my abilities as an engineer. (Q1769)	3	2	1	0	1	1	4.3
I developed the ability to solve real world engineering problems. (Q1770)	4	1	1	0	2	0	4.5
I felt included and valued when working with other students. (Q253)	5	2	0	0	1	0	4.7

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Michal Derezinski was an excellent teacher. (Q2)	4	1	3	0	0	0	4.5

University of Michigan
Winter 2024 Instructor Report
EECS 498-005: Special Topics
Michal Derezinski

10 out of 19 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	6	4	0	0	0	0	4.7	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	4	3	1	1	1	0	4.2	4.2	4.2
I knew what was expected of me in this course.(Q1633)	4	6	0	0	0	0	4.3	4.4	4.6
I had a strong desire to take this course.(Q4)	4	6	0	0	0	0	4.3	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	0	1	1	8	0	1.1	2.9	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Michal Derezinski seemed well prepared for class meetings.(Q230)	7	3	0	0	0	0	4.8	4.7	4.8
Michal Derezinski explained material clearly.(Q199)	4	5	1	0	0	0	4.3	4.6	4.7
Michal Derezinski treated students with respect.(Q217)	7	3	0	0	0	0	4.8	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	3	5	0	2	0	0	4.1
I felt included and valued when working with other students. (Q253)	4	4	1	0	0	0	4.4

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Michal Derezinski was an excellent teacher. (Q2)	3	7	0	0	0	0	4.2

The medians are calculated from Winter 2024 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2024 Midterm Instructor Report
EECS 498 005 - CSE 598 005
Michal Derezinski

10 out of 26 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
I am learning a great deal in this course. (Q966)	8	2	0	0	0	0	4.88

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Michal Derezinski is enthusiastic. (Q114)	6	4	0	0	0	0	4.67
Overall, this is an excellent course. (Q964)	5	3	1	1	0	0	4.50
Overall, Michal Derezinski is an excellent teacher. (Q965)	6	3	1	0	0	0	4.67
Michal Derezinski acknowledges all questions insofar as possible. (Q968)	6	4	0	0	0	0	4.67
Michal Derezinski uses techniques to foster class participation. (Q972)	6	2	2	0	0	0	4.67
Michal Derezinski is willing to meet and help students outside class. (Q975)	7	3	0	0	0	0	4.79
Michal Derezinski keeps students informed of their progress. (Q977)	6	2	1	1	0	0	4.67

Course Approval Request Form

Office of the Registrar, University of Michigan

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-21
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 475	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 475
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) Introduction to Cryptography	Course Title (full title) Introduction to Cryptography
☐	Abbreviated Title (20 char) Intro Cryptography	Abbreviated Title (20 char) Intro Cryptography
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Covers fundamental concepts, algorithms, and protocols in cryptography. Topics: ancient ciphers, Shannon theory, symmetric encryption, public key encryption, hash functions, digital signatures, key distribution. Emphasizes attack models, precise definitions of security, reductions, and proof techniques.	
☐	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 475

☐	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) EECS 376 or a proof-based math course
☑	Enforced Prerequisite (254 char) [EECS 376; (C or better, No OP/F)] or Graduate Standing in CSE. Enrollment in one minor elective allowed for Computer Science Minors. Minimum grade requirement: C	Enforced Prerequisite (254 char) [EECS 281; (C or better, No OP/F)] or Graduate Standing in CSE. Minimum grade requirement: C
☐	Credit Exclusions	Credit Exclusions

☑	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☑ Discussion ☐ Independent Study	Graded Component ☑ ☐ ☐ ☐ ☐ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Christopher Peikert Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ariana Powell Email: powellar@umich.edu Phone:

CoE Curriculum Committee Representative:	Print: Amir Kamil	Date: 12/21/24
CoE Curriculum Committee Chair:	Print:	Date:
Home Department Chair:	Print: Andrew DeOrio	Date: 12/27/24
Cross-Listed Department Chair:	Print:	Date:
Cross-Listed Department Chair:	Print:	Date:
Cross-Listed Department Chair:	Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Covers fundamental concepts, algorithms, and protocols in cryptography. Topics: ancient ciphers, Shannon theory, symmetric encryption, public key encryption, hash functions, digital signatures, key distribution. Emphasizes attack models, precise definitions of security, reductions, and proof techniques.	Course Description Covers fundamental concepts, algorithms, and protocols in cryptography. Topics: ancient ciphers, Shannon theory, symmetric encryption, public key encryption, hash functions, digital signatures, key distribution. Emphasizes attack models, precise definitions of security, reductions, and proof techniques.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation) 1	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Upper-level CS elective for BS CS-LSA and BSE CS-Eng

Special resources of facilities required for this course:

Supporting statement:
We are moving EECS 376 from an enforced prerequisite to an advisory prerequisite because this course does not depend on material from EECS 376, but does depend on mathematical maturity that can also be achieved through other courses. We are also allowing minors to take more than one elective course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-21
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 477	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 477
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) Introduction to Algorithms	Course Title (full title) Introduction to Algorithms
☐	Abbreviated Title (20 char) Intro to Algorithms	Abbreviated Title (20 char) Intro to Algorithms
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Fundamental techniques for designing efficient algorithms and basic mathematical methods for analyzing their performance. Paradigms for algorithm design: divide-and-conquer, greedy methods, graph search techniques, dynamic programming. Design of efficient data structures and analysis of the running time and space requirements of algorithms in the worst and average cases.	
☐	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 477

☐

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) EECS 376 or a proof-based math course
☑	Enforced Prerequisite (254 char) EECS 281 and EECS 376; (C or better, No OP/F). Enrollment in one minor elective allowed for Computer Science Minors. Minimum grade requirement: C	Enforced Prerequisite (254 char) EECS 281; (C or better, No OP/F). Minimum grade requirement: C
☐	Credit Exclusions No credit to a student who has taken CSE 586.	Credit Exclusions No credit to a student who has taken CSE 586.

☐

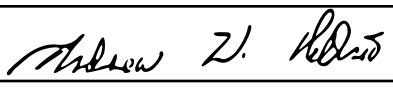
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☑ Discussion	☐
☐ Independent Study	☐

Terms Typically Offered
- ☑ Fall
- ☑ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Seth Pettie Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ariana Powell Email: powellar@umich.edu Phone:

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 12/21/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Andrew DeOrio	Date: 12/27/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Fundamental techniques for designing efficient algorithms and basic mathematical methods for analyzing their performance. Paradigms for algorithm design: divide-and-conquer, greedy methods, graph search techniques, dynamic programming. Design of efficient data structures and analysis of the running time and space requirements of algorithms in the worst and average cases.	Course Description Fundamental techniques for designing efficient algorithms and basic mathematical methods for analyzing their performance. Paradigms for algorithm design: divide-and-conquer, greedy methods, graph search techniques, dynamic programming. Design of efficient data structures and analysis of the running time and space requirements of algorithms in the worst and average cases.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation) 1	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Tech Elective

Special resources of facilities required for this course:

Supporting statement:
We are moving EECS 376 from an enforced prerequisite to an advisory prerequisite because this course does not depend on material from EECS 376, but does depend on mathematical maturity that can also be achieved through other courses. We are also allowing minors to take more than one elective course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-21
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 490	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 490
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) Programming Languages	Course Title (full title) Programming Languages
☐	Abbreviated Title (20 char) Prog Lang	Abbreviated Title (20 char) Prog Lang
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Programming languages are rich mathematical structures and powerful user interfaces. Students will learn about modern languages from the perspective of both language designers and users, building up from mathematical first principles, and covering human factors in language design, language prototyping, and techniques for reasoning about program behavior.	
☐	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 490

☐

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) EECS 281; (C or better, No OP/F) or Graduate Standing in CSE. Enrollment in one minor elective allowed for Computer Science Minors. Minimum grade requirement: C	Enforced Prerequisite (254 char) EECS 281; (C or better, No OP/F) or Graduate Standing in CSE. Minimum grade requirement: C
☐	Credit Exclusions	Credit Exclusions

☐

Course Components
- ☑ Lecture
- ☐ Seminar
- ☐ Recitation
- ☐ Lab
- ☑ Discussion
- ☐ Independent Study

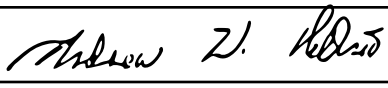
Graded Component
- ☑
- ☐
- ☐
- ☐
- ☐
- ☐

Terms Typically Offered
- ☑ Fall
- ☑ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Cyrus Omar Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ariana Powell Email: powellar@umich.edu Phone:

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 12/21/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Andrew DeOrio	Date: 12/27/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Programming languages are rich mathematical structures and powerful user interfaces. Students will learn about modern languages from the perspective of both language designers and users, building up from mathematical first principles, and covering human factors in language design, language prototyping, and techniques for reasoning about program behavior.	Course Description Programming languages are rich mathematical structures and powerful user interfaces. Students will learn about modern languages from the perspective of both language designers and users, building up from mathematical first principles, and covering human factors in language design, language prototyping, and techniques for reasoning about program behavior.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation) 1	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Tech Elective

Special resources of facilities required for this course:

Supporting statement:
We have enough capacity in this course that we no longer need to restrict CS minors from taking it in addition to another elective.

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Fax: 734.936.3148

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-13
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Engineering Subject: ENGR Catalog: 110	Dept (Home): Engineering Subject: ENGR Catalog: 110
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) Design Your Engineering Experience	Course Title (full title) Design Your Engineering Experience
☐	Abbreviated Title (20 char) Des Your Engr Exp	Abbreviated Title (20 char) Des Your Engr Exp
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Through online modules, faculty and alumni engagements, and near-peer led discussions sessions, students learn about: the foundations of engineering and its influence on society; the engineering majors, minors and co-curricular opportunities offered at Michigan; and, the roles that personal strengths, values, ethics, and social identity play in personal and professional decision making. Students incorporate this information into a personalized plan for their educational experience in Michigan Engineering.	
☐	Full Term Credit Hours Undergraduate Min: 2 Graduate Min: Undergraduate Max: 2 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Engineering Catalog: 110

☐	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) Non-freshman and non-sophomore students interested should seek instructor consent.
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Freshman and Sophomore Standing Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐	Course Components ☐ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☑ Discussion ☐ Independent Study	Graded Component ☐ ☐ ☐ ☐ ☑ ☐	Terms Typically Offered ☑ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Frank Marsik	Cognizant Faculty Member Title: Faculty Director of First Year Student Engagement

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Ryan Latimer Email: rlatimer@umich.edu Phone: 734-647-9039

CoE Curriculum
Committee Representative:

Rachael Schmedlen — Print: Rachael Schmedlen — Date: 12/13/24

CoE Curriculum Committee Chair: — Print: — Date:

Home Department Chair: Kevin Pipe — Print: Kevin Pipe — Date: 12/16/2024

Cross-Listed Department Chair: — Print: — Date:

Cross-Listed Department Chair: Print: Date:

Cross-Listed Department Chair: Print: Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description In this elective course, you explore the breadth of opportunities available to engineers in both their education and their career. You will have a chance to explore the foundations of the field, and its influence on ourselves and the world we live in. You will learn about the engineering majors offered at Michigan, and the types of career paths available as an engineer. You will identify your own interests and goals, and discover the broader opportunities available through academic minors and co-curricular opportunities that align with your passions. And, you will actively incorporate this information into a plan for your educational experience in Michigan Engineering.	Course Description Through online modules, faculty and alumni engagements, and near-peer led discussions sessions, students learn about: the foundations of engineering and its influence on society; the engineering majors, minors and co-curricular opportunities offered at Michigan; and, the roles that personal strengths, values, ethics, and social identity play in personal and professional decision making. Students incorporate this information into a personalized plan for their educational experience in Michigan Engineering.
Class Length Full term	Class Length Full term
Contact hours (lecture):	Contact hours (lecture):
Contact hours (recitation) 2	Contact hours (recitation) 2
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Free Elective

Special resources of facilities required for this course:

Supporting statement:
This course is intended to help both first-year engineering students, or those considering cross-campus transfer into the College of Engineering, to learn more about the engineering field and the opportunities within Michigan Engineering, in

order to develop a plan for their time within Michigan Engineering. In recent years, we have noted an increase in the number of upper level undergraduate students taking the course simply to complete two remaining credits needed for graduation. This course is not designed to serve these latter students, and thus we seek to restrict upper level undergraduates from taking the course, unless unique circumstances exist.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-09-26
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING			**REQUESTED LISTING**		
☐	Dept (Home): Mechanical Engineering Subject: MECHENG Catalog: 524			Dept (Home): Mechanical Engineering Subject: MECHENG Catalog: 524		
☑	☐ Course is Cross-Listed with Other Departments			☑ Course is Cross-Listed with Other Departments		
	Department	Subject	Catalog Number	Department	Subject	Catalog Number
				Biomedical Engineering - BIOMEDE - 524		
☐	Course Title (full title) Advanced Engineering Acoustics			Course Title (full title) Advanced Engineering Acoustics		
☐	Abbreviated Title (20 char) Adv Eng Acoustics			Abbreviated Title (20 char) Adv Eng Acoustics		
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Derivation of the acoustic wave equation in complex media including inhomogeneous biomaterials with viscous loss and development of solution techniques. Transmission and reflection from solids, plates and impedance boundaries. Radiation and scattering from non-simple geometries such as bubbles as imaging contrast agents. Green's functions; boundary element and finite element methods. Sound in waveguides and enclosures. Introduction to structural-acoustic coupling. Biomedical imaging and other applications considered..					
☑	Full Term Credit Hours Undergraduate Min: 3 Undergraduate Max: 3	Graduate Min: 3 Graduate Max: 3		Half Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: Graduate Max:	
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student					
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:			☐ Course is Y graded ☐ Can be taken more than once in the same term		

Subject: Mechanical Engineering Catalog: 524

☐	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☑	Advisory Prerequisite (254 char) MECHENG 424	Advisory Prerequisite (254 char) MECHENG 424 or BIOMEDE 424
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☐ Discussion ☐ Independent Study	Graded Component ☑ ☐ ☐ ☐ ☐ ☐	Terms Typically Offered ☐ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: David Dowling Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Email: Phone:

CoE Curriculum Committee Representative:	Xiaogan Liang	Print: Xiaogan Liang	Date: 12/11/2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Kazu Saitou	Date: 12/10/2024
Cross-Listed Department Chair:	Zhongming Liu	Print: Zhongming Liu	Date: 10/31/2024
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Derivation of the acoustic wave equation and development of solution techniques. Transmission and reflection from solids, plates and impedance boundaries. Radiation and scattering from non-simple geometries. Green's functions; boundary element and finite element methods. Sound in ducts and enclosures. Introduction to structural-acoustic coupling. Automotive and other applications considered.	Course Description Derivation of the acoustic wave equation in complex media including inhomogeneous biomaterials with viscous loss and development of solution techniques. Transmission and reflection from solids, plates and impedance boundaries. Radiation and scattering from non-simple geometries such as bubbles as imaging contrast agents. Green's functions; boundary element and finite element methods. Sound in waveguides and enclosures. Introduction to structural-acoustic coupling. Biomedical imaging and other applications considered.
Class Length Full term	Class Length Full Term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
ME524 provides the fundamental understanding of acoustic wave physics, propagation, scattering, and interactions with structures and matters like bubbles as contrast agents, which will be essential for graduate and undergraduate students interested in ultrasound imaging and therapy. Particularly, compared with the existing crosslist ME/BME424, ME524 will focus more on ultrasound propagation in inhomogeneous media with viscous loss that is a better model for biomaterials and biological samples. Moreover, the discussion on wave-bubble interactions, boundary element methods, acoustic radiation, and acoustic resonators in ME524 will provide BME students with comprehensive understanding of how ultrasound works from the transducers, in the tissues, and sensed by transducers or hydrophones, important for their research in imaging and therapeutic ultrasound in vitro, ex vivo, and in vivo. Thus, it makes sense to crosslist ME524 with BME.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-12
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Robotics Subject: ROB Catalog: 415
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Robot Control
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Robot Control
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Feedback control design/analysis for robotics applications, including linear and nonlinear systems. Classical topics include linearization, time response, stability, transfer functions, poles/zeros, root locus, frequency response, Bode plots, gain/phase margins, lead/lag/PID control. State space topics include state transition matrix, multivariable robot control, linear quadratic optimal control and observers.	
☑	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Catalog:

☑ Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) (ROB 101 or MATH 214 or MATH 217) and (MECHENG 240 or BIOMEDE 231) Minimum grade requirement: C-
☐	Credit Exclusions	Credit Exclusions

☑ Course Components / Graded Component

	Course Components	Graded Component
☑	Lecture	☑
☐	Seminar	☐
☑	Recitation	☐
☐	Lab	☐
☐	Discussion	☐
☐	Independent Study	☐

Terms Typically Offered
- ☑ Fall
- ☐ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Robert Gregg

Cognizant Faculty Member Title: Associate Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Kayla Dombrowski Email:kakelle@umich.edu Phone: 734-936-7999

CoE Curriculum Committee Representative:	Anouck R Girard	Print: Anouck Girard	Date: 12-23-2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Dawn Tilbury	Date: 12-18-24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Feedback control design/analysis for robotics applications, including linear and nonlinear systems. Classical topics include linearization, time response, stability, transfer functions, poles/zeros, root locus, frequency response, Bode plots, gain/phase margins, lead/lag/PID control. State space topics include state transition matrix, multivariable robot control, linear quadratic optimal control and observers.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Upper Level Elective for the Robotics BSE program, will be a key part of ROB undergrad controls pathway.

Special resources of facilities required for this course:

Supporting statement:
Offered twice, second time with very healthy enrollment (30+)

ROB 415 is also set-up to grant Rackham Graduate Credit, making it eligible for transferring or double-counting towards SUGS programs.

ROB 498 / 599: ROBOT CONTROL

FALL 2024

Tue/Thu 10:30am-12pm, 107 GFL (Lecture)

Fri 3:30pm-4:30pm, 1008 FXB (Recitation)

INSTRUCTOR and GSI INFORMATION

Instructor

Robert Gregg (rdgregg@umich.edu)

Associate Professor, Department of Robotics

2260 Ford Robotics Building, 2505 Hayward St., Ann Arbor, MI 48109

Office Hours: Tuesdays at 12-1p in FRB 2260 or by appointment

GSI

Jiefu Zhang (zjiefu@umich.edu), PhD Candidate, Department of Robotics

Office Hours: Thursdays at 2-3p in FRB 2320.

COURSE INFORMATION

Prerequisites: ME 240 or equivalent

Textbook: None Required. Material and notes will be posted on Canvas. Recommended textbooks (available online through UM library) are listed under “Additional References”

Attendance Policy: In-person attendance (for both lectures and recitation sessions) is highly encouraged but not required. If you must miss class for any reason, recordings will be made available under the Lecture Recordings section on Canvas within 24 hours of the lecture.

Course Outline: Feedback control design and analysis with emphasis on robotics applications, including linear (e.g., independent joint) and nonlinear (e.g., coupled joints) systems. Classical control theory topics include linearization, time response, stability, Routh-Hurwitz

stability analysis, transfer functions, poles and zeros, root locus, frequency response, Bode plots, gain and phase margins, lead/lag/PID control. State space topics include state transition matrix, multivariable robot control, linear quadratic optimal control and observers.

Course Learning Objectives

1. Teach the students the basic concepts of automatic control
2. Introduce the students to time domain and frequency domain system analysis techniques based on linear models
3. Introduce the students to feedback control design methods and their application to control of robotic systems (both linear and nonlinear)
4. Familiarize students with relevant Matlab software tools

Grade Distribution

Homework …… 40%

Midterm Exam …… 30%

Final Exam ……..... 30%

Grading Policy

1. **Homework:** There will be homework due approximately every other week. The exact due dates will be solidified later in the semester.

Homework will generally be due at 11:59pm on the due date, and will be submitted to Gradescope (accessible through Canvas). **It is your responsibility to ensure that you have uploaded all your homework files properly and on time.** The submission site will remain open for 15 minutes past the nominal deadline of 11:59pm to accommodate any last-minute technological issues. Past that grace period you will not be able to submit. **No extensions will be granted!**

You are encouraged to discuss homework with your fellow students at the conceptual level, but you must complete all calculations and write-up, from scrap to final form, on your own. In particular, verbatim copying of another student's work is forbidden. You are not permitted to consult homework solutions from previous terms and courses.

Hints: We highly encourage you to **start working on your homework early**, i.e., work on the corresponding problems as the material is being covered in the lectures and the discussion section. This way you will have enough time to complete the homework within the deadline – note that **no extensions will be given**. Always study the lecture notes and, if you find it useful, review the lecture recordings prior to starting working on the homework. Keep in mind that most problems are not just application of formulas in this week's lecture notes, but rather require synthesis of concepts that have been taught up to that point in the semester.

2. **Midterm Exam:** TBD

3. **Final Exam**: Monday, December 16 at 4-6p, set by the Registrar

Piazza site: Piazza (accessible through Canvas) is meant to facilitate Q&A and discussions among the students. Rather than emailing questions to the teaching staff, please post your questions on Piazza (except when related to grades). You should first check to see if your question has already been posted and answered. You are encouraged to contribute to answers on Piazza; the more you help others the more they will help you! The instructors or GSI will regularly check the site, but do not expect that your question will be answered immediately (especially at night before a deadline). Please refrain from discussing the exact homework solutions prior to their due date.

Additional References (Textbooks and Software)

Suggested (**not required**) textbooks (Should be accessible from UM Library):

[1] Hassan Khalil, "Control Systems: An Introduction", 2023

[2] Mark W. Spong, Seth Hutchinson and M. Vidyasagar, "Robot modeling and control", 2020

[3] Karl Johan Aström, Richard M. Murray, "Feedback Systems: An Introduction for Scientists and Engineers", 2008

[4] Control Tutorials for Matlab and Simulink

University of Michigan College of Engineering Honor Code

All students are presumed to be decent and honorable, and all students are bound by the College of Engineering Honor Code. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work. Any violation of the honor policies will be reported to the Honor Council.

For more information about the Standards of Conduct, Honor Code, and Statement of Student Rights and Responsibilities, please consult the following resource:

https://bulletin.engin.umich.edu/rules/

Disability Statement

The University of Michigan is committed to providing equal opportunity for participation in all programs, services and activities. Request for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G664 Haven Hall. The SSD phone number is 734-763-3000. Once your eligibility for an accommodation has been determined you will be issued a verified individual services accommodation (VISA) form. Please present this form to me at the beginning of the term, or at least two weeks prior to the need for the accommodation (test, homework, etc…).

Inclusion Statement

It is our intention that students from all backgrounds and perspectives will be well served by this course, and that the diversity that students bring to this class will be viewed as an asset. We welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, socioeconomic background, family education level, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class. Your suggestions are encouraged and appreciated.

University of Michigan
Winter 2024 Instructor Report
ROB 498-002: Spec Topics Robotics
Robert Gregg

6 out of 13 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	3	3	0	0	0	0	4.5	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	2	3	1	0	0	0	4.2	4.2	4.2
I knew what was expected of me in this course.(Q1633)	2	3	1	0	0	0	4.2	4.4	4.6
I had a strong desire to take this course.(Q4)	1	3	2	0	0	0	3.8	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	0	3	2	0	1	2.7	2.9	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Robert Gregg seemed well prepared for class meetings.(Q230)	5	1	0	0	0	0	4.9	4.7	4.8
Robert Gregg explained material clearly.(Q199)	6	0	0	0	0	0	5.0	4.6	4.7
Robert Gregg treated students with respect.(Q217)	4	1	1	0	0	0	4.8	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	3	2	1	0	0	0	4.5
I gained a good understanding of concepts/principles in this field. (Q121)	2	3	1	0	0	0	4.2
The amount of work required was appropriate for the credit received. (Q239)	1	3	1	0	0	1	4.0
Grades were assigned fairly and impartially. (Q365)	2	3	0	0	0	1	4.3

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Robert Gregg was an excellent teacher. (Q2)	4	1	1	0	0	0	4.8
Robert Gregg appeared to have a thorough knowledge of the subject. (Q207)	5	1	0	0	0	0	4.9
Robert Gregg acknowledged all questions insofar as possible. (Q216)	4	2	0	0	0	0	4.8

The medians are calculated from Winter 2024 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Winter 2024 Instructor Report
ROB 498-003: Spec Topics Robotics
Robert Gregg

7 out of 14 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	2	4	0	1	0	0	4.1	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	2	2	2	1	0	0	3.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	2	2	2	0	0	1	4.0	4.4	4.6
I had a strong desire to take this course.(Q4)	2	3	2	0	0	0	4.0	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	0	5	1	0	1	2.9	2.9	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Robert Gregg seemed well prepared for class meetings.(Q230)	5	2	0	0	0	0	4.8	4.7	4.8
Robert Gregg explained material clearly.(Q199)	4	3	0	0	0	0	4.6	4.6	4.7
Robert Gregg treated students with respect.(Q217)	5	1	1	0	0	0	4.8	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	3	2	1	1	0	0	4.3
The lab instructions are clear and complete. (Q1765)	0	3	0	0	0	4	4.0
The provided lab materials (templates, tutorials, etc.) are clear and helpful. (Q1766)	0	2	1	0	0	4	3.8
Overall, my experience with my assigned group members has been excellent. (Q1767)	1	0	0	0	0	6	5.0
The amount of assistance given outside scheduled lab time has been sufficient. (Q1768)	1	2	0	0	0	4	4.3

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Robert Gregg was an excellent teacher. (Q2)	2	4	0	0	0	1	4.3

The medians are calculated from Winter 2024 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2024 Midterm Instructor Report
ROB 498 003 - ROB 599 003
Robert Gregg

7 out of 34 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
Overall, this was an excellent course. (Q1)	3	1	0	1	1	0	4.50
I had a strong desire to take this course. (Q4)	4	2	0	0	0	0	4.75
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	0	3	2	0	0	2.83
This course advanced my understanding of the subject matter. (Q1631)	2	2	0	1	1	0	4.00
My interest in the subject has increased because of this course. (Q1632)	2	3	0	0	1	0	4.17
I knew what was expected of me in this course. (SA=Almost Always, A=Frequently, N=Sometimes, D=Occasionally, SD=Hardly Ever).	3	1	0	1	1	0	4.50
I gained a good understanding of concepts/principles in this field. (Q121)	4	0	0	1	1	0	4.75
The amount of work required was appropriate for the credit received. (Q239)	3	1	1	1	0	0	4.50
Grades were assigned fairly and impartially. (Q365)	3	1	0	1	0	1	4.67

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Overall, Robert Gregg was an excellent teacher. (Q2)	3	1	0	1	1	0	4.50
Robert Gregg seemed well prepared for class meetings. (Q230)	4	0	1	0	1	0	4.75
Robert Gregg explained material clearly. (Q199)	4	0	0	0	2	0	4.75
Robert Gregg treated students with respect. (Q217)	4	1	1	0	0	0	4.75
Robert Gregg appeared to have a thorough knowledge of the subject. (Q207)	4	1	0	0	1	0	4.75
Robert Gregg acknowledged all questions insofar as possible. (Q216)	3	1	1	1	0	0	4.50

University of Michigan
Fall 2024 Midterm Instructor Report
ROB 498 004 - ROB 599 004
Robert Gregg

3 out of 34 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
Overall, this was an excellent course. (Q1)	1	0	0	0	0	0	5.00
I had a strong desire to take this course. (Q4)	2	0	0	0	0	0	5.00
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	0	2	0	0	0	3.00
This course advanced my understanding of the subject matter. (Q1631)	2	0	0	0	0	0	5.00
My interest in the subject has increased because of this course. (Q1632)	2	0	0	0	0	0	5.00
I knew what was expected of me in this course. (SA=Almost Always, A=Frequently, N=Sometimes, D=Occasionally, SD=Hardly Ever).	2	0	0	0	0	0	5.00
I gained a good understanding of concepts/principles in this field. (Q121)	2	0	0	0	0	0	5.00
The amount of work required was appropriate for the credit received. (Q239)	1	1	0	0	0	0	4.50
Grades were assigned fairly and impartially. (Q365)	2	0	0	0	0	0	5.00

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Overall, Robert Gregg was an excellent teacher. (Q2)	2	0	0	0	0	0	5.00
Robert Gregg seemed well prepared for class meetings. (Q230)	1	0	0	0	0	1	5.00
Robert Gregg explained material clearly. (Q199)	1	0	0	0	0	1	5.00
Robert Gregg treated students with respect. (Q217)	1	0	0	0	0	1	5.00
Robert Gregg appeared to have a thorough knowledge of the subject. (Q207)	1	0	0	0	0	1	5.00
Robert Gregg acknowledged all questions insofar as possible. (Q216)	1	0	0	0	0	1	5.00

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-12
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Robotics Subject: ROB Catalog: 416
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Multi-Robot Systems
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Multi-Robot Systems
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Taxonomies and Architectures of Multi-Robot Systems; Graph-theoretic Models of Multi-Robot Networks; Agreement and Formation Control; Task Assignment and Motion Planning; Distributed Estimation; Distributed Optimization; Target Tracking and Localization; Elements of Lyapunov Theory and Control Barrier Functions; Resilient Network Control and Estimation; Multi-Agent Reinforcement Learning; Coverage and Exploration	
☑	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject:	Catalog:

☑	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent	Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) (ROB 415 or AEROSP 470 or MECHENG 461 or EECS 460) Minimum grade requirement: C-
☑	Credit Exclusions	Credit Exclusions Only one course may earn credit from ROB 416 and ROB 516

☑	Course Components ☑ Lecture ☐ Seminar ☑ Recitation ☐ Lab ☐ Discussion ☐ Independent Study	Graded Component ☑ ☐ ☐ ☐ ☐ ☐	Terms Typically Offered ☐ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer

Cognizant Faculty Member Name: Dimitra Panagou	Cognizant Faculty Member Title:Associate Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Kayla Dombrowski Email:kakelle@umich.edu Phone: 734-936-7999

CoE Curriculum Committee Representative: Anouck R Girard	Print: Anouck Girard	Date: 12-23-2024
CoE Curriculum Committee Chair:	Print:	Date:
Home Department Chair:	Print: Dawn Tilbury	Date: 12-18-24
Cross-Listed Department Chair:	Print:	Date:
Cross-Listed Department Chair:	Print:	Date:
Cross-Listed Department Chair:	Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description	Course Description Taxonomies and Architectures of Multi-Robot Systems; Graph-theoretic Models of Multi-Robot Networks; Agreement and Formation Control; Task Assignment and Motion Planning; Distributed Estimation; Distributed Optimization; Target Tracking and Localization; Elements of Lyapunov Theory and Control Barrier Functions; Resilient Network Control and Estimation; Multi-Agent Reinforcement Learning; Coverage and Exploration
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Upper Level Elective for Robotics BSE program

Special resources of facilities required for this course:

Supporting statement:
Multi-robot and (more generally) multi-agent systems are core areas (in terms of both theory and applications) within robotics and other control engineering domains, e.g., aerospace, automotive, transportation. To the best of my knowledge, this is a very unique course across the entire CoE curriculum. Starting from the next offering, I would like to actively advertise it outside ROB as well; e.g., ECE, AERO, ME.

ROB 416 is also set-up to grant Rackham Graduate Credit, making it eligible for transferring or double-counting towards SUGS programs.

Creating two separate undergraduate and graduate listings will help with enrollment and distribution of seats.

ROB 498/599: Multi-Robot Systems

Fall 2024

Instructor: Prof. Dimitra Panagou (dpanagou@umich.edu), Associate Professor of Robotics and Associate Professor of Aerospace Engineering

Graduate Student Instructor: Haejoon Lee (haejoonl@umich.edu), PhD Student in Robotics

Lectures: MoWe 3pm-4:30pm, 1005 DOW
Discussion: We 5:30pm-6:30pm, 107 GFL
The discussion section will be taught by the GSI and cover 1) material complementary to the lectures (e.g., review of required mathematical concepts in control and optimization) and 2) results from research papers on multi-robot applications. Notes are posted.

Attendance: Attendance is not required but is strongly recommended. You are responsible for the material covered in the lectures and discussion sections. Both the lectures and the discussions will be recorded and the recordings will be made available on Canvas.

Office hours: Dimitra Panagou: Fridays 10am-11am at FRB 3260 and by appointment
Haejoon Lee: Mondays and Wednesdays 11am-12:30pm at FRB 3310

Help outside of office hours: Use Piazza. Piazza is meant to facilitate discussions primarily among the students, and students are expected to help one another via Piazza. Before posting a question, see if it has already been posted and answered. Duplicate questions may not be answered. The instructors will check Piazza sporadically, thus you should not assume that their responses will be immediate. Link: https://piazza.com/umich/fall2024/rob498005fa2024

Prerequisites: ROB 498: Robot Control or equivalent[1].

It is strongly recommended that you have already completed an undergraduate course in controls and that you have working knowledge of MATLAB (or other similar programming tool). A graduate-level understanding of linear systems and control, state-space methods, and real analysis (e.g., if you have already completed, or you are taking in parallel, EECS 560: Linear Systems, ROB 501: Math for Robotics, or equivalent) is beneficial but not required, as we will cover the relevant topics in class and in the recitations.

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[1]As a reference, ROB 498: Robot Control (from the W24 offering) includes: Feedback control design and analysis with emphasis on robotics applications, including linear (e.g., independent joint) and nonlinear (e.g., coupled joints) systems. Classical control theory topics include linearization, time response, stability, Routh-Hurwitz stability analysis, transfer functions, poles and zeros, root locus, frequency response, Bode plots, gain and phase margins, lead/lag/PID control. State space topics include state transition matrix, multivariable robot control, linear quadratic optimal control and observers.

Course description: Taxonomies and architectures of multi-robot systems; graph-theoretic modeling of multi-robot networks; connectivity, agreement, formation control; coordination, coverage control and exploration; multi-agent task assignment and motion planning; resilient multi-agent consensus under attacks; distributed filtering and estimation; distributed localization; elements of control theory (linear, nonlinear) and optimization for multi-robot applications.

Objectives: This course is primarily designed for graduate and senior undergraduate students in robotics and control. It aims to familiarize the students with the fundamentals of multi-robot systems (in terms of modeling, control, planning, tasking) and enable them to identify, formulate and solve multi-agent/multi-robot problems that arise in real-world applications. Specifically, the course focuses on the fundamental graph-theoretic representations of multi-agent/multi-robot and networked control systems, and on the methods from control and optimization that address multi-robot problems under constraints and uncertainty.

Grading Policy: Four Mini-Projects (25% each). Submission dates (**tentative**): Thursday September 26, Thursday October 24, Thursday November 21, Tuesday December 17. Details on the format of each project and the finalized due dates will be posted on Canvas.

Textbook: None required. Notes will be posted on Canvas after the lectures. Some good references on the topics of the course (not thorough list):

1. *Graph Theoretic Methods in Multi-Agent Networks*, by Mehran Mesbahi and Magnus Egerstedt, Princeton Series in Applied Mathematics (Available online from the Michigan Library)
2. *Distributed Consensus in Multi-vehicle Cooperative Control*, by Wei Ren and Randal W. Beard, Springer, London, 2008 (Available online from the Michigan Library
3. *Nonlinear Systems*, 3rd Edition, by Hassan K. Khalil, Prentice Hall, 2002
4. *Convex Optimization*, by Stephen Boyd and Lieven Vandenberghe, Cambridge University Press (Available online at https://web.stanford.edu/~boyd/cvxbook/)

Useful Papers: Relevant research papers on the topics that will be covered in lectures and recitations will be uploaded on Canvas. Check throughout the semester for updates.

University of Michigan College of Engineering Honor Code: All students are presumed to be decent and honorable, and all students are bound by the College of Engineering Honor Code. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work. Any violation of the honor policies will be reported to the Honor Council.

For more information about the Standards of Conduct, Honor Code, and Statement of Student Rights and Responsibilities, please consult the following resource:

https://bulletin.engin.umich.edu/rules/

DEI Statement

U-M is committed to a policy of equal opportunity for all persons, and it does not discriminate on the basis of race, color, national origin, age, marital status, sex, sexual orientation, gender identity, gender expression, disability, religion, height, weight, or veteran status. In this class, I aim to treat everyone with fairness and respect, and I expect you to do the same. I aim to create an environment where we can learn together, freely ask questions, and help each other achieve better, while following the Engineering Honor Code. Please feel free to contact me with any problem, concern, or suggestion.

Resources to Report Sexual and Gender-based Misconduct

Here is some information about how to report sexual and gender-based misconduct. People in certain roles are considered “Individuals with Reporting Obligations” (IROs) and are required to report suspected Prohibited Conduct to the Equity, Civil Rights and Title IX Office at the University of Michigan. I AM an IRO. You can use the following link to notify the Equity, Civil Rights and Title IX Office at the University of Michigan (ECRT) about assault or harassment: ECRT. Please note that Title IX offices often distinguish between making a “report,” which does not launch an investigation, and filing a “complaint,” which does.

Mental Health Resources

Resources and support are available for students through the Michigan Engineering C.A.R.E. Center, Dean of Students Office or Counseling and Psychological Services. The University also offers SilverCloud, an online mental health tool that offers self-guided programs for anxiety, depression, stress, resilience, or insomnia.

Fall 2024 ROB 498/599

Multi-Robot Systems

Course Topics

Taxonomies and Architectures of Multi-Robot Systems; Graph-theoretic Models of Multi-Robot Networks; Agreement and Formation Control; Task Assignment and Motion Planning; Distributed Estimation; Distributed Optimization; Target Tracking and Localization; Elements of Lyapunov Theory and Control Barrier Functions; Resilient Network Control and Estimation; Multi-Agent Reinforcement Learning; Coverage and Exploration

Tentative Outline of Lectures

Mon Aug 26: Lecture 01: MAS and MRS: Definitions and Taxonomies
Wed Aug 28: Lecture 02: Taxonomies (Continuation) and Review on State-Space Models, Equilibria, Linearization.
Recitation 1: Topics: Review of math tools (Linear Algebra, Complex Numbers) Review of Linear Systems (e.g., Eigenvalues, Modal Decomposition) State-Space Models

Mon Sep 02: NO CLASS
Wed Sep 04: Lecture 03: Graph theory tools - Directed and Undirected Graphs, Adjacency and Laplacian Matrices of Undirected Graphs, Incidence Matrix of Undirected (Oriented) Graph.
Recitation 2: Topics: Review of Linear Systems Continued: State Transition Matrix, Solutions of LTI Systems, Stability of LTI Systems, Routh Hurwitz
+
Review of "A Critical Review of Communications in Multi-Robot Systems", by J. Gielis, A. Shankar, A. Prorok

Mon Sep 09: Lecture 04: Main Results on Undirected Graphs (Proof of Theorem 2.8)
Wed Sep 11: Lecture 05: Agreement Protocol (Undirected and Directed Graphs)
Recitation 3: Topics: Proof of Theorem 3.4 and Edge Agreement (Reference: "Agreement via the Edge Laplacian", by D. Zelazo, A. Rahmani, M. Mesbahi)

Mon Sep 16: Lecture 06: Formation Control (Overview from Survey Paper and Introduction to Formation Specifications)
Wed Sep 18: Lecture 07: Formation Control (Based on Relative States)
Recitation 4: Topics: Review of "Information Consensus in Multi-vehicle Cooperative Control", by W. Ren, R. Beard, E. M. Atkins

Mon Sep 23: Lecture 08: Formation Control (Based on Formational Offsets) and Task Assignment (Hungarian Method)

Wed Sep 25: Lecture 09: Task Assignment (Swarm Distribution) and Introduction to Task and Motion Planning
Recitation 5: Topics: Review of "A Distributed Optimization Framework for Localization and Formation Control" by R. Tron, J. Thomas, G. Loianno, K. Daniilidis, and V. Kumar

Mini Project 1 Due Thu Sep 26

Mon Sep 30: Lecture 10: Task and Motion Planning (Overview from Survey Papers)
Wed Oct 02: Lecture 11: Distributed Least Squares
Recitation 6: Topics: Review of Path Finding Algorithms (A*, DFS, Dijkstra's, RRT)

Mon Oct 07: Lecture 12: Distributed Optimization (Problem Formulation, Centralized vs Distributed Optimization; Examples: Multi-Robot Target Tracking, Multi-Robot Task Assignment)
Wed Oct 09: Lecture 13: Distributed Optimization Continued (Examples: Multi-Robot Distributed Planning and Control via MPC, Multi-Robot Learning); Distributed Algorithms: First-Order Methods, Sequential Convex Programming)
Recitation 7: Topics: Gradient Descent, Linear Programming, Quadratic Programming

Mon Oct 14: NO CLASS
Wed Oct 16: Lecture 14: Distributed Optimized Continued: Alternating Directions Method of Multipliers (ADMM). Introduction to Lyapunov Theory and LaSalle's Principle
Recitation 8: Topics: Review of Lyapunov Theory with Examples

Mon Oct 21: Lecture 15: Revisiting Agreement and Formation Control using Lyapunov Theory
Wed Oct 23: Lecture 16: Control Lyapunov Functions and Control Barrier Functions
Recitation 9: Topics: CBF-QPs (Fixed-time, Predictive) and Multi-Robot CBF references

Mini Project 2 Due Thu Oct 24

Mon Oct 28: Lecture 17: Control Barrier Functions for Multi-Robot Systems
Wed Oct 30: Lecture 18: Introduction to Switched Systems Theory; Application to Task and Motion Planning via Multiple Lyapunov-like Barrier Functions
Recitation 10: Topics: Learning CBFs (T. Kim's work (Panagou group) + list of references)

Mon Nov 04: Lecture 19: Resilient Network Control (Part 1)
Wed Nov 06: Lecture 20: Resilient Network Control (Part 2)
Recitation 11: Topics: Resilient Consensus: Review of "Resilient Asymptotic Consensus in Robust Networks" by H. J. LeBlanc, H. Zhang, X. Koutsoukos and S. Sundaram

Mon Nov 11: Lecture 21: r-reachable Sets and r-robust Graphs
Wed Nov 13: Lecture 22: Resilient Formations
Recitation 12: Topics: Resilient Formations (H. Lee's work (Panagou group))

Mon Nov 18: Lecture 23: Distributed Estimation
Wed Nov 20: Lecture 24: Resilient Estimation
Recitation 13: Topics: Resilient Estimation: Review of "Byzantine-resilient Distributed Observers for LTI Systems" by A. Mitra and S. Sundaram

Mini Project 3 Due Thu Nov 21

Mon Nov 25: Lecture 25: Multi-Robot Exploration using Reinforcement Learning
Wed Nov 27: NO CLASS

Mon Dec 02: Lecture 26: Multi-Agent Reinforcement Learning: A Survey
Wed Dec 04: Lecture 27: Multi-Agent Reinforcement Learning: A Survey
Recitation 14: Topics: Review of "A Comprehensive Review on Leveraging Machine Learning for Multi-Agent Path Finding", by J. -M. Alkazzi and K. Okumura (Paper on Multi-Robot Exploration and/or RL)

Mon Dec 09: Lecture 28: TBD Review or discussion on final projects or cancel

Mini Project 4 Due Tue Dec 17 (Final Exam Due Date)

University of Michigan
Fall 2024 Midterm Instructor Report
ROB 498 005 - ROB 599 005
Dimitra Panagou

11 out of 27 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
Overall, this was an excellent course. (Q1)	7	4	0	0	0	0	4.71
I had a strong desire to take this course. (Q4)	8	1	2	0	0	0	4.81
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	2	1	7	1	0	0	3.14
This course advanced my understanding of the subject matter. (Q1631)	6	5	0	0	0	0	4.58
My interest in the subject has increased because of this course. (Q1632)	7	4	0	0	0	0	4.71
I knew what was expected of me in this course. (SA=Almost Always, A=Frequently, N=Sometimes, D=Occasionally, SD=Hardly Ever).	6	5	0	0	0	0	4.58
I gained a good understanding of concepts/principles in this field. (Q121)	9	2	0	0	0	0	4.89
The amount of work required was appropriate for the credit received. (Q239)	8	3	0	0	0	0	4.81
Grades were assigned fairly and impartially. (Q365)	5	3	2	0	0	1	4.50

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Overall, Dimitra Panagou was an excellent teacher. (Q2)	8	3	0	0	0	0	4.81
Dimitra Panagou seemed well prepared for class meetings. (Q230)	8	2	0	0	0	0	4.88
Dimitra Panagou explained material clearly. (Q199)	7	4	0	0	0	0	4.71
Dimitra Panagou treated students with respect. (Q217)	10	1	0	0	0	0	4.95
Dimitra Panagou appeared to have a thorough knowledge of the subject. (Q207)	10	1	0	0	0	0	4.95
Dimitra Panagou acknowledged all questions insofar as possible. (Q216)	10	1	0	0	0	0	4.95

University of Michigan
Fall 2024 Midterm Instructor Report
ROB 498 006 - ROB 599 006
Dimitra Panagou

7 out of 27 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
Overall, this was an excellent course. (Q1)	6	1	0	0	0	0	4.92
I had a strong desire to take this course. (Q4)	6	0	1	0	0	0	4.92
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	1	4	1	0	0	3.13
This course advanced my understanding of the subject matter. (Q1631)	4	3	0	0	0	0	4.63
My interest in the subject has increased because of this course. (Q1632)	5	2	0	0	0	0	4.80
I knew what was expected of me in this course. (SA=Almost Always, A=Frequently, N=Sometimes, D=Occasionally, SD=Hardly Ever).	4	3	0	0	0	0	4.63
I gained a good understanding of concepts/principles in this field. (Q121)	6	1	0	0	0	0	4.92
The amount of work required was appropriate for the credit received. (Q239)	6	1	0	0	0	0	4.92
Grades were assigned fairly and impartially. (Q365)	4	3	0	0	0	0	4.63

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Overall, Dimitra Panagou was an excellent teacher. (Q2)	6	1	0	0	0	0	4.92
Dimitra Panagou seemed well prepared for class meetings. (Q230)	6	1	0	0	0	0	4.92
Dimitra Panagou explained material clearly. (Q199)	5	2	0	0	0	0	4.80
Dimitra Panagou treated students with respect. (Q217)	6	1	0	0	0	0	4.92
Dimitra Panagou appeared to have a thorough knowledge of the subject. (Q207)	6	1	0	0	0	0	4.92
Dimitra Panagou acknowledged all questions insofar as possible. (Q216)	6	1	0	0	0	0	4.92

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-12-04
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Subject: Catalog:	Dept (Home): Robotics Subject: ROB Catalog: 472
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Marine Robotics
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Marine Rob
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Overview of marine robotic systems, including autonomous surface vehicles, remotely operated vehicles, and autonomous underwater vehicles. Topics include vehicle design, kinematic and dynamic modeling, control, sensing, and navigation. Examples draw from real robotic missions across a range of applications from inspection of critical subsea infrastructure to exploration of ocean worlds.	
☑	Full Term Credit Hours Undergraduate Min: 3 Graduate Min: 3 Undergraduate Max: 3 Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student, Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Catalog:

☑	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) Computational Linear Algebra (ROB 101) or Linear Algebra (MATH 214, MATH 217, MATH 417, or MATH 419); proficiency in MATLAB
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☑	Credit Exclusions	Credit Exclusions Only one course may earn credit from ROB 472 and ROB 572.
☑	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☐ Discussion ☐ Independent Study Graded Component ☑ ☐ ☐ ☐ ☐ ☐ Terms Typically Offered ☐ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer	

Cognizant Faculty Member Name: Katie Skinner Cognizant Faculty Member Title: Assistant Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Kayla Dombrowski Email: kakelle@umich.edu Phone: 734-936-7999

CoE Curriculum Committee Representative: Anouck R Girard Print: Anouck Girard Date: 12-23-2024

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Print: Dawn Tilbury Date: 12-18-24

Cross-Listed Department Chair: Print: Date:

Cross-Listed Department Chair: Print: Date:

Cross-Listed Department Chair: Print: Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Overview of marine robotic systems, including autonomous surface vehicles, remotely operated vehicles, and autonomous underwater vehicles. Topics include vehicle design, kinematic and dynamic modeling, control, sensing, and navigation. Examples draw from real robotic missions across a range of applications from inspection of critical subsea infrastructure to exploration of ocean worlds.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
The objective of ROB 472 is to expose students to theory and practice of marine robotics. Topics will include challenges and considerations for underwater vehicle design, mathematical modeling of kinematics and dynamics of an autonomous underwater vehicle, PID control for an AUV, underwater sensing, and autonomous navigation. This course will reinforce core concepts taught throughout the ROB 300-level courses for robot design, mathematical modeling of kinematics and dynamics, and algorithm development for localization and mapping to present these topics in a specialized manner through the lens of marine systems.

Students will also benefit from MATLAB programming assignments to implement an AUV simulator. This experience will enable students to transfer theory learned in lectures to real implementation. Building and interacting with the simulator will also improve students' intuition for AUV dynamics to learn how components of the dynamic model of an AUV affect the motion of the vehicle. MATLAB is used across many fields of engineering today and thus is a critical skill for students to practice throughout their coursework.

Lectures and assignments will be supplemented with a semester-long open-ended project. This project will enable students to do a deep-dive into a specific topic of their choice to explore state-of-the-art in marine robotics and to practice design and algorithm development for specific applications in marine robotics. This project will also allow students to improve their skills across team building, project management, and project presentations.

ROB 472 will count towards the Robotics BSE Upper Level Elective requirement.

Special resources of facilities required for this course:

Supporting statement:
ROB 572: Marine Robotics has been successfully offered at the graduate level for three terms (Winter 2024, and Winter 2022/Winter 2021 when it was offered as a special topics course, NA599). This course offers an overview of marine robotic systems, with a focus on vehicle design, kinematic and dynamic modeling, control, sensing, and navigation. Course materials and assignments draw examples from real robotics missions in ocean and Great Lakes environments. The course attracts students across departments in the College of Engineering, including Robotics, Naval Architecture and Marine Engineering, and Electrical Engineering and Computer Science. Often, this course is the first introduction for students to marine robotics, and it provides critical context on opportunities across academia, industry, and government to participate in the field. This request is to open an undergraduate (4xx level) section for the course, to support undergraduate students who are interested in learning about the field of marine robotics. In recent semesters, undergraduate students have been permitted to enroll, with instructor permission (1 undergraduate student in Winter 2022, and 3 undergraduate students in Winter 2024). Formally expanding this course to offer an undergraduate section will provide a unique opportunity for undergraduate students at the University of Michigan to learn about the exciting field of marine robotics as they are starting to consider graduate studies and future career opportunities.

ROB 472 is also set-up to grant Rackham Graduate Credit, making it eligible for transferring or double-counting towards SUGS programs.

Creating a separate undergraduate listing will help with enrollment and managing of seats.

University of Michigan
ROB572/NA569 – Marine Robotics
Winter 2024

Description: This course will provide an overview of marine robotic systems, including autonomous surface vehicles (ASVs), remotely operated vehicles (ROVs), and autonomous underwater vehicles (AUVs). Topics include vehicle design, kinematic and dynamic modeling, basic control, path planning, sensing, and navigation. Examples will draw from real robotic missions across a wide range of applications from inspection of critical subsea infrastructure to exploration of ocean worlds.

Instructor: Prof. Katie Skinner
3244 Ford Robotics Building
kskin@umich.edu

Lecture: Tuesday/Thursday 1:30-3:00PM – 1003 EECS

Office Hours: Friday 9:30-10:30AM – 3244 FRB
By appointment: https://calendar.app.google/7Rt3WzAPMr22vELfA

Prerequisites: Recommended coursework in linear algebra and differential equations or graduate standing; recommended programming experience with MATLAB.

Readings: There is no required textbook for the course. Supplementary readings and resources will be posted on the course Canvas site. The "Handbook of Marine Craft Hydrodynamics and Motion Control" (Fossen) is also recommended as a reference textbook for the course.

Learning Outcomes: By the end of this course you should be able to:

- Describe the various types and classes of underwater robots and discuss trade-offs in vehicle design for specific applications.
- Describe an underwater robot through mathematical modeling.
- Apply basic low-level control structures on AUVs.
- Solve basic motion planning problems for AUVs.
- Select appropriate sensors for a given task, calibrate sensors, and process sensor data for marine applications.
- Gain familiarity with state estimation algorithms for marine robots.
- Develop a mission plan for field tests of an underwater vehicle.

Activities: You will be graded on the following activities:

- Assignments (4 assignments each 15%): There will be 4 independent assignments that will reinforce key concepts from lectures. Some assignments will have a programming component requiring MATLAB. Assignments will all be submitted on Canvas and due at 10:00PM on the due date. There is no penalty off if submitted less than 48 hours (2 days) late; 50% will be taken off each day after that. You may discuss assignments with your classmates at the conceptual level but must complete write-ups and code on your own.

- Final project (30%): The final project will be completed throughout the semester. This will be a group project with groups of 2-3 students. You will be graded on a project proposal (5%), project progress report (5%), a final report (10%) and a final in-class presentation (10%). Project late policy: 50% off if one day late; zero credit if more than one day late.

- Participation (10%): There will be several opportunities to gain class participation points throughout the semester including attendance and participation in class, class presentations, Piazza participation, course surveys and evaluations, peer evaluations, and project presentation evaluations.

Grading:

Assignments	60%
Final Project	30%
Participation	10%

Attendance: Lectures will be held on Tuesdays. You may attend lecture either in-person or virtually. You are expected to attend *most* ($> 50\%$) lectures synchronously to receive full participation. Lectures will be recorded.

Discussions will be held on Thursdays. You are expected to regularly attend discussions to receive full participation. You are encouraged to attend discussions in-person, when possible. If you cannot attend a discussion in-person, please plan to attend and participate in the discussion synchronously over Zoom. If you cannot attend a discussion synchronously either virtually or in-person, you can make up the absence by completing a paper reflection/review.

Tentative Course Schedule

Date	Topic
0. Basics - History & Definitions	
Th Jan 10	Introduction
1. Underwater Vehicle Design	
Tu Jan 16	Vehicle Components, Environmental Considerations & Design Methodology
Th Jan. 18	Discussion: Lighting Presentations
Tu Jan. 23	Buoyancy, Stability & Ballast
Th Jan. 25	Discussion: Vehicle Design Considerations
2. Mathematical Modeling	
Tu Jan. 30	Kinematics
Th Feb. 1	Discussion: Kinematics
Tu Feb. 6	Dynamics
Th Feb. 8	Discussion: Project Proposals
Tu Feb. 13	Hydrostatics & Hydrodynamics
Th Feb. 15	Discussion: Hydrodynamics
3. Guidance & Control	
Tu Feb. 20	Marine Robot Control Systems
Th Feb. 22	Discussion: Guest Lecture (Tentative)
Tu Feb. 27	NO CLASS – Spring Break
Th Feb. 29	NO CLASS – Spring Break
Tu March 5	Guidance & Planning
Th March 7	Discussion: Guidance & Control
4. Sensing & Navigation	
Tu March 12	Marine Robot Sensors
Th March 14	Discussion: Project Updates
Tu March 19	Underwater Imaging
Th March 21	Discussion: Camera Systems
Tu March 26	Acoustics
Th March 28	Discussion: Acoustics
Tu April 2	Localization & SLAM
Th April 4	Discussion: Localization
5. Operations	
Tu April 9	Field Work
Th April 11	MHL Demo Day (optional)
6. Course Wrap-Up & Final Presentations	
Tu April 16	Final Project Presentations I
Th April 18	Final Project Presentations II
Tu April 23	Future of Marine Robotics

*This schedule is subject to change.
Last Updated – January 3rd, 2024

Course Policies

Academic Integrity: All students in the class are presumed to be decent and honorable, and all students in the class are bound by the College of Engineering Honor Code. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work.

Accommodations for Students with Disabilities: If you think you need an accommodation for a disability, please let me know at your earliest convenience so that we can work with the Services for Students with Disabilities (SSD) office to help us determine appropriate academic accommodations (734-763-3000; http://ssd.umich.edu). Any information you provide is private and confidential and will be treated as such.

Diversity Statement: All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences.

Student Well-Being: Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being on the Well-being for U-M Students website: https://wellbeing.studentlife.umich.edu/.

Family Educational Rights and Privacy Act (FERPA): Course lectures may be audio/video recorded and made available to other students in this course. As part of your participation in this course, you may be recorded. If you do not wish to be recorded, please contact Prof. Skinner (kskin@umich.edu) the first week of class to discuss alternative arrangements. Students may not record or distribute any class activity without written permission from the instructor, except as necessary as part of approved accommodations for students with disabilities. Any approved recordings may only be used for the student's own private use.

University of Michigan
Winter 2024 Instructor Report
ROB 572 001 - NAVARCH 569 001
Katie Skinner

12 out of 13 students responded to this evaluation.

Responses to University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
This course advanced my understanding of the subject matter. (Q1631)	10	2	0	0	0	0	4.9	4.4	4.5
My interest in the subject has increased because of this course. (Q1632)	9	3	0	0	0	0	4.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	11	1	0	0	0	0	5.0	4.4	4.6
I had a strong desire to take this course.(Q4)	8	3	1	0	0	0	4.8	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	0	4	7	0	0	1	3.3	2.9	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	School/College Median	Univ-Wide Median
Katie Skinner seemed well prepared for class meetings.(Q230)	11	1	0	0	0	0	5.0	4.7	4.8
Katie Skinner explained material clearly.(Q199)	9	3	0	0	0	0	4.8	4.6	4.7
Katie Skinner treated students with respect.(Q217)	12	0	0	0	0	0	5.0	4.8	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	10	2	0	0	0	0	4.9
I gained a good understanding of concepts/principles in this field. (Q121)	10	2	0	0	0	0	4.9
The amount of work required was appropriate for the credit received. (Q239)	11	1	0	0	0	0	5.0
Grades were assigned fairly and impartially. (Q365)	9	3	0	0	0	0	4.8

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Katie Skinner was an excellent teacher. (Q2)	10	2	0	0	0	0	4.9
Katie Skinner appeared to have a thorough knowledge of the subject. (Q207)	11	1	0	0	0	0	5.0
Katie Skinner acknowledged all questions insofar as possible. (Q216)	10	2	0	0	0	0	4.9

The medians are calculated from Winter 2024 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are graduate level with enrollment of 1 to 15 in College of Engineering.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
ro.curriculum@umich.edu
ro.umich.edu

Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☑ New Course
- ☐ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2025-01-03
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING			**REQUESTED LISTING**		
☑	Dept (Home): Subject: Catalog:			Dept (Home): Robotics Subject: ROB Catalog: 516		
☐	☐ Course is Cross-Listed with Other Departments			☐ Course is Cross-Listed with Other Departments		
	Department	Subject	Catalog Number	Department	Subject	Catalog Number
☑	Course Title (full title)			Course Title (full title) Multi-Robot Systems		
☑	Abbreviated Title (20 char)			Abbreviated Title (20 char) Multi-Robot Systems		
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Taxonomies and Architectures of Multi-Robot Systems; Graph-theoretic Models of Multi-Robot Networks; Agreement and Formation Control; Task Assignment and Motion Planning; Distributed Estimation; Distributed Optimization; Target Tracking and Localization; Elements of Lyapunov Theory and Control Barrier Functions; Resilient Network Control and Estimation; Multi-Agent Reinforcement Learning; Coverage and Exploration. Graduate credit includes additional homework problems and/or research components.					
☑	Full Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: 4 Graduate Max: 4		Half Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: Graduate Max:	
☑	Course Credit Type Rackham Graduate Student, Non-Rackham Graduate Student					
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:			☐ Course is Y graded ☐ Can be taken more than once in the same term		

Subject: Catalog:

☑

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) ROB 501
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) (ROB 415 or AEROSP 470 or MECHENG 461 or EECS 460) or graduate standing Minimum grade requirement: C-
☑	Credit Exclusions	Credit Exclusions Only one course may earn credit from ROB 416 and ROB 516

☑

Course Components / Graded Component
- ☑ Lecture / ☑
- ☐ Seminar / ☐
- ☑ Recitation / ☐
- ☐ Lab / ☐
- ☐ Discussion / ☐
- ☐ Independent Study / ☐

Terms Typically Offered
- ☐ Fall
- ☑ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Dimitra Panagou

Cognizant Faculty Member Title: Associate Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person:Kayla Dombrowski Email: kakelle@umich.edu Phone: 734-936-7999

CoE Curriculum Committee Representative:	Anouck R Girard	Print: Anouck Girard	Date: 12-23-2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Dawn Tilbury	Date: 12-18-24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Taxonomies and Architectures of Multi-Robot Systems; Graph-theoretic Models of Multi-Robot Networks; Agreement and Formation Control; Task Assignment and Motion Planning; Distributed Estimation; Distributed Optimization; Target Tracking and Localization; Elements of Lyapunov Theory and Control Barrier Functions; Resilient Network Control and Estimation; Multi-Agent Reinforcement Learning; Coverage and Exploration. Graduate credit includes additional homework problems and/or research components.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Can be taken by MS/PhD students towards Acting or Reasoning distributions

Special resources of facilities required for this course:

Supporting statement:
Multi-robot and (more generally) multi-agent systems are core areas (in terms of both theory and applications) within robotics and other control engineering domains, e.g., aerospace, automotive, transportation. To the best of my knowledge, this is a very unique course across the entire CoE curriculum. Starting from the next offering, I would like to actively advertise it outside ROB as well; e.g., ECE, AERO, ME.

Each project/assignment will have 1-2 questions/problems (e.g., one "proof question", and/or one "paper reading and review question") that will be required for graduate students and optional for undergraduate students.

Creating two separate undergraduate and graduate listings will help with enrollment and distribution of seats.

ROB 498/599: Multi-Robot Systems

Fall 2024

Instructor: Prof. Dimitra Panagou (dpanagou@umich.edu), Associate Professor of Robotics and Associate Professor of Aerospace Engineering

Graduate Student Instructor: Haejoon Lee (haejoonl@umich.edu), PhD Student in Robotics

Lectures: MoWe 3pm-4:30pm, 1005 DOW
Discussion: We 5:30pm-6:30pm, 107 GFL
The discussion section will be taught by the GSI and cover 1) material complementary to the lectures (e.g., review of required mathematical concepts in control and optimization) and 2) results from research papers on multi-robot applications. Notes are posted.

Attendance: Attendance is not required but is strongly recommended. You are responsible for the material covered in the lectures and discussion sections. Both the lectures and the discussions will be recorded and the recordings will be made available on Canvas.

Office hours: Dimitra Panagou: Fridays 10am-11am at FRB 3260 and by appointment
Haejoon Lee: Mondays and Wednesdays 11am-12:30pm at FRB 3310

Help outside of office hours: Use Piazza. Piazza is meant to facilitate discussions primarily among the students, and students are expected to help one another via Piazza. Before posting a question, see if it has already been posted and answered. Duplicate questions may not be answered. The instructors will check Piazza sporadically, thus you should not assume that their responses will be immediate. Link: https://piazza.com/umich/fall2024/rob498005fa2024

Prerequisites: ROB 498: Robot Control or equivalent[1].

It is strongly recommended that you have already completed an undergraduate course in controls and that you have working knowledge of MATLAB (or other similar programming tool). A graduate-level understanding of linear systems and control, state-space methods, and real analysis (e.g., if you have already completed, or you are taking in parallel, EECS 560: Linear Systems, ROB 501: Math for Robotics, or equivalent) is beneficial but not required, as we will cover the relevant topics in class and in the recitations.

[1]As a reference, ROB 498: Robot Control (from the W24 offering) includes: Feedback control design and analysis with emphasis on robotics applications, including linear (e.g., independent joint) and nonlinear (e.g., coupled joints) systems. Classical control theory topics include linearization, time response, stability, Routh-Hurwitz stability analysis, transfer functions, poles and zeros, root locus, frequency response, Bode plots, gain and phase margins, lead/lag/PID control. State space topics include state transition matrix, multivariable robot control, linear quadratic optimal control and observers.

Course description: Taxonomies and architectures of multi-robot systems; graph-theoretic modeling of multi-robot networks; connectivity, agreement, formation control; coordination, coverage control and exploration; multi-agent task assignment and motion planning; resilient multi-agent consensus under attacks; distributed filtering and estimation; distributed localization; elements of control theory (linear, nonlinear) and optimization for multi-robot applications.

Objectives: This course is primarily designed for graduate and senior undergraduate students in robotics and control. It aims to familiarize the students with the fundamentals of multi-robot systems (in terms of modeling, control, planning, tasking) and enable them to identify, formulate and solve multi-agent/multi-robot problems that arise in real-world applications. Specifically, the course focuses on the fundamental graph-theoretic representations of multi-agent/multi-robot and networked control systems, and on the methods from control and optimization that address multi-robot problems under constraints and uncertainty.

Grading Policy: Four Mini-Projects (25% each). Submission dates (**tentative**): Thursday September 26, Thursday October 24, Thursday November 21, Tuesday December 17. Details on the format of each project and the finalized due dates will be posted on Canvas.

Textbook: None required. Notes will be posted on Canvas after the lectures. Some good references on the topics of the course (not thorough list):

1. *Graph Theoretic Methods in Multi-Agent Networks*, by Mehran Mesbahi and Magnus Egerstedt, Princeton Series in Applied Mathematics (Available online from the Michigan Library)
2. *Distributed Consensus in Multi-vehicle Cooperative Control*, by Wei Ren and Randal W. Beard, Springer, London, 2008 (Available online from the Michigan Library
3. *Nonlinear Systems*, 3rd Edition, by Hassan K. Khalil, Prentice Hall, 2002
4. *Convex Optimization*, by Stephen Boyd and Lieven Vandenberghe, Cambridge University Press (Available online at https://web.stanford.edu/~boyd/cvxbook/)

Useful Papers: Relevant research papers on the topics that will be covered in lectures and recitations will be uploaded on Canvas. Check throughout the semester for updates.

University of Michigan College of Engineering Honor Code: All students are presumed to be decent and honorable, and all students are bound by the College of Engineering Honor Code. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work. Any violation of the honor policies will be reported to the Honor Council.

For more information about the Standards of Conduct, Honor Code, and Statement of Student Rights and Responsibilities, please consult the following resource:

https://bulletin.engin.umich.edu/rules/

DEI Statement

U-M is committed to a policy of equal opportunity for all persons, and it does not discriminate on the basis of race, color, national origin, age, marital status, sex, sexual orientation, gender identity, gender expression, disability, religion, height, weight, or veteran status. In this class, I aim to treat everyone with fairness and respect, and I expect you to do the same. I aim to create an environment where we can learn together, freely ask questions, and help each other achieve better, while following the Engineering Honor Code. Please feel free to contact me with any problem, concern, or suggestion.

Resources to Report Sexual and Gender-based Misconduct

Here is some information about how to report sexual and gender-based misconduct. People in certain roles are considered “Individuals with Reporting Obligations” (IROs) and are required to report suspected Prohibited Conduct to the Equity, Civil Rights and Title IX Office at the University of Michigan. I AM an IRO. You can use the following link to notify the Equity, Civil Rights and Title IX Office at the University of Michigan (ECRT) about assault or harassment: ECRT. Please note that Title IX offices often distinguish between making a “report,” which does not launch an investigation, and filing a “complaint,” which does.

Mental Health Resources

Resources and support are available for students through the Michigan Engineering C.A.R.E. Center, Dean of Students Office or Counseling and Psychological Services. The University also offers SilverCloud, an online mental health tool that offers self-guided programs for anxiety, depression, stress, resilience, or insomnia.

Fall 2024 ROB 498/599

Multi-Robot Systems

Course Topics

Taxonomies and Architectures of Multi-Robot Systems; Graph-theoretic Models of Multi-Robot Networks; Agreement and Formation Control; Task Assignment and Motion Planning; Distributed Estimation; Distributed Optimization; Target Tracking and Localization; Elements of Lyapunov Theory and Control Barrier Functions; Resilient Network Control and Estimation; Multi-Agent Reinforcement Learning; Coverage and Exploration

Tentative Outline of Lectures

Mon Aug 26: Lecture 01: MAS and MRS: Definitions and Taxonomies
Wed Aug 28: Lecture 02: Taxonomies (Continuation) and Review on State-Space Models, Equilibria, Linearization.
Recitation 1: Topics: Review of math tools (Linear Algebra, Complex Numbers) Review of Linear Systems (e.g., Eigenvalues, Modal Decomposition) State-Space Models

Mon Sep 02: NO CLASS
Wed Sep 04: Lecture 03: Graph theory tools - Directed and Undirected Graphs, Adjacency and Laplacian Matrices of Undirected Graphs, Incidence Matrix of Undirected (Oriented) Graph.
Recitation 2: Topics: Review of Linear Systems Continued: State Transition Matrix, Solutions of LTI Systems, Stability of LTI Systems, Routh Hurwitz
+
Review of "A Critical Review of Communications in Multi-Robot Systems", by J. Gielis, A. Shankar, A. Prorok

Mon Sep 09: Lecture 04: Main Results on Undirected Graphs (Proof of Theorem 2.8)
Wed Sep 11: Lecture 05: Agreement Protocol (Undirected and Directed Graphs)
Recitation 3: Topics: Proof of Theorem 3.4 and Edge Agreement (Reference: "Agreement via the Edge Laplacian", by D. Zelazo, A. Rahmani, M. Mesbahi)

Mon Sep 16: Lecture 06: Formation Control (Overview from Survey Paper and Introduction to Formation Specifications)
Wed Sep 18: Lecture 07: Formation Control (Based on Relative States)
Recitation 4: Topics: Review of "Information Consensus in Multi-vehicle Cooperative Control", by W. Ren, R. Beard, E. M. Atkins

Mon Sep 23: Lecture 08: Formation Control (Based on Formational Offsets) and Task Assignment (Hungarian Method)

Wed Sep 25: Lecture 09: Task Assignment (Swarm Distribution) and Introduction to Task and Motion Planning
Recitation 5: Topics: Review of "A Distributed Optimization Framework for Localization and Formation Control" by R. Tron, J. Thomas, G. Loianno, K. Daniilidis, and V. Kumar

Mini Project 1 Due Thu Sep 26

Mon Sep 30: Lecture 10: Task and Motion Planning (Overview from Survey Papers)
Wed Oct 02: Lecture 11: Distributed Least Squares
Recitation 6: Topics: Review of Path Finding Algorithms (A*, DFS, Dijkstra's, RRT)

Mon Oct 07: Lecture 12: Distributed Optimization (Problem Formulation, Centralized vs Distributed Optimization; Examples: Multi-Robot Target Tracking, Multi-Robot Task Assignment)
Wed Oct 09: Lecture 13: Distributed Optimization Continued (Examples: Multi-Robot Distributed Planning and Control via MPC, Multi-Robot Learning); Distributed Algorithms: First-Order Methods, Sequential Convex Programming)
Recitation 7: Topics: Gradient Descent, Linear Programming, Quadratic Programming

Mon Oct 14: NO CLASS
Wed Oct 16: Lecture 14: Distributed Optimized Continued: Alternating Directions Method of Multipliers (ADMM). Introduction to Lyapunov Theory and LaSalle's Principle
Recitation 8: Topics: Review of Lyapunov Theory with Examples

Mon Oct 21: Lecture 15: Revisiting Agreement and Formation Control using Lyapunov Theory
Wed Oct 23: Lecture 16: Control Lyapunov Functions and Control Barrier Functions
Recitation 9: Topics: CBF-QPs (Fixed-time, Predictive) and Multi-Robot CBF references

Mini Project 2 Due Thu Oct 24

Mon Oct 28: Lecture 17: Control Barrier Functions for Multi-Robot Systems
Wed Oct 30: Lecture 18: Introduction to Switched Systems Theory; Application to Task and Motion Planning via Multiple Lyapunov-like Barrier Functions
Recitation 10: Topics: Learning CBFs (T. Kim's work (Panagou group) + list of references)

Mon Nov 04: Lecture 19: Resilient Network Control (Part 1)
Wed Nov 06: Lecture 20: Resilient Network Control (Part 2)
Recitation 11: Topics: Resilient Consensus: Review of "Resilient Asymptotic Consensus in Robust Networks" by H. J. LeBlanc, H. Zhang, X. Koutsoukos and S. Sundaram

Mon Nov 11: Lecture 21: r-reachable Sets and r-robust Graphs
Wed Nov 13: Lecture 22: Resilient Formations
Recitation 12: Topics: Resilient Formations (H. Lee's work (Panagou group))

Mon Nov 18: Lecture 23: Distributed Estimation
Wed Nov 20: Lecture 24: Resilient Estimation
Recitation 13: Topics: Resilient Estimation: Review of "Byzantine-resilient Distributed Observers for LTI Systems" by A. Mitra and S. Sundaram

Mini Project 3 Due Thu Nov 21

Mon Nov 25: Lecture 25: Multi-Robot Exploration using Reinforcement Learning
Wed Nov 27: NO CLASS

Mon Dec 02: Lecture 26: Multi-Agent Reinforcement Learning: A Survey
Wed Dec 04: Lecture 27: Multi-Agent Reinforcement Learning: A Survey
Recitation 14: Topics: Review of "A Comprehensive Review on Leveraging Machine Learning for Multi-Agent Path Finding", by J. -M. Alkazzi and K. Okumura (Paper on Multi-Robot Exploration and/or RL)

Mon Dec 09: Lecture 28: TBD Review or discussion on final projects or cancel

Mini Project 4 Due Tue Dec 17 (Final Exam Due Date)

University of Michigan
Fall 2024 Midterm Instructor Report
ROB 498 005 - ROB 599 005
Dimitra Panagou

11 out of 27 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
Overall, this was an excellent course. (Q1)	7	4	0	0	0	0	4.71
I had a strong desire to take this course. (Q4)	8	1	2	0	0	0	4.81
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	2	1	7	1	0	0	3.14
This course advanced my understanding of the subject matter. (Q1631)	6	5	0	0	0	0	4.58
My interest in the subject has increased because of this course. (Q1632)	7	4	0	0	0	0	4.71
I knew what was expected of me in this course. (SA=Almost Always, A=Frequently, N=Sometimes, D=Occasionally, SD=Hardly Ever).	6	5	0	0	0	0	4.58
I gained a good understanding of concepts/principles in this field. (Q121)	9	2	0	0	0	0	4.89
The amount of work required was appropriate for the credit received. (Q239)	8	3	0	0	0	0	4.81
Grades were assigned fairly and impartially. (Q365)	5	3	2	0	0	1	4.50

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Overall, Dimitra Panagou was an excellent teacher. (Q2)	8	3	0	0	0	0	4.81
Dimitra Panagou seemed well prepared for class meetings. (Q230)	8	2	0	0	0	0	4.88
Dimitra Panagou explained material clearly. (Q199)	7	4	0	0	0	0	4.71
Dimitra Panagou treated students with respect. (Q217)	10	1	0	0	0	0	4.95
Dimitra Panagou appeared to have a thorough knowledge of the subject. (Q207)	10	1	0	0	0	0	4.95
Dimitra Panagou acknowledged all questions insofar as possible. (Q216)	10	1	0	0	0	0	4.95

University of Michigan
Fall 2024 Midterm Instructor Report
ROB 498 006 - ROB 599 006
Dimitra Panagou

7 out of 27 students responded to this midterm evaluation.

Responses to questions related to the course:

	SA	A	N	D	SD	N/A	Median
Overall, this was an excellent course. (Q1)	6	1	0	0	0	0	4.92
I had a strong desire to take this course. (Q4)	6	0	1	0	0	0	4.92
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	1	4	1	0	0	3.13
This course advanced my understanding of the subject matter. (Q1631)	4	3	0	0	0	0	4.63
My interest in the subject has increased because of this course. (Q1632)	5	2	0	0	0	0	4.80
I knew what was expected of me in this course. (SA=Almost Always, A=Frequently, N=Sometimes, D=Occasionally, SD=Hardly Ever).	4	3	0	0	0	0	4.63
I gained a good understanding of concepts/principles in this field. (Q121)	6	1	0	0	0	0	4.92
The amount of work required was appropriate for the credit received. (Q239)	6	1	0	0	0	0	4.92
Grades were assigned fairly and impartially. (Q365)	4	3	0	0	0	0	4.63

Responses to questions related to the instructor:

	SA	A	N	D	SD	N/A	Median
Overall, Dimitra Panagou was an excellent teacher. (Q2)	6	1	0	0	0	0	4.92
Dimitra Panagou seemed well prepared for class meetings. (Q230)	6	1	0	0	0	0	4.92
Dimitra Panagou explained material clearly. (Q199)	5	2	0	0	0	0	4.80
Dimitra Panagou treated students with respect. (Q217)	6	1	0	0	0	0	4.92
Dimitra Panagou appeared to have a thorough knowledge of the subject. (Q207)	6	1	0	0	0	0	4.92
Dimitra Panagou acknowledged all questions insofar as possible. (Q216)	6	1	0	0	0	0	4.92

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2024-09-26
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Robotics Subject: ROB Catalog: 560	Dept (Home): Robotics Subject: ROB Catalog: 560
☑	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Mechanical Engineering - MECHENG - 547
☐	Course Title (full title) BioInspired Robotic Design	Course Title (full title) BioInspired Robotic Design
☐	Abbreviated Title (20 char) Bio-Insp Rob	Abbreviated Title (20 char) Bio-Insp Rob
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Examines original scientific research to extract general principles that can be applied to robotics, such as: template and anchor models, walking, running, swimming, flying, sensing, and navigation. Students build functional prototypes and learn about the bioinspired design process through case studies that highlight health, the environment, and safety.	
☐	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: 4 Undergraduate Max: 4 Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate Student, Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Robotics Catalog: 560

☐ Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char) ROB 550	Advisory Prerequisite (254 char) ROB 550
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions
☐	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☑ Lab ☑ Discussion ☐ Independent Study Graded Component ☑ ☐ ☐ ☐ ☐ ☐ Terms Typically Offered ☐ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer	

Cognizant Faculty Member Name: Talia Moore Cognizant Faculty Member Title:

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person: Kayla Dombrowski Email: kakelle@umich.edu Phone: 734-936-7999

CoE Curriculum Committee Representative:	Anouck R Girard	Print: Anouck Girard	Date: 12-23-2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Dawn Tilbury	Date: 12-18-2024
Cross-Listed Department Chair:		Print: Ellen Arruda	Date: 11-19-2024
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Examines original scientific research to extract general principles that can be applied to robotics, such as: template and anchor models, walking, running, swimming, flying, sensing, and navigation. Students build functional prototypes and learn about the bioinspired design process through case studies that highlight health, the environment, and safety.	Course Description Examines original scientific research to extract general principles that can be applied to robotics, such as: template and anchor models, walking, running, swimming, flying, sensing, and navigation. Students build functional prototypes and learn about the bioinspired design process through case studies that highlight health, the environment, and safety.
Class Length Full term	Class Length Full term
Contact hours (lecture): 2	Contact hours (lecture): 2
Contact hours (recitation) 1	Contact hours (recitation) 1
Contact hours (lab) 2	Contact hours (lab) 2

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
This will be an elective course that fulfills the acting requirement for the Robotics MS and PhD programs. This will be an elective course that fulfills the ME 500 level or cognate requirement for the Mechanical Engineering MS and PhD programs.

Special resources of facilities required for this course:
Availability of a lab space with open areas where both hard and soft robots can be tested. We need access to a makerspace with laser cutters, 3D printers, heat press, saws, drills, etc. We also need a basic electronics workstation.

Supporting statement:
The objective of Bio-Inspired Robotics is to define a biologically informed analogical design strategy that can be systematically applied to robotic systems. Students will learn both hard and soft skills to support interdisciplinary collaboration and research. The project-based laboratory element will provide students with opportunities to design, build, and test their designs in the real world.

Students will learn how to search for and understand relevant research in biological primary scientific literature (i.e. peer-reviewed journal articles). From these original scientific discoveries, students will then identify a mechanistic biological principle that can be abstracted and applied to engineering design. Students will systematically assess the strength of the analogy between the biological inspiration and the novel design.

There will be three types of lectures in this class. First the “Design” lectures lay out the bio-inspired design process. This includes how to find biological sources of inspiration, how to abstract the biological principle, how to appropriately reduce

the complexity of the mechanism, how and why to scale the mechanism for the design, and how to consider and overcome the constraints of biological systems. The “Case Study” lectures will describe topics in bio-inspired design through case studies of diverse researchers in the field. These examples demonstrate a diversity of ways in which interdisciplinary teams of researchers work together to translate research from science into robotics. These lectures will be used to demonstrate successful ways in which teams of diverse people with complementary skill sets can work together. These will also be used to demonstrate how bio-inspired design can advance health, environmental, infrastructure, and artistic goals. The Case Studies will be organized around Mechanical Engineering concepts, such as fluid mechanics, solid mechanics, sensing, controls, and locomotion dynamics. The “Deep Dive” lectures will follow the interdisciplinary work of one research group as they went from original biological discovery, through hypothesis testing, prototype design, and application. These lectures will provide students with a clearer understanding of what it is like to work in an academic research laboratory environment. Throughout the course, relevant research currently being conducted by laboratories in Robotics and Mechanical Engineering will be highlighted.

The laboratory activities enable the students to apply the design strategies from the lectures as they work in interdisciplinary teams. These labs may change from year to year, but will involve legged robotics, soft robotics, control, and an open-ended design project of the students’ choice. In the lab presentations, students will explicitly learn tips for successful interdisciplinary teamwork. Assignments will be in the style of peer-reviewed research and will include elements related to collaborative goal-setting, assigning roles based on individual strengths, and aiming for equitable contribution.

This course has planned offerings in future winter terms and will be taught by the cognizant faculty member who has a dual appointment in Robotics and Mechanical Engineering.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

Action Requested
- ☐ New Course
- ☑ Modification of Existing Course
- ☐ Deletion of Existing Course

Date of Submission: 2025-01-03
Effective Term: Fall 2025

☑	Course Offered ☑ Indefinitely ☐ One term only	**RO USE ONLY** Date Received: Date Completed: Completed By:

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Robotics Subject: ROB Catalog: 572	Dept (Home): Robotics Subject: ROB Catalog: 572
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Naval Architecture & Marine Engineering - NAVARCH - 569	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Naval Architecture & Marine Engineering - NAVARCH - 569
☐	Course Title (full title) Marine Robotics	Course Title (full title) Marine Robotics
☐	Abbreviated Title (20 char) Marine Rob	Abbreviated Title (20 char) Marine Rob
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Overview of marine robotic systems, including autonomous surface vehicles, remotely operated vehicles, and autonomous underwater vehicles. Topics include vehicle design, kinematic and dynamic modeling, control, sensing, and navigation. Examples draw from real robotic missions across a range of applications from inspection of critical subsea infrastructure to exploration of ocean worlds. Graduate credit includes additional homework problems and research components.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Robotics Catalog: 572

☐	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent Drop Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char) Computational Linear Algebra (ROB 101) or Linear Algebra (MATH 214, MATH 217, MATH 417, or MATH 419) or graduate standing; proficiency in MATLAB	Advisory Prerequisite (254 char) Computational Linear Algebra (ROB 101) or Linear Algebra (MATH 214, MATH 217, MATH 417, or MATH 419) or graduate standing; proficiency in MATLAB
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☑	Credit Exclusions	Credit Exclusions Only one course may earn credit from ROB 472 and ROB 572.
☐	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☐ Lab ☐ Discussion ☐ Independent Study Graded Component ☑ ☐ ☐ ☐ ☐ ☐ Terms Typically Offered ☐ Fall ☑ Winter ☐ Spring ☐ Summer ☐ Spring/Summer	
Cognizant Faculty Member Name: Katie Skinner		Cognizant Faculty Member Title: Assistant Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

Contact Person:Kayla Dombrowski Email: kakelle@umich.edu Phone: 734-936-7999

CoE Curriculum Committee Representative:	Anouck R Girard	Print: Anouck Girard	Date: 12-23-2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Dawn Tilbury	Date: 12-18-24
Cross-Listed Department Chair:	David Dowling	Print: David Dowling	Date: 12/7/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Overview of marine robotic systems, including autonomous surface vehicles, remotely operated vehicles, and autonomous underwater vehicles. Topics include vehicle design, kinematic and dynamic modeling, control, sensing, and navigation. Examples draw from real robotic missions across a range of applications from inspection of critical subsea infrastructure to exploration of ocean worlds.	Course Description Overview of marine robotic systems, including autonomous surface vehicles, remotely operated vehicles, and autonomous underwater vehicles. Topics include vehicle design, kinematic and dynamic modeling, control, sensing, and navigation. Examples draw from real robotic missions across a range of applications from inspection of critical subsea infrastructure to exploration of ocean worlds. Graduate credit includes additional homework problems and research components.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
ROB 572 can be taken by MS/PhD students towards the acting distribution or as an elective.

Special resources of facilities required for this course:
Availability of a CAEN Lab.

Supporting statement:
ROB 572: Marine Robotics has been successfully offered at the graduate level for three terms (Winter 2024, and Winter 2022/Winter 2021 when it was offered as a special topics course, NA599). The creation of an undergraduate (4xx level) section for the course will support undergraduate students who are interested in learning about the field of marine robotics. The credit exclusion will ensure students only enroll in this course once.

The graduate level version of the course will have an extra challenge problem required for each assignment. Additionally, graduate students will be asked to identify, read, and present 1 prior published research paper related to a lecture topic during the semester.

Creating two separate undergraduate and graduate listings will help with enrollment and distribution of seats.