UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, September 17, 2024

Attending: Varun Agrawal, Achilleas Anastasopoulos, Scott Baalrud, Yavuz Bozer, Alexander Burgers, Xudong Fan, Chris Fidkowski, Anouck Girard, Saadet Albayrak Guralp, Vineet Kamat, Amir Kamil, Brian Kiedrowski, Leena Lalwani, Ryan Latimer, Xiaogan Liang, Frank Marsik, Radoslaw Michalowski, Nolgi Oquendo-Colon, Kevin Pipe, Elyse Vigiletti, Won Sik Yang

Support Staff: Mercedes Carmona, Matthew Faunce

Call to Order: 1:32 PM

Adjourned: 2:56 PM

Agenda:

1. Presentation by Kevin Pipe, Associate Dean of Undergraduate Education
    a. CoE Curriculum Committee members need to attend meetings for each CoE department to have representation. Engagement seems to be lacking due to not attending meetings, not knowing a CARF is to be presented and what the CARF changes are, not reviewing meeting minutes/agendas, and HLC audit responsibilities. While we understand this is challenging due to teaching and other department responsibilities, the CoE Curriculum Committee is one of the only committees to have representation for all departments, so this is important to remember and actively attend and engage in meetings.
        i. IOE representative states most challenges come from faculty waiting too long for CARFs/proposals even with telling departments of deadline dates for the CoE CC and University Registrar Office. Also, reminds department that these committees and/or offices only meet so often to review the items needed for the department and that items cannot be reviewed and approved quickly.
        ii. Robotics mentions there are other topics to be discussed that affect undergraduate students and the change in engineering due to AI and COVID rather than the time spent on CARFs and proposals. More participation would occur if more important topics were to be discussed.
            1. Kevin says to form and/or join subcommittees that address the type of topics that need to be covered. The CoE CC is intended for CARFs, proposals, and/or other topics that relate to CoE overall.
            2. CoE CC Chair mentioned that on the 9.3.2024 CoE CC meeting that these topics were discussed for big picture issues, such as the change to Common Degree requirements.
                a. Kevin states that there is a First-Year program committee forming to look at requirements and/or other issues/topics to be discussed. Working with this new committee and the CoE CC could be something that happens in the future due to the ongoing topics, such as online learning and what this should look like in the future for CoE.
    b. Any CoE CC member is more than welcome to reach out to Kevin to discuss any issues/topics as needed.
2. Approval of 9.3.2024 Meeting Minutes – Page 4 - **APPROVED**
3. Proposal for CoE Grade Grievance Policy – Information Item – Page 7 – **TABLED**
    a. This item will be pushed to the next CoE CC Meeting on 10.1.2024. Members are to review the policies and information given in the document to be prepared to go over in the next meeting.
4. Proposal for ECE Graduate Major Modification – Action Item – Page 12 - **APPROVED**

a. New graduate major area in Quantum Engineering, Science, and Technology (QUEST) within the Electrical Computer Engineering division of the EECS Department with an effective term of Fall 2025. Quantum technology is growing rapidly, so establishing quantum engineering as a focused graduate area of study is putting Michigan Engineering as a leader in this field. Available for both Master's and PhD students to take, but only will appear on a Master's student transcript and not for a PhD student. The major requirement is that students must take 9 credits in the major area with 6 credits needing to be 500+ level courses.
b. Question as to what are the other existing major areas for ECE?
    i. Just to name a few are Power and Energy, Optics & Photonics, Integrated Circuits & VLSI, Embedded Systems, Computer Vision. The Bulletin and Department websites contain all information for major areas for ECE Graduate students.
c. CoE CC members voted unanimously to approve this proposal. The proposal will appear at the December CoE Faculty meeting.

5. Proposal for IOE BSE Program Modification – Action Item – Page 18 - **APPROVED**
    a. ROB 101 as a substitute for the existing linear algebra requirement for students majoring in IOE effective for Fall 2025. 3 unique points this will benefit IOE students:
        i. First-year students do not need prerequisite knowledge of calculus. Allows for an accelerated trajectory to take higher-level IOE courses compared to the complete of MATH 214 for the calculus sequence.
        ii. ROB 101 mirrors MATH 214, but also includes written problem sets for theoretical comprehension as well as integrating programming assignments along with linear algebra concepts to real world computational problems.
        iii. ROB 101 introduces linear algebra with an engineering focus needed for IOE students, such as computation and robotics.
    b. CEE department mentions if there would be any ABET implications due to a 200-level course being replaced by a 100-level course.
    c. TCHNCLCM asks if the CoE CC is to encourage modifications such as this and if not then whose role would that be?
        i. CoE CC Chair states that any changes to program requirements for linear algebra and/or any other changes should come through the CoE CC for review and approval.
            1. Robotics states that the department is fully onboard with IOE making this program modification for IOE students.
    d. MECHENG states that the department is pilot testing for students to take an engineering course to substitute MATH 216. Should the department be making a proposal for this change already?
        i. CoE CC Chair says that exceptions are fine in this case as this is early and still testing out for MECHENG students. If the department is to expect this change to be long term for MECHENG students and alter MECHENG degree requirements, then a proposal would need to be reviewed at a CoE CC meeting.
    e. CoE CC Chair brings up that further discussions need to be had with either this committee and/or subcommittees regarding the math requirements for CoE students as students do not enjoy taking UM math courses and more students are taking these courses externally to transfer credit.
    f. CoE CC members voted unanimously to approve this proposal. The proposal will appear at the December CoE Faculty meeting.
6. Proposal for NERS BSE Program Modification – Action Item – Page 30 – **APPROVED**
    a. Effective for Fall 2025, NERS is making changes to their BSE degree by:
        i. MATH 216 to be removed from the CoE Common Degree requirements and replaced with NERS 320 for NERS BSE students.
        ii. With the moving of NERS 320 from the NERS Program Subjects requirements, NERS 420 is a new course that will replace NERS 320.
    b. The department's reasoning for these changes:
        i. MATH 216 is not meeting the needs for NERS majors.
        ii. The NERS Department would like to cover more topics which currently do not fit in the curriculum.
        iii. NERS 420 will fill a need for an expanded mathematics curriculum for many incoming graduate students.
    c. IOE brings up concern with increasing the workload for departments by creating a course within a department.
        i. NERS department weighed the pros and cons and ultimately it was best to invest in the students as this course will be beneficial in the long run to cover the topics NERS students need.
        ii. EECS-ECE mentions how does the math department feel regarding CoE departments creating courses that are substitutes for math courses. Should we be reaching out to the math department to go over the curriculum/topics covered that are missing for engineering students?

1. COE CC Chair brings up that MATH 214 was created for engineering and still does not cover the topics needed for engineering students. Conversations should be had between CoE departments and the math department as needed.
2. For example, the Robotics department has been in conversations and worked with the math department for ROB courses to be taken instead of math courses and the math department was amenable.

d. CoE CC members voted unanimously to approve this proposal. The proposal will appear at the December CoE Faculty meeting.

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
33	BIOMEDE	517	MOD	Change in Course Description, Full Term Credit Hours, Course Credit Type, and Course Components. Adding a new Cross-Listing with ROB 517.	WT 2025	B	YES	CONDITIONAL APPROVAL	Recommended change to the Abbreviated Title to reflect the Course Title.	
36	EECS	415	NEW		WT 2025	NO	NO	APPROVED		
48	IOE	461	MOD	Change in Abbreviated Title, Course Description, Advisory Prerequisite, and Credit Exclusions.	WT 2025	C-	YES	CONDITIONAL APPROVAL	Cross-listed with MFG 461. Change Page 3 Course Description – Requested Listing Side to reflect the change on Page 1.	
51	IOE	465	MOD	Change in Course Description, Advisory Prerequisite, and Credit Exclusions.	WT 2025	C-	YES	APPROVED		
54	IOE	466	MOD	Change in Course Description and Credit Exclusions.	WT 2025	C-	YES	APPROVED	Cross-listed with MFG 466.	
57	KINESLGY	533	MOD	Change in Course Subject.	WT 2025	NO	YES	APPROVED	Cross-listed with BIOMEDE 533.	
60	NAVARCH	470	MOD	Change in Course Components.	WT 2025	NO	YES	TABLED – No member to present	Cross-listed with MFG 470.	
63	NERS	320	MOD	Change in Course Title, Abbreviated Title, Course Description, Enforced Prerequisite, and Terms Typically Offered.	WT 2026	C	YES	CONDITIONAL APPROVAL	Change Abbreviated Title to include engineering, such as “App Math Eng Phys I”.	
66	NERS	420	NEW		FT 2026	C	NO	CONDITIONAL APPROVAL	Change Abbreviated Title to include engineering, such as “App Math Eng Phys II”.	
75	NERS	471	MOD	Change in Course Description and Advisory Prerequisite. Adding a new Cross-Listing with EECS 415.	WT 2025	NO	YES	APPROVED		

87	**STATS**	**570**	**MOD**	Change in Home Department, Abbreviated Title, Course Description, Full Term Credit Hours, Course Credit Type, and Advisory Prerequisite.	**WT 2025**	**NO**	**YES**	**CONDITIONAL APPROVAL**	Cross-listed with IOE 570. Cross-listing checkbox needs to be checked with STATS 570 to be listed on the Requested Listing Side.	

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, September 3, 2024

Attending: Varun Agrawal, Achilleas Anastasopoulos, Yavuz Bozer, Chris Fidkowski, Saadet Albayrak Guralp, Vineet Kamat, Amir Kamil, Leena Lalwani, Ryan Latimer, Xiaogan Liang, Yili Liu, Frank Marsik, Radoslaw Michalowski, Deepak Nagarth, Kristel Oelke, Nolgi Oquendo-Colon, Yulin Pan, Elyse Vigiletti, Won Sik Yang

Support Staff: Mercedes Carmona, Betsy Dodge, Matthew Faunce

Call to Order: 1:35 PM

Adjourned: 2:57 PM

Agenda:

1. Voting for CoE Curriculum Committee Chair for 2024-2025
    a. Amir Kamil nominated and unanimously voted upon by Curriculum Committee to be the chair for the next academic year.
2. Approval of 4.9.2024 Meeting Minutes – Page 3 - **APPROVED**
3. Proposal for New CARF Email – Information Item – Page 6
    a. New CARF email created that will direct questions, information, and requests directly to the CoE Curriculum Committee administrative support needed to review CARFs, answer questions, and provide information.
    b. An email will be sent to all CoE CC members and support staff to start using this new email as soon as possible. All website and document locations with CARF information will be updated to reflect the new email.
4. Proposal for ROB 102 for EECS-CSE – Action Item – Page 7 - **APPROVED**
    a. EECS-CSE to request that ROB 102 be approved as a substitution for the ENGR 101 requirement for CS-Eng majors. This would be beneficial to add this course as another option for students as EECS 180 and ENGR 151 are currently offered along with ENGR 101.
    b. ROB questions that due to the influx of CS-Eng students being directed to take ROB 102, will the ROB department and instructors be prepared and what influence, if any, will this have on the course taught, such as will the learning outcomes be altered for CS-Eng students. Also, what is the communication between EECS-CSE and Robotics for this type of change.
        i. EECS-CSE says that there have been ongoing conversations with the department and there will be no altering of how ROB 102 is currently taught. Conversations will happen between departments if any issue(s) arise.
            1. Graduate Education asks if a letter of support from the involved departments would need to be created and questions what department is to make changes to a course? What does the workflow for a change like this look like?
                a. Chair says that communication needs to happen between departments with these types of changes and any changes for proposals and CARFs. All departments need to be involved in ongoing conversations before creating a proposal or CARF to be presented at a CoE CC meeting. Currently, there is no workflow, but it is expected departments are having the conversations needed for CARFs and proposals.
    c. CLaSP requests what are the specific numbers for the declared degrees provided in the proposal and why the EAC advised students to take ROB 102. Also expresses concern for the ROB department to not be overwhelmed with an influx of students taking this course.
        i. Currently, there are 35 students enrolled in ROB 102, which is the most this has ever been. This could be due to students who initially wanted to pursue ROB but have changed their mind or want to pursue a dual degree. Also, other majors do not accept ROB 102.
    d. CoE CC members voted unanimously to approve this proposal. The proposal will appear at the next CoE Faculty meeting.

5. Proposal for IOE Undergraduate Minor in Human Factors Engineering (HFE) – Action Item - Page 9 - **APPROVED**
    a. The IOE HFE Minor requires 15 credits of IOE courses and is open to all undergraduate students except students pursuing IOE majors, who can take these HFE courses to gain knowledge and skills to be used as part of the major requirements. Upon approval in the CoE, the IOE department will pursue other schools/colleges within the University. This proposal is to have an effective term of Winter 2025.
        i. Other minor requirements:
            1. Students must declare a Major, other than IOE, before declaring the HFE Minor. No additional prerequisite is required for the HFE minor.
            2. No transfer credit allowed.
            3. Students must have at least a 2.0 GPC for the 15 credits of core and elective HRE courses for the minor.
            4. Courses must be a regular grade and receive a C- or better.
    b. EECS-CSE questions how many students would pursue this minor.
        i. Not a specific number to provide, but rather the departments that would be interested would be ROB, EECS-CS, BIOMEDE, and AEROSP due to the courses offered.
    c. Graduate Education asks what type of marketing or communication is being used to spread the word about this minor and would this minor be a concentration for graduate students.
        i. Upon approval, our department will work on this to market to all students interested in this minor. The minor will only be offered to Undergraduate students, but this is the first step for the minor and to adapt/progress in the future once this minor begins.
    d. CoE CC members voted unanimously to approve this proposal. The proposal will appear at the next CoE Faculty meeting.

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
13	BIOMEDE	514	NEW		WT 2025	C-	NO	CONDITIONAL APPROVAL	Add parenthesis around the Enforced Prerequisite courses (BIOMEDE 221 and BIOMEDE 418). Modify Course Description, specifically the last sentence and use present tense throughout.	
21	CSE	577	NEW		WT 2025	C	NO	APPROVED		
39	EECS	110	MOD	Change in Course Description and Enforced Prerequisite.	WT 2025	NO	YES	APPROVED		
42	EECS	183	MOD	Change in Enforced Prerequisite.	WT 2025	NO	YES	APPROVED		
45	EECS	477	MOD	Change in Credit Exclusions.	WT 2025	C	YES	APPROVED		
48	EECS	479	NEW		WT 2025	C	NO	APPROVED		
67	EECS	487	MOD	Change in Credit Exclusions.	WT 2025	C	YES	APPROVED		
70	EECS	492	MOD	Change in Credit Exclusions.	WT 2025	C	YES	APPROVED		
73	IOE	333	MOD	Change in Course Description and Enforced Prerequisite.	WT 2025	NO	YES	APPROVED		

CoE Grade Grievance Policy Proposal

Per a request from Kevin Pipe, following a discussion with faculty, he requested that the CoE Curriculum Committee review our current Grade Grievance Policy and possibly consider aligning with LSA's policy that includes deadlines (in bold under the LSA's Policy section), if needed.

For the CCC consideration:

1. Would the committee like to add deadlines to our current policy?
2. What should the deadlines be (e.g., align with LSA)?
3. Does the committee want the language to be as detailed as LSA's policies (see below)? Are there other issues that should be addressed?
4. We can bring back a final draft for the committee to vote upon at the next meeting.

CoE's Current Policy in the Online CoE Bulletin:

Grade Grievances Procedure

If there is justification to question the accuracy of an assigned grade, the student should first pursue the matter with the instructor. The responsibility for the assignment of grades is primarily that of the instructor and should be settled between the student and instructor whenever possible. Further pursuit of a grade grievance should be addressed with the instructor's Department Chair. The final appeal at the College level is by petition to the Associate Dean for Undergraduate Education or the Associate Dean for Graduate and Professional Education.

Student Grievances

The College of Engineering has a grievance procedure to address student complaints.

Undergraduate and graduate students should follow these steps until a resolution is achieved:

1. Attempt to resolve the grievance directly with the individual involved (faculty member, staff member, or fellow student).
2. If the matter is unresolved, and the grievance is with a faculty member or teaching assistant, discuss the grievance with the appropriate Department Chair.
3. If the issue is still unresolved, undergraduate students should see the Associate Dean for Undergraduate Education and graduate students should see the Associate Dean for Graduate and Professional Education who are both located in the Robert H. Lurie Engineering Center.

4. All students have the right to appeal to the Dean of the College if they feel their grievances have not been resolved satisfactorily by another dean.

LSA's Current Policies from their LSA Academic Policies website:

Grade Grievance

Grade Change Policy

"A grade change may be submitted by your instructor to correct an error on a Supplementary Grade Report which the instructor obtains from their department office. The request must be accompanied by a formal explanation by the faculty member in charge of the course outlining the circumstances surrounding the original error and justifying the grade change." (Faculty Code B5.07)

LSA Student Records cannot approve any Supplementary Grade Report for a grade change when "extra work is submitted," "student rewrote a paper," "student retook the final," or another special arrangement unless the instructor is able to provide a statement that the arrangement giving this one student the opportunity to raise his/her grade was an arrangement available to and known by every student in the course. If the grade is being changed because the work was submitted after grades were due and no "incomplete" grade was originally given, the grade will be posted with and "I" as long as the work was completed during the incomplete deadline period.

When the instructor is changing a grade from "incomplete", they must include the date the student submitted their completed work. Even if the course has lapsed to E the grade can still be approved for posting if the work completed by the student was within the incomplete deadline date or the extended deadline date.

Grade Grievance Procedures

Introduction

Instructors are expected to set fair and consistent grading procedures for their respective courses. The following policy provides students a means to contest a final course grade received in a credit-bearing course if a student believes fair and consistent grading procedures have not been followed. A final grade is only subject to review when 1) a procedural error has been discovered in the calculation or recording of a grade, or 2) there is a concern that the grade was not fairly given. Disagreeing with grading policies or an instructor's assessment of work is not a basis for a grade grievance.

Occasionally, the basis of a student's grade grievance is that the student was subjected to harassment or discrimination. It is not the function of the Grade Grievance process to evaluate claims of discrimination or harassment. Please contact the Office of Diversity, Equity & Inclusion (ODEI), and the Associate Chair of Undergraduate Studies (ACUS) or Director of Undergraduate Studies (DUS) in the department in question will evaluate whether the grade grievance should be paused until the OIE matter is resolved.

The steps for the grade grievance process are outlined below:

Step 1: Seek Resolution with the Instructor

As the first step in the grade grievance process, the student should inquire about the accuracy of their final grade to the lead instructor of the course. This initial inquiry should take place **within the first 15 university business days** of the beginning of the following winter term for courses taken during the fall semester, and **within the first 15 university business days** of the beginning of the following fall semester for courses taken during the winter, spring, or summer sessions. In the case of an incomplete or a grade that is submitted after the start of the next full term, the initial inquiry should take place within the first 15 university business days after the official posting of the grade.

If, after this inquiry, the student is not satisfied with the instructor's response, the student may choose to initiate a formal grade grievance. If the lead instructor has left the University, is on approved leave, or does not respond to the student after a reasonable effort (within 10 business days), the student may also proceed directly to Step 2 and initiate a formal grade grievance.

Step 2: Submit a Formal Grade Grievance

To begin the formal grade grievance process the student must submit to the Associate Chair of Undergraduate Studies (ACUS) or Director of Undergraduate Studies (DUS) [refer to the LSA Grade Grievance Department Contact list] a written statement that includes the following information:

- the basis for the allegation of arbitrary grading, including specific evidence (e.g. course syllabus, graded work) that supports the allegation
- a summary of the outcome of the initial inquiry to the course instructor, indicating what aspects are in dispute and any documentation to support the initial inquiry with the instructor
- the desired outcome for the grievance

This written statement must be submitted **within the first 30 university business days** of the beginning of the following winter term for courses taken during the fall semester, and **within the first 30 university business days** of the beginning of the following fall semester for courses taken during the winter, spring, or summer sessions. In the case of an incomplete or a grade that is submitted after the start of the next full term, the written statement must be submitted within the first 30 university business days after the official posting of the grade.

If any of the above deadlines are not met by the student, the grievance will be considered invalid and closed, unless, due to extenuating circumstances, the office of the LSA Assistant Dean of Undergraduate Education and Student Academic Affairs grants an extension of time. If you believe there was an extenuating circumstance (i.e. hospitalization, extended leave from health reasons) please contact the LSA Office of Student Academic Affairs (lsa.saa.office@umich.edu) for more information.

Upon receipt of the written complaint in Step 2, the ACUS/DUS will notify the office of the LSA Assistant Dean of Undergraduate Education and Student Academic Affairs of the complaint within 5 business days of receipt of the complaint. The ACUS/DUS will then ask the instructor to provide a written summary explaining how the final grade was determined and responding to the specific claims made by the student. After receiving the response from the instructor, the ACUS/DUS will determine if sufficient evidence exists to convene the Department's Grade Grievance Committee. If the ACUS/DUS determines that there is insufficient evidence for the grade grievance, the matter is considered closed, and the original grade stands. The ACUS/DUS will communicate this in writing to the student **within 15 university business days** from receipt of the complaint. A copy of the response should also be sent to the office of the LSA Office of Student Academic Affairs at the same time.

Step 3: Formal Grade Grievance Hearing

If the ACUS/DUS determines that the grade grievance should proceed, an appropriate Departmental Grade Grievance Committee will be selected, and a date for a formal hearing with the Grade Grievance Committee will be set. The hearing should occur no more than 60 days after submission of the complaint. All parties (student, instructor, and committee) will be provided with copies of the written student complaint and the instructor's summary in advance of the formal hearing. During the formal hearing, the student will be asked to first present the basis of their complaint; the instructor will then be asked to present their explanation for how grades were determined. Following an open period of questions to all parties, the formal hearing will be adjourned.

The Grade Grievance Committee will then have **ten university business days** to determine its recommendation and submit a written report to the ACUS/DUS.

- If the Grade Grievance Committee decides that a grade change is not warranted, the ACUS/DUS will convey this in writing to the student and the instructor. The original grade will stand and the matter is considered closed.
- If the committee recommends a grade change, the ACUS/DUS will communicate that decision directly to the instructor. The instructor will then be asked to respond in writing within five university business days to the ACUS/DUS indicating whether or not they will abide by the Grade Grievance Committee's recommendation.
    - If the instructor agrees to a grade change, the ACUS/DUS will in writing inform the student of the instructor's decision and the student's final course grade will be changed. The matter is considered closed.
    - If an instructor does not accept the Grade Grievance Committee's recommendation to change the final grade, the original grade will stand. A final course grade rests solely with the instructor and, as such, a course grade cannot be changed without the instructor's consent. When this occurs, the ACUS/DUS will convey in writing this decision to the student. The matter is considered closed. There is no appeal beyond the Department.
- A report stating what procedures were followed and what decision was reached will be sent to the office of the LSA Office of Student Academic Affairs by the ACUS/DUS **within 5 business days** after the conclusion of the review process.

August 19, 2024

Dear College of Engineering Curriculum Committee,

Please find the attached proposal for a new graduate major area in Quantum Engineering, Science, and Technology (QUEST) within the Electrical and Computer Engineering (ECE) division of the EECS department. The requested effective term is Fall 2025.

The University of Michigan College of Engineering has always been at the forefront of technological innovation. This is reflected in our world-class research activities and innovative teaching. Quantum technologies are expanding rapidly, and we must prepare our graduates with the knowledge and resources to lead this emerging technology sector. Establishing a focused graduate area of study in quantum engineering is the first step toward positioning Michigan Engineering as a leader in the field.

The attached proposal will establish a graduate major area in QUEST under the ECE division. Master's Students may choose QUEST as a major area, which will appear on their transcript. The major area does not appear on a PhD transcript, however, the department requires all students without a relevant Master's to take courses in a graduate major area.

The proposal outlines the courses needed to fulfill the major requirement. Courses that count automatically toward the major are labeled "M", while courses labeled "E" can satisfy the major area with advisor approval. To meet the major requirement, students (both Master's and PhD) must take 9 credits in the major area, 6 of which must be at the 500+ level.

This proposal has been reviewed and approved by both the ECE graduate committee and the ECE faculty. Please feel free to contact me via email (aburgers@umich.edu) with any questions.

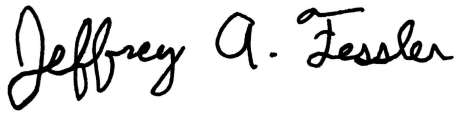
Thank you for your consideration.

Sincerely,

Alex Burgers
Assistant Professor, Electrical and Computer Engineering

I have discussed this proposal with ECE Grad Chair Peter Seiler and Master's Chair Clay Scott, who support it and have authorized me to sign on behalf of all of us.

Sincerely,



Jeffrey A. Fessler
Interim Chair, Electrical and Computer Engineering
William L. Root Collegiate Professor of Electrical Engineering and Computer Science

Proposed Quantum Major Area to the ECE Division of the EECS Department

This is a proposal to add a new Major Area to the ECE graduate program, “Quantum Engineering, Science and Technology (QuEST).” It will be added to the list of Major Areas students select from when applying to the ECE MS and PhD program. The requested effective term is Fall 2025 . This major area appears on the MS student transcript but not the PhD transcript. Both MS and PhD (without a relevant Master’s) students are required to select a Major Area of study. QuEST would be one of those in ECE that students could select. Note that this proposal does NOT create a new research area with an area director or affect how fellowship funds are allocated.

Reason for the new Major Area:
Quantum engineering, science, and technology (QuEST) is rapidly growing in academia and private industry. Academic labs and startup companies are pushing the frontiers of fields like quantum computing and quantum sensing. Established companies such as IBM, Google, and Honeywell have significantly invested in quantum technology. As a result of these trends, enrollment in quantum-related courses and degree programs has spiked around the country and the world. Recently, the University of Michigan launched the Quantum Research Institute in an effort to propel the university to the forefront of academic quantum research. In an effort to complement these endeavors and show significant leadership in QuEST at the University and beyond, the ECE division is seeking to create a new major area in QuEST. The following courses will form the basis for this new major area in ECE, along with the descriptions of how they relate to QuEST.

Courses:

The following courses will initially be added to the ECE grad course list for the QuEST Major Area.

M - Denotes courses that are automatically counted in the Major Area
E - Denotes courses that count in the Major Area after advisor approval

ECE 540 Applied Quantum Mechanics I - **M**
Description: Introduction to nonrelativistic quantum mechanics. Summary of classical mechanics, postulates of quantum mechanics and operator formalism, stationary state problems (including quantum wells, harmonic oscillator, angular momentum theory and spin, atoms and molecules, band theory in solids), time evolution, approximation methods for time-independent and time-dependent interactions including electromagnetic interactions, scattering.

Relevance to QuEST: Establishes a foundational understanding of quantum mechanics upon which all quantum technological advancements are based.

ECE 541 Applied Quantum Mechanics II - **M**

Description: Continuation of nonrelativistic quantum mechanics. Advanced angular momentum theory, second quantization, non-relativistic quantum electrodynamics, advanced scattering theory, density matrix formalism, reservoir theory.

Relevance to QuEST: Discusses advanced topics in quantum mechanics related to interactions of quantum systems with radiation, and expands the topic of angular momentum, which is the formalism used to describe quantum bits.

ECE 520 Solid State Physics- **M**
Description: Crystal structure; Phonons; Introduction to Quantum Mechanics, Free electron Fermi gas; Low dimensional conductor; Electronic structure – Energy bands; Properties of semiconductors; Dielectrics response; Light absorption and emission; Magnetic effects; Superconductivity

Relevance to QuEST: Introduces the quantum mechanical properties of solids and addresses interactions with solids and external fields which are used for quantum manipulation and sensing. Additionally, the course explores how superconductivity arises, which is responsible for generating the nonlinearity in superconducting Circuits, a leading platform for quantum computing.

ECE 638 Quantum Optics - **M**
Description: The atom-field interaction; density matrix; quantum theory of radiation including spontaneous emission; optical Bloch equations and theory of resonance fluorescence; coherent pulse propagation; dressed atoms and squeezed states; special topics in nonlinear optics.

Relevance to QuEST: Describes the quantum mechanical interactions between radiation and quantum systems. The radiation field is quantized and further discussed in the context of entanglement generation and generating non-classical states of light.

EECS 428 Introduction to Quantum Nanotechnology - **E**
Description: The atom-field interaction; density matrix; quantum theory of radiation including spontaneous emission; optical Bloch equations and theory of resonance fluorescence; coherent pulse propagation; dressed atoms and squeezed states; special topics in nonlinear optics.

Relevance to QuEST: This course introduces the basic concepts in quantum mechanics as they relate to current technologies. The students learn how the basic theories can be applied to describe real-world situations.

EECS 498 Special Topics - **E**
Description: Several special topics courses directly relate to QISE and will be approved by the adviser.

ECE 598 Special Topics - **E**

Description: Several special topics courses directly relate to QISE and will be approved by the adviser.

ECE 598-012 Quantum Optoelectronics - **E**
Description: The coupling of quantized light to electrons is investigated in detail, while the many-body Coulomb interactions of charge carriers are fully included. We will analyze which quantum effects and quasiparticles optical experiments can detect and control in terms of excitonic effects, plasmonics, quasiparticle accelerators, and ultrafast spectroscopy. To extend the quantum ideas further, we will follow how including quantum fluctuations of light to laser spectroscopy will transform it into quantum spectroscopy, a new realm where dropletons, entanglement, quantum memory, etc effects can be explored.

Relevance to QuEST: Next-generation quantum innovations are explored and formulated for semiconductor-based quantum-optical systems.

ECE 598-005 Quantum Information, Probability and Computing - **E**
Description: This course introduces students to gate-based quantum information processing with an emphasis on the probabilistic nature inherent in quantum mechanics and how algorithms leverage this nature while requiring a deterministic output.

Relevance to QuEST: Introduction to quantum gates, algorithms, computation, error correction, & communications.

ECE 634 Nonlinear Optics - **E**
Description: Formalism of wave propagation in nonlinear media; susceptibility tensor; second harmonic generation and three-wave mixing; phase matching; third order nonlinearities and four-wave mixing processes; stimulated Raman and Brillouin scattering. Special topics: nonlinear optics in fibers, including solitons and self-phase modulation.

Relevance to QuEST: This course introduces optical phenomena that are the processes by which researchers generate quantum states of light, and discuss optical measurement techniques used to investigate the coherence in quantum systems.

ECE 521 Solid State Devices - **E**
Description: Physics of operation of three terminal device structures important for high-frequency analog or high-speed digital applications. Emphasis on proven field-effect and bipolar-junction transistors, also including current and speculative nanoelectronic devices. Detailed study of static current-voltage characteristics and models for small and large signal behavior.

Relevance to QuEST: Discusses device technology based on semiconductors that require quantum mechanics to operate. These device's operational infrastructure is an important backbone for controlling quantum systems that may be embedded within the structures.

ECE 537 Classical Optics - **E**
Description: Theory of electromagnetic, physical, and geometrical optics. Classical theory of dispersion. Linear response, Kramers-Kronig relations, and pulse propagation. Light scattering. Geometrical optics and propagation in inhomogeneous media. Dielectric waveguides. Interferometry and theory of coherence. Diffraction, Fresnel and Fraunhofer. Gaussian beams and ABCD law.

Relevance to QuEST: This course introduces the foundational knowledge in optics and light, which is an essential requirement for extending the description of light into the quantum mechanical regime. Additionally, the analysis of light manipulation in the course is an important skill for students working in the field of quantum optics.

ECE 538 Optical Waves in Crystals - **E**
Description: Propagation of laser beams: Gaussian wave optics and the ABCD law. Manipulation of light by electrical, acoustical waves; crystal properties and the dielectric tensor; electro-optic, acousto-optic effects and devices. Introduction to nonlinear optics; harmonic generation, optical rectification, four-wave mixing, self-focusing and self-phase modulation.

Relevance to QuEST: This course discusses the propagation of light in various media which is important for nonlinear optics and generation of entangled photons. Additionally, discussions or electro-optic effect and acusto-optic effect are essential for technical manipulation of otpical beams that coherently manipulate and control the quantum states of matter.

ECE 539 Lasers - **E**
Description: Complete study of laser operation: the atom-field interaction; homogeneous and inhomogeneous broadening mechanisms; atomic rate equations; gain and saturation; laser oscillation; laser resonators, modes, and cavity equations; cavity modes; laser dynamics, Q-switching and modelocking. Special topics such as femto-seconds lasers and ultrahigh power lasers.

Relevance to QuEST: This course covers the fundamentals of lasers, which are an essential tool in the control and coherent manipulation of most quantum systems. Moreover, the fundamental discussions that arise regarding atom-field interactions, gain, and saturation are important concepts in QuEST.

IOE INDUSTRIAL & OPERATIONS ENGINEERING UNIVERSITY OF MICHIGAN

April 9, 2024

Dear CoE Curriculum Committee:

I am writing to submit a formal request for the acceptance of ROB 101: Computational Linear Algebra as an approved substitute for the existing linear algebra requirement for students majoring in Industrial and Operations Engineering (IOE) within the College of Engineering.

ROB 101 is developed to provide an introductory experience in linear algebra, with an emphasis on computational and engineering applications. It has a goal to "teach linear algebra as a means for reasoning about data and making discoveries about the world". Topics included in the course are systems of linear equations, vectors, matrices, inverses, regression, matrix factorization, and spatial coordinates.

ROB 101 has three unique points compared to the course offered by the Mathematics Department: (1) it allows first-year students to take it without a prerequisite knowledge of calculus. The structure of ROB 101 offers students an accelerated trajectory towards higher-level IOE courses compared to the traditional pathway that necessitates the completion of MATH 214 following the calculus sequence; (2) The curriculum of ROB 101 mirrors the mathematical rigor of MATH 214, with the inclusion of written problem sets for theoretical comprehension. It goes a step further by integrating programming assignments that apply these linear algebra concepts to real-world computational problems—an element invaluable for the IOE major; (3) ROB 101, compared to MATH 214, is specifically tailored to introduce linear algebra with an engineering focus, involving computation and robotics—domains integral to the IOE discipline. The real-world applications include cameras, LiDAR, accelerometers, single-axis gyroscopes, encoders, and so on.

It is the consensus among the IOE faculty teaching advanced courses that require a foundational understanding of linear algebra, that ROB 101 fulfills the educational requirements of IOE students.

- IOE 310: Optimization and Computational Methods
- IOE 316: Introduction to Markov Processes
- IOE 366: Introduction to Engineering Data Analytics
- IOE 435 (ROB 435): Quantifying Human Motion Through Wearable Sensors

It is important to note that this proposal does not require modification to the sample schedule for the IOE program as the majority of our students are currently enrolled in MATH 214. We seek to present ROB 101 as an additional, not replacing, option that could be beneficial to both current and future IOE students from the Fall term of 2025 onward.

We respectfully request your consideration of this proposal and are open to any questions or discussions that this may prompt. Please direct your responses to me and Ms. Leonora Lucaj (lucajl@umich.edu), who is our Undergraduate Student Advisor.

X. Jessie Yang
Associate Professor, Industrial and Operations Engineering
Interim Associate Chair of Undergraduate Studies

Additional Information

ROB 101: Computational Linear Algebra

ROB101 is a course developed in the newly established Robotics Department. It has a goal to teach linear algebra as a means for reasoning about data and making discoveries about the world. The real-world applications involve cameras, LiDAR, accelerometers, single-axis gyroscopes, and encoders. Topics included in the course are systems of linear equations, vectors, matrices, inverses, regression, matrix factorization, and spatial coordinates. See syllabus of ROB 101 in the supporting document. Course Textbook: Notes for Computational Linear Algebra, developed by the Robotics department.

MATH 214: Applied Linear Algebra

MATH 214 provides an introduction to matrices and linear algebra. This course covers the basics needed to understand a wide variety of applications that use the ideas of linear algebra, from linear programming to mathematical economics. Topics include vectors, matrices, inverses, regression, determinants, and matrix factorization. See syllabus of Math 214 in the supporting document. Course Textbook: Linear algebra with applications by Otto Bretscher, 5th Edition

See Syllabi of ROB 101 and MATH 214.

Course Syllabus

Course Information

ROB101 | Computational Linear Algebra
4 Credits
Fall 2023
In-Person Section 001
Online Section 881

Location, Date, & Time
Herbert H. Dow Building (DOW) 1013
Lecture | Tuesday & Thursday 1:30 pm - 3:00 pm

Ford Motor Company Robotics Building (FRB) 1060
Lab | Friday 10:30 am - 12:30 pm

Course Overview

Pre-Requisites: None

ROB101 has a goal to teach linear algebra as a means for reasoning about data and making discoveries about the world. Students will be able to use large, real-world datasets by programming in the open-source Julia language. Some topics included in the course are systems of linear equations, vectors, matrices, inverses, regression, matrix factorization, and spatial coordinates. The real-world applications involve cameras, LiDAR, accelerometers, single-axis gyroscopes, and encoders. In addition, students will learn about optimization techniques with a bonus chapter in early machine learning skills.

ROB101 is the result of a curriculum redesign with a goal to engage all students, including those from underrepresented communities, in robotics, math, and artificial intelligence. Read more in the "Solving for Equity" article ASEE PRISM Magazine, Winter 2021. The initial idea for the course came from Professor Chad Jenkins!

Instructors

Jamie Berger
Office: FRB 2280
Email: bergerja@umich.edu

Ram Vasudevan
Office: FRB 3252
Email: ramv@umich.edu

Values

Michigan Robotics enthusiastically supports UM's policy of equal opportunity for all persons and 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 employment, educational programs and activities, and admissions. We also value the U-M Engineering Honor Code: LINK

Course Syllabus

Course Policies

Class Time

Lecture | Lecture takes place twice a week, covers content from the textbook, and is led by the primary instructor. The free link to the textbook will be provided on Canvas. If you are enrolled in the in-person section, then please follow the health and safety guidelines of the College of Engineering.

Lab | Lab is split into two hours. The first hour goes over important programming concepts in Julia that are helpful for programming homework and projects. The second hour is used as a group office hour. Students may work together on homework and other practice problems, or ask questions on course content.

Assignments

Homework | There are 9 written homework assignments and 7 programming homework assignments. Late homework is not accepted. Students may collaborate on homework and are required to individually write up and submit them. Written homework is due on Thursdays at 11:59 pm EST. Programming homework is due on Tuesdays at 11:59 pm EST.

Projects | There are 3 main projects with real-world applications. Projects are meant to be completed individually and are due on Fridays at 11:59 pm EST. Late projects are accepted with a 15% per 24 hours penalty.

Participation | There are various participation assignments that primarily consist of course evaluations, feedback, and 4 reflection assignments. No late participation assignments will be accepted.

Note: There are no major exams!

Course Syllabus

Grading Policy

30% Homework Sets

- ➔ The 2 lowest grades on written homework and 2 lowest programming homework grades dropped.
  - ◆ Homework 5 (Written) can not be dropped.
  - ◆ Homework 4 (Programming) can not be dropped.
- ➔ 15% of written homework + 15% of programming homework

60% Projects

- ➔ Each project is worth 20%. They will be accepted late with a 15% penalty per 24 hours late (prorated).

10% Participation

Regrade Requests must be addressed within 1 week of receiving feedback (via a grade) on any assignment. After that time, your grade is locked in and ineligible for a change.

Absences

Lectures and labs will be recorded and posted to Canvas. Please note that your voice and/or image may appear in the lecture recordings. Attendance of synchronous lectures and labs is your choice, you will not be penalized for participating asynchronously. However, please keep in mind that *synchronous learning is the most beneficial to the student experience*. It is highly recommended that if you do participate asynchronously, then you are staying on pace with the lecture recordings (3 a week = 2 lecture + 1 lab).

Office Hours

We highly encourage the use of Piazza to ask questions on lectures, labs, and assignments. It is expected that questions are posted on Piazza as opposed to emailing the instructor. Lab is used to receive help on Julia programming in the first hour, and the second hour is used to receive help on the assignments. If you seek additional one-on-one assistance, office hours will be held by the instructor and instructional aides. The days and times are TBD and will be posted on the homepage of Canvas.
Do not use Canvas massaging to contact your instructors. Please use Piazza or Email only!

Generative Artificial Intelligence

ChatGPT and similar technologies are rapidly becoming part of our professional lives. As such, it is expected that you will incorporate these technologies into your work in this class as appropriate, and will treat the work you produce as demonstration of your abilities to engage with these new tools. We do ask that you cite the technologies used as part of your submission so that we're all engaging in a dialogue around the role and efficacy of these tools. A citation can be as simple as writing "*I used ChatGPT to help solve this problem*" next to your solution or writing a Julia comment *#I used ChatGPT to help write this code* next to the line(s) of code.

Course Syllabus

Course Schedule	
Week	**Topics**
1 [Jan. 10 - 12]	Introduction to Systems of Linear Equations (Ch.1)
2 [Jan. 15 - 19] **MLK Jr. Day Jan. 15**	Vectors, Matrices, and Determinants (Ch. 2) Triangular Systems of Equations (Ch. 3)
3 [Jan. 22 - 26]	Matrix Multiplication (Ch. 4)
4 [Jan. 29 - Feb. 2]	LU - Factorization (Ch. 5)
5 [Feb. 5 - 9]	Determinants of a Matrix Product, Matrix Inverses, Matrix Transposes, and Permutation Matrices (Ch. 6) The Vector Space $\mathbb{R}^n$: Part 1 (Ch. 7)
6 [Feb. 12 - 16]	The Vector Space $\mathbb{R}^n$: Part 1 (Ch. 7)
7 [Feb. 19 - 23]	Euclidean Norm, Least Squared Error Solutions to Linear Equations, and Linear Regression (Ch. 8)
8 [Feb. 26 - Mar. 1]	**BREAK**
9 [Mar. 4 - 8]	The Vector Space $\mathbb{R}^n$: Part 2 (Ch. 9)
10 [Mar. 11 - 15]	The Vector Space $\mathbb{R}^n$: Part 2 (Ch. 9)
11 [Mar. 18 - 22]	The Vector Space $\mathbb{R}^n$: Part 3 (Ch. 10)
12 [Mar. 25 - 29]	Solutions of Nonlinear Equations (Ch. 11)
13 [Apr. 1 - 5]	Basic Ideas of Optimization (Ch. 12)
14 [Apr. 8 - 12]	Background for Classification and Machine Learning (Ch. 13)
15 [Apr. 15 - 19]	*No new topics*
16 [Apr. 22 - 23]	N/A

>> VIEW HERE FOR DETAILED COURSE PLAN INCLUDING ASSIGNMENT DUE DATES <<

Math 214 Syllabus

Description

Math 214 provides an introduction to matrices and linear algebra. This course covers the basics needed to understand a wide variety of applications that use the ideas of linear algebra, from linear programming to mathematical economics. The emphasis is on concepts and problem solving.

The sequence 214-215 is not intended for math majors. It is designed as an alternative to the sequence 215-216 for engineering students who need more linear algebra and less differential equations background. The linear algebra course that is intended as preparation for the math degree is Math 217.

Webpage

The webpage for the course will be http://www.math.lsa.umich.edu/courses/214/.

Resources

Section

Section meets for four hours a week. Sections will be interactive and should provide useful perspectives, context and reformulations of the course material; we strongly encourage you to attend. This term, we have built specific rewards for section attendance into the grading system; see section attendance below.

Office hours

Each instructor will hold three hours of office hours each week. Here is the schedule of office hours. Any student is welcome to attend office hours with any instructor.

Course Text

Linear algebra with applications by Otto Bretscher, 5th Edition. There are several different ISBNs which all correspond to the same text book: We know of 978-0-321-79694-2, 978-0-321-79697-7 and 978-0-321-91691-4, and there may be others as well. Any book labeled as 5th edition is fine.

We intend to cover 1.1–3.4, 5.1–5.4 and 6.1–6.3, 7.1–7.5, 8.1 and 8.3. We will use the textbook to assign readings, as a source of problems to discuss in class, and as a source of homework problems.

Videos

The course coordinator, David Speyer, recorded lecture videos for the entire course in Fall 2020, when the course was entirely online. These videos are available online and are an optional but recommended resource.

Work expected

Students enrolled in Math 214 are expected to read the appropriate portions of the textbook. They are expected to turn in the weekly written homework and WebWork and to work in groups on the two applied projects and the final presentation. They are expected to pass the Gateway exam and to take the two midterm exams and the final exam.

Exams

This course has two evening midterm exams and a final exam. See the exams page for more on exam policies and dates. Students should make sure that they will be available, in Ann Arbor, to take the exams at the scheduled dates and times.

This course also has a "Gateway exam", a computer administered exam on basic computational material from the first Chapter of the book/first week of class. Students have many opportunities to pass this exam but must do so by January 22. Students who do not pass the Gateway by this deadline will recieve a penalty of 1/3 of a letter on their final grade (A becomes A-, A- becomes B+, etcetera.) See for more information on the Gateway.

Students in need of accomodations for a disability must provide documentation from the Services for Students with Disabilities (SSD) office. Students should provide that documentation as soon as possible; students providing documentation less than one week before an exam may be refused.

Projects

A significant portion of your grade will be derived from two group projects. Each of these projects will guide you through an applications of linear algebra.

After these, the class will conclude with one final group project; a presentation on an application of your choice. These presentations will take place during the final class days of the semester, primarily at the scheduled class times.

More information about the projects will be provided here.

Written homework

On most weeks, there will be a homework assignment consisting of problems from the textbook. It will be due on **Thursday night at 11:59 PM**.

The assignment will be turned in and returned through Gradescope. Click here to log into Gradescope.

Webwork

On most weeks, there will be a WeBWorK assignment, administered online. The assignment will contain routine computations on the material studied that week. It will be due on **Thursday night at 11:59 PM**.

The assignment will be administered automatically through the WeBWork system. Click here to log into WeBWork.

Section attendance

Students are expected to attend sections in person and, when there, to interact with the course material and their fellow students. The schedule of sections can be found here. Missing section occasionally for medical reasons or for sporadic commitments is fine, but the course is taught on the assumption that you will usually be present and learning in your classroom. Of course, if you are ill, please stay home and please contact your instructor or fellow students for notes.

We will add bonus points for section attendance. We will give 0.5 points toward the final course grade (see "grade apportionment" below) for each week in which students attend for at least two hours (so one two-hour section or two one-hour sections), starting with the week of January 9-13 and ending with the week of April 17-18, up to a maximum of 5 points (10 weeks). Attendance will be taken in section to this purpose.

We are not going to implement a system of excused absences or a special system for students who add the course late. There are 14 weeks in the term (not counting Jan 4-6, before the system starts); this means there are already 4 weeks of exceptions built in.

Students may occasionally attend sections other than their own; we will merge all sections before comuting attendance points so this is not something you need to explicitly tell us about. Students planning to regularly attend a section other than their own should inform the course coordinator; this will probably be fine but we may need to limit it if too many people move.

Academic Integrity

As the LSA Community Standards of Academic Integrity says, "The LSA undergraduate academic community, like all communities, functions best when its members treat one another with honesty, fairness, respect, and trust... the College promotes the assumption of personal

responsibility and integrity and prohibits all forms of academic dishonesty and misconduct. Academic dishonesty may be understood as any action or attempted action that may result in creating an unfair academic advantage for oneself or an unfair academic advantage or disadvantage for any other member or members of the academic community." **By enrolling in this course, students commit to not use inappropriate resources which would provide them with unfair advantages.**

On **homework assignments**, you may collaborate with other students in Math 214, but you must understand the work you turn in and write it in your own words. You may similarly collaborate on WeBWork, but must be involved in all the computations you submit. On **group projects**, you are of course expected to collaborate with your group, and may ask members of other groups for ideas. Your instructors are also glad to provide help; see here for a list of office hours. If you seek help from mathematicians or students outside the course, you should be seeking general advice, not specific solutions, and must disclose this help. Math problems are often called "exercises"; note that you cannot get stronger by watching someone else exercise!

You **MAY NOT** post homework problems to internet websites seeking solutions. You may post questions asking for clarifications and alternate perspectives on concepts and results we have covered. Students whose solutions are extremely similar to solutions posted on internet websites may find their work closely scrutinized for signs of plagiarism on future assignments.

On **exams**, you may not seek help from any other person, or from any resource other than those expressly permitted. You also **may not provide such help** to any other student in the course, and you **may not distribute exam questions to any other person, or upload them to websites**.

Grade apportionment

A numeric score will be computed by the following formula. This formula may be modified for certain individuals to address unusual circumstances. In rare cases to compensate for unusual circumstances.

- **Midterm 1**: 20 points toward final grade
- **Midterm 2**: 20 points toward final grade
- **Final exam**: 20 points toward of final grade
- **First two group projects**: 5 points toward final grade each (10 points total)
- **Final project**: 10 points toward final grade
- **Homework**: 10 points toward final grade, lowest two will be dropped
- **WeBWorK**: 10 points toward final grade, lowest two will be dropped
- **Attendance bonus points**: 5 points toward toward final grade

Note that this adds up to 105 points available, with 100 points available if you don't count attendance. This is our attempt to compromise between "we are not requiring you to attend section" and "but it would certainly be a good idea".

That score will then be converted to a letter grade. We expect that the conversions between numbers and grades will be given by the following table. **We will not use a curve more harsh than this. If you have a score of 95%, you will receieve at least an A, no matter how many of your class mates do similarly.**

A+	score ≥ 97
A	97 > score ≥ 93
A-	93 > score ≥ 90
B+	90 > score ≥ 87
B	87 > score ≥ 83
B-	83 > score ≥ 80
C+	80 > score ≥ 77
C	77 > score ≥ 73
C-	73 > score ≥ 70
D+	70 > score ≥ 67
D	67 > score ≥ 60
E	60 > score

In past terms, our cut offs have been very close to these and we have not needed much of a positive curve. Particularly in the A and B ranges, students should expect the cutoffs to be as above, and be pleasantly surprised if they do a bit better.

Students who do not pass the Gateway exam will recieve a penalty of 1/3 of a letter on their final grade (A becomes A-, A- becomes B+, etcetera.)

A note for those who like to be mathematically precise: First of all, good for you! This is a good course for people like you! When combining WeBWorK or homework grades, the grades will first all be rescaled to be out of the same number of points, then the lowest rescaled scores will be dropped, and then the grades will be combined. For example, suppose your homework grades are 32/40, 72/75, 30/30, 40/50 and 72/80. These would be converted to 32/40 = 80%, 72/75 = 96%, 30/30=100%, 44/50=88% and 76/80 = 95%. The lowest two, 80% and 88%, would be dropped, and we would then take the average of the others to get a combined grade of (96%+100%+95%)/3 = 97%. All computations are done without rounding.

11 September 2024

CoE Curriculum Committee

Subject: NERS BSE Degree Modification

Dear CoE Curriculum Committee:

The Department of Nuclear Engineering & Radiological Sciences requests a degree modification to the Nuclear Engineering and Radiological Sciences B.S.E degree program. We request this modification take effect for students entering the program beginning in Fall 2025. We will work with current Nuclear Engineering & Radiological Sciences students on a case-by-case basis if any substitutions/approvals are needed to ensure that the student's time to graduation is not delayed. The requested modifications will provide students the necessary mathematical foundation to be successful in the Nuclear Engineering & Radiological Sciences B.S.E. degree program.

Modification Requests (2):

1) Math 216 to be removed from the CoE Common Requirements and replaced by NERS 320; making the CoE Common Core Math Requirements for NERS BSE students: Math 115, Math 116, Math 215, and NERS 320.

NERS 320 Description: Applied linear algebra, ordinary differential equations, systems of ordinary differential equations, Laplace transforms, basic numerical methods, differential and integral vector calculus, curvilinear coordinates. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.

Rationale: The NERS department is adding an additional math course to the NERS BSE degree requirements (NERS 420). We're modifying NERS 320, as this course will be a prerequisite to NERS 420.

2) NERS 420 is added to the list of required NERS Program Subjects

NERS 420 Description: Fundamentals of probability, partial differential equations, complex numbers, integration in the complex plane, Fourier and Laplace transforms, special functions. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.

Rationale: NERS 420 is meant to serve as a second course as part of a two-part sequence, with NERS 320 being the first one. The goal of this sequence is to provide engineering students with a solid background in the mathematical techniques encountered in engineering along with practical applications. Currently there is no course at UM that teaches this focused combination of topics nor do they provide useful context for engineering students.

Thank you for your consideration.

Todd Allen
Glenn F. and Gladys H. Knoll Department Chair of Nuclear Engineering and Radiological Sciences

Nuclear Engineering and Radiological Sciences Sample Schedule

	Total Credit Hours	Term: 1	2	3	4	5	6	7	8
Subjects required by all programs (51 hours)									
Mathematics 115, 116, 215, and NERS 320	12	4	4	4	4	-	-	-	-
Engr 100, Intro to Engr[1]	4	4	-	-	-	-	-	-	-
Engr 101, Intro to Computers	4	-	4	-	-	-	-	-	-
Chemistry 125/126 and 130 or Chemistry 210 and 211[2]	5	5	-	-	-	-	-	-	-
Physics 140 with Lab 141; Physics 240 with Lab 241[3]	10	-	5	5	-	-	-	-	-
Intellectual Breadth	16	4	4	4	-	-	4	-	-
Related Technical Subjects (11 hours)									
MATSCIE 250, Princ of Eng Materials or MSE 220, Intro to Materials and Manf	4	-	-	-	4	-	-	-	-
EECS 215, Intro to Circuits or EECS 314,Electrical Circuits, Systems, and Applications	4	-	-	-	-	4	-	-	-
MECHENG 235, Thermodynamics I	3	-	-	-	-	3	-	-	-
Program Subjects (49 hours)									
NERS 250, Fundamentals of Nuclear Eng and Rad Sci	4	-	-	-	4	-	-	-	-
NERS 311, Ele of Nuc Eng & Rad Sci I	3	-	-	-	-	3	-	-	-
NERS 312, Ele of Nuc Eng & Rad Sci II	3	-	-	-	-	-	3	-	-
NERS 315, Nuclear Instr Lab	4	-	-	-	-	-	4	-	-
NERS 344, Fluid Mech Nucl Eng	3	-	-	-	-	-	3	-	-
NERS 420, Applied Mathematics for Engineering Physics II	4				-	4			
NERS 441, Nuclear Reactor Theory I	4	-	-	-	-	-	-	4	-
NERS 444, Fundamentals of Heat and Mass Transfer								3	
Laboratory Course (above NERS 315)[4]	4	-	-	-	-	-	-	-	4
NERS 491, Nuclear Engineering and Radiological Sciences Design I	1	-	-	-	-	-	-	1	-
NERS 492, Nuclear Engineering and Radiological Sciences Design II	3	-	-	-	-	-	-	-	3
NERS Electives[5]	12	-	-	-	-	-	-	3	6
Electives (17 hours)									
Technical Electives (5 hours)[6]	5	-	-	-	-	2	-	-	3
General Electives (12 hours)	12	-	-	3	3	-	3	3	-
Total	***128***	***17***	***17***	***16***	***15***	***16***	***17***	***14***	***16***

effective: Fall 2025

Candidates for the Bachelor of Science Degree in Engineering in Nuclear Engineering and Radiological Sciences - B.S.E. in N.E.R.S. - must complete the program listed above.
This sample schedule is an example of one leading to graduation in eight terms.
Notes:

[1] EECS 180 credit (Exam/Transfer Introductory Computer Programming) will not meet the programming requirement on its own. Students must also select from: Engr 101, Engr 151, Engr 161, or EECS 280.

[2] If you have a satisfactory score or grade in Chemistry AP, A-Level, IB Exams or transfer credit from another institution for Chemistry 125/126/130 you will have met the Chemistry Core Requirement for the College of Engineering.

[3] If you have a satisfactory score or grade in Physics AP, A-Level, IB Exams or transfer credit from another institution for Physics 140/141 and Physics 240/241 you will have met the Physics Core Requirement for the College of Engineering.

[4] Laboratory course, (above NERS 315) select one of the following: NERS 425, 535, 575, 586.

[5] One course must be selected from the following: NERS 421, 471, and NERS 484. A maximum of 3 credit hours of independent study (NERS 499) can count as a NERS elective. All additional NERS 499 credits beyond those 3 credits can only be counted as a general elective.

[6] Technical electives are defined as: 300-level and above Mathematics, Physics, or non-NERS engineering courses. Content must be technical. All subsitutions must be approved by the faculty advisor.

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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: 2024-08-22
Effective Term: Winter 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: 517	Dept (Home): Biomedical Engineering Subject: BIOMEDE Catalog: 517
☑	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Robotics - ROB - 517
☐	Course Title (full title) Sensing & Machine Learning for Neural Interfaces	Course Title (full title) Sensing & Machine Learning for Neural Interfaces
☐	Abbreviated Title (20 char) Neural Engr	Abbreviated Title (20 char) Neural Engr
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Focuses on techniques for interfacing with the human nervous system to obtain control signals for assistive technologies. Students first implement quantitative models of neural recording and stimulation. Then students apply machine learning techniques to extract control signals from large neural datasets. This course has a flipped format with classtime dedicated to help with code implementation. Real datasets from brain machine interfaces and nerve/muscle controlled prostheses will be used throughout the course.	
☑	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: Biomedical Engineering Catalog: 517

☐

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) [(BIOMEDE 211 or EECS 215 or EECS 314) and (EECS 216) and (MATH 216) and (ENGR 101 or EECS 183 or EECS 180 or EECS 280); (B> for all courses, no optional pass/fail)] or Graduate Standing Minimum Grade Requirement: B	Enforced Prerequisite (254 char) [(BIOMEDE 211 or EECS 215 or EECS 314) and (EECS 216) and (MATH 216) and (ENGR 101 or EECS 183 or EECS 180 or EECS 280); (B> for all courses, no optional pass/fail)] or Graduate Standing Minimum Grade Requirement: B
☐	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: Cynthia Chestek Cognizant Faculty Member Title:

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

Contact Person: Chris Mueller Email: muchris@umich.edu Phone: 734 647 8040

CoE Curriculum Committee Representative:	Zhongming Liu	Print: Zhongming Liu	Date: 08/22/2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Ariella Shikanov	Print: Ariella Shikanov	Date: 08/18/2024
Cross-Listed Department Chair:		Print: Dawn Tilbury	Date: 8-20-2024
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Focuses on techniques for understanding and interacting with the nervous system. Students first implement quantitative models of neurons followed by models of recording and stimulation. Next students apply machine learning techniques to extract information from large neural datasets.	Course Description Focuses on techniques for interfacing with the human nervous system to obtain control signals for assistive technologies. Students first implement quantitative models of neural recording and stimulation. Then students apply machine learning techniques to extract control signals from large neural datasets. This course has a flipped format with classtime dedicated to help with code implementation. Real datasets from brain machine interfaces and nerve/muscle controlled prostheses will be used throughout the course.
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)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
Elective Course for BME and Robotics students

Special resources of facilities required for this course:

Supporting statement:
This course has been offered every Winter semester but one since 2015, originally as a special topics course and then as BME 517. Neuroprosthetics or neurorobotics refers to prosthetic devices controlled by neural signals from the body. This is a growing field and sits between BME and Robotics, where robotic prostheses are a major topic of study. This topic is of strong interest to both BME students interested in neural interfaces and to Robotics students interested in assistive technologies and prosthetics. Each semester for the past few years has included graduate students from both departments. The course focuses on signal processing techniques for acquiring noisy and small neural signals from the body as well as a variety of machine learning algorithms used to control a prosthetic device from neural signals in real time. The course is taught in a flipped format in the computer lab, with students working through computational lab modules. At the end of the course there is a final project that is chosen by the students, using one or more of the techniques introduced in the class. The cognizant faculty works in this area, and has a nonzero appointment in both BME and Robotics.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
Phone: 734.763.2113
Fax: 734.936.3148
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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: 2024-03-19
Effective Term: Winter 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: 415		
	☐ Course is Cross-Listed with Other Departments			☑ Course is Cross-Listed with Other Departments		
☑	Department	Subject	Catalog Number	Department	Subject	Catalog Number
				Nuclear Engineering & Radiological Sciences - NERS - 471		
☑	Course Title (full title)			Course Title (full title) Introduction to Plasmas and Fusion		
☑	Abbreviated Title (20 char)			Abbreviated Title (20 char) Intro to Plasmas		
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Wave phenomena in plasmas. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices and applications, including fusion and plasma materials semiconductor processing. Introduction to plasma kinetic theory.					
☑	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					
☐	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	Add Consent	Drop Consent
☑	☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only	☐ Department Consent ☐ Instructor Consent ☑ No Consent	☐ Department Consent ☐ Instructor Consent ☑ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) Physics 240 or 260 and junior standing (or by permission)
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

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

Cognizant Faculty Member Name: Ryan McBride 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: Achilleas Anastasopoulos Print: Achilleas Anastasopoulos Date: 3/19/24

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Shai Revzen Print: Shai Revzen for ECE chair Date: 2024-04-01

Cross-Listed Department Chair: Todd Allen Print: Todd R Allen Date: 19 Mar 24

Cross-Listed Department Chair: Print: Date:

Cross-Listed Department Chair: Print: Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description	Course Description Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Wave phenomena in plasmas. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices and applications, including fusion and plasma materials semiconductor processing. Introduction to plasma kinetic theory.
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:
Cross-listed dept

Describe how this course fits with the degree requirements:
This is an EE elective for the BSE EE program.

Special resources of facilities required for this course:

Supporting statement:
The vast majority of hardware topics associated with ECE rely on plasma materials processing. Essentially all microelectronics devices, quantum devices, optical devices and MEMS devices depend in part or in whole on plasma etching, deposition, passivation and implantation for their fabrication. It is therefore in students' best interest to provide opportunities to learn about the fundamental plasma processes upon which their discipline relies. Since a large fraction of our undergraduates will be employed in the semiconductor fabrication industry which relies on plasma processing, having instruction in these fundamentals would be advantageous to future employment. To date, there is no course offering for undergraduates in ECE that addresses these fundamental processes. (EECS 517 addresses the fundamentals at a graduate level.) NERS 471 is the introductory plasma course for NERS undergraduates that addresses plasma fundamentals and applications. Cross listing NERS 471 as EECS 415 provides this valuable learning opportunity for ECE students while receiving elective credit.

Nuclear Engineering and Radiological Sciences 471
Introduction to Plasmas and Fusion
Fall Term 2022

Instructor: Professor Ronald M. Gilgenbach
Graduate Student Instructor: Levi Welch
Grader: Ryan Revolinsky
Lectures: In person in Cooley Room G906
Faculty Lectures: Tuesdays & Thursdays, 10:30AM-11:50AM
Faculty Office Hours: after class until 1:00 or arrange phone/Zoom meetings by e-mail
Faculty Phone: 763-1261, Please leave a message if I am not in.
Faculty e-mail: rongilg@umich.edu
Graduate Student Instructor e-mail: leviw@umich.edu
GSI Discussion session: to be arranged
GSI Office Hours: to be arranged
Grader e-mail: revolins@umich.edu

Required Reading

1) F.F. Chen, Introduction to Plasma Physics and Controlled Fusion, Springer, ISBN 978-3-319-22308-7; Available in electronic format from UM Library:
https://link-springer-com.proxy.lib.umich.edu/content/pdf/10.1007/978-3-319-22309-4.pdf
2) A.A. Harms, K.F. Schoepf, G.H. Miley, and D.R. Kingdon, Principles of Fusion Energy, World Scientific, 2000, ISBN 978-981-02-4335-7
Chapters available in electronic format from UM Library:
https://ebookcentral-proquest-com.proxy.lib.umich.edu/lib/umichigan/detail.action?docID=183764#goto_toc

Optional Reading

1) J.L. Shohet, The Plasma State, Academic Press, 1971
2) T.J.M. Boyd and J.J. Sanderson, Plasma Dynamics, Thomas Nelson and Sons, 1969
3) S. Ramo, J.R. Whinnery and T. Van Duzer, Fields and Waves in Communication Electronics, (3rd Edition) 1994, Wiley, ISBN-13: 9780471585510

Grades:

Grades will be determined by the following formula:

homework assignments	*35%*
midterm exam	*30%*

final exam	*35%*
	100%

NERS471 Syllabus

Homework

You may work with each other on the homework assignments, but the solution sets that you turn in must be written up on your own (i.e., no copying!). Use of computer tools, such as MATLAB and Mathematica, are encouraged; these may be used for generating plots, solving algebraic equations, solving differential equations, etc. Problem sets that are submitted after they are due (without having made prior arrangements with me to do so) will incur an initial 10% reduction in score, plus an additional 10% reduction for each additional week that they are late (2% per weekday). Students are expected to adhere to the University of Michigan's policy on academic integrity and the Honor Code as defined by the Engineering Honor Council:

https://elc.engin.umich.edu/honor-council/

Exams:
Midterm Exam: in class, closed book and 2-notesheets allowed
Final Exam: Will be given online through Canvas. Open book and open notes; no collaboration
Starts at 1:30 PM on Wednesday, December 14

Students Requiring Accommodations: Students that have documented disabilities and require academic accommodations should make an appointment to discuss their needs with the course instructor. Students must contact the Services for Students with Disabilities:
ssd.umich.edu (Links to an external site.)
to verify their eligibility for appropriate accommodations.

- **Inclusion Statement:** It is my 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. I 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. If you have any questions or concerns regarding Diversity, Equity, and Inclusion you may contact the DEI leads in your home department www.engin.umich.edu/about/diversity/faculty/dei-department-leads/ (Links to an external site.)

In addition, I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

Student Resources: If you require additional resources please contact the Office of Student Support and Accountability, ossa.engin.umich.edu (Links to an external site.)or engin-support@umich.edu.
In addition, if you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. You can learn more about the broad range of confidential mental health services available on campus viacaps.umich.edu/mitalk (Links to an external site.)

See next page....

NERS471 Course Outline
Fall 2022
Prof. R. M. Gilgenbach
(Required Reading Assignments)

1) Introduction to Fusion and Plasma Concepts
(Chen, Ch. 1; Harms Chs. 1, 2, 3.1-3.4)
Intro to fusion and plasma applications (slides)
plasma definition, velocity distribution functions, Maxwellian distribution
Review of electricity and magnetism
Rutherford/ Coulomb Scattering
concepts of temperature
Debye shielding

2) Single Charged Particle Motion (ch. 2 of Chen)
Review of Lorentz Force and Maxwell's equations
motion of charged particles in E and B fields
guiding center theory and drift equations
adiabatic invariants
applications to magnetic mirrors

3) Introduction to Fluid Plasma Theory (ch. 3 of Chen)
Boltzmann equation and moments of Boltzmann equation
two-fluid model
single-fluid model
magnetohydrodynamic (MHD) theory

4) Plasma Waves (ch. 4 of Chen; Appendix B of Chen)
review of Maxwell's equations
classification of waves: longitudinal, transverse
dispersion relations and characteristic frequencies: plasma, cyclotron, upper hybrid, lower hybrid
waves in magnetized plasmas, extraordinary, ordinary, circularly polarized, linearly polarized
MHD waves

5) Diffusion (ch. 5 of Chen)
Diffusion and mobility in weakly ionized plasmas
collision cross section, mean free path, collision frequency
particle flux, Fick's law

diffusion coefficients: ambipolar, classical, Bohm

6) Equilibrium and Stability (Ch. 6 of Chen)

7) Introduction to Kinetic Theory (Ch. 7 of Chen)
Moments of the Boltzmann equation

8) Fusion Reactions (Ch. 1, 10 of Chen; Chs. 3-5 of Harms)
deuterium-deuterium and deuterium-tritium reactions
reaction cross sections, reaction rates
fusion power generation
plasma radiation mechanisms: bremsstrahlung, cyclotron radiation. Effect of impurities on radiation losses
ignition temperature for fusion reactors
Lawson criterion

9) Nonlinear Effects (Ch. 8 of Chen)

10) Other Plasma Applications (Ch. 9 of Chen and slides)

University of Michigan
Fall 2023 Instructor Report
NERS 471-001: Int Plasmas-Fusn
Carolyn Kuranz

13 out of 37 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	6	0	0	1	0	4.4	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	4	5	1	3	0	0	4.0	4.2	4.2
I knew what was expected of me in this course.(Q1633)	8	5	0	0	0	0	4.7	4.4	4.5
I had a strong desire to take this course.(Q4)	6	4	3	0	0	0	4.4	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)	0	6	5	1	0	1	3.5	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
Carolyn Kuranz seemed well prepared for class meetings.(Q230)	10	2	0	1	0	0	4.9	4.7	4.8
Carolyn Kuranz explained material clearly.(Q199)	8	3	1	1	0	0	4.7	4.6	4.7
Carolyn Kuranz treated students with respect.(Q217)	11	2	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)	4	4	4	0	1	0	3.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Carolyn Kuranz was an excellent teacher. (Q2)	8	3	1	1	0	0	4.7

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 upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2022 Instructor Report
NERS 471-001: Int Plasmas-Fusn
Ronald Gilgenbach

13 out of 36 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	4	2	1	0	0	4.4	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	5	4	3	0	1	0	4.1	4.2	4.2
I knew what was expected of me in this course.(Q1633)	7	3	1	2	0	0	4.6	4.6	4.4
I had a strong desire to take this course.(Q4)	6	5	1	0	1	0	4.4	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	3	8	1	0	0	3.2	3.0	2.8

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Ronald Gilgenbach seemed well prepared for class meetings.(Q230)	9	3	1	0	0	0	4.8	4.8	4.8
Ronald Gilgenbach explained material clearly.(Q199)	7	1	4	1	0	0	4.6	4.7	4.7
Ronald Gilgenbach treated students with respect.(Q217)	11	1	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)	7	1	4	0	1	0	4.6

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Ronald Gilgenbach was an excellent teacher. (Q2)	7	3	1	2	0	0	4.6

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 upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2021 Instructor Report With Comments
NERS 471-001: Int Plasmas-Fusn
Carolyn Kuranz

9 out of 25 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)	5	4	0	0	0	0	4.6	4.2	4.2
I knew what was expected of me in this course.(Q1633)	6	3	0	0	0	0	4.8	4.5	4.4
I had a strong desire to take this course.(Q4)	5	4	0	0	0	0	4.6	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	3	6	0	0	0	3.3	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
Carolyn Kuranz seemed well prepared for class meetings.(Q230)	8	0	1	0	0	0	4.9	4.8	4.7
Carolyn Kuranz explained material clearly.(Q199)	7	2	0	0	0	0	4.9	4.7	4.7
Carolyn Kuranz treated students with respect.(Q217)	9	0	0	0	0	0	5.0	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)	8	1	0	0	0	0	4.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Carolyn Kuranz was an excellent teacher. (Q2)	8	1	0	0	0	0	4.9

The medians are calculated from Fall 2021 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 2020 Instructor Report With Comments
NERS 471-801: Int Plasmas-Fusn
Ronald Gilgenbach

11 out of 24 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)	9	1	1	0	0	0	4.9	4.6	4.5
My interest in the subject has increased because of this course. (Q1632)	8	2	1	0	0	0	4.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	8	3	0	0	0	0	4.8	4.5	4.4
Overall, this was an excellent course.(Q1)	7	4	0	0	0	0	4.7	4.4	4.3
I had a strong desire to take this course.(Q4)	5	5	1	0	0	0	4.4	4.1	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	4	6	0	0	0	3.4	2.9	2.8
How did you participate in this course? (Q1854)	7	4	0	0	0	0	4.7	4.7	4.5

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Overall, Ronald Gilgenbach was an excellent teacher.(Q2)	5	5	1	0	0	0	4.4	4.7	4.7
Ronald Gilgenbach seemed well prepared for class meetings.(Q230)	10	1	0	0	0	0	5.0	4.8	4.7
Ronald Gilgenbach explained material clearly.(Q199)	5	6	0	0	0	0	4.4	4.7	4.7
Ronald Gilgenbach treated students with respect.(Q217)	9	2	0	0	0	0	4.9	4.9	4.8

The medians are calculated from Fall 2020 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.

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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: 2024-05-08
Effective Term: Winter 2025

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 461	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 461
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Manufacturing - MFG - 461	Manufacturing - MFG - 461
☐	Course Title (full title) Quality Engineering Principles and Analysis	Course Title (full title) Quality Engineering Principles and Analysis
☑	Abbreviated Title (20 char) Qual Engin Prin	Abbreviated Title (20 char) Qual Engin Prin Anys
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Provides students with the analytical and management tools necessary to solve manufacturing quality problems and implement effective quality systems. Topics include voice of the customer analysis, the Six Sigma problem solving methodology, process capability analysis, measurement system analysis, design of experiments, statistical process control, failure mode and effects of analysis, quality function deployment and reliability analysis.	
☐	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, 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: Industrial & Operations Engin Catalog: 461

☐

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) Enforced)=IOE 366; C- or better or graduate standing.	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char) IOE 366; C- or better or Graduate Standing Minimum grade requirement: C-	Enforced Prerequisite (254 char) IOE 366; C- or better or Graduate Standing Minimum grade requirement: C-
☑	Credit Exclusions Not for IOE Graduate Credit	Credit Exclusions Not for IOE Graduate Credit, Students may earn a maximum of 6 credits from IOE 461, IOE 465, and IOE 466.

☐

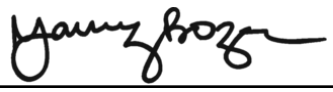
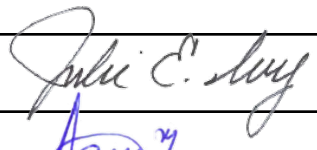
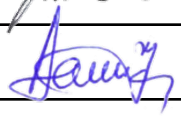
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Judy Jin Cognizant Faculty Member Title: Professor

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

Contact Person: Leonora Lucaj Email: lucajl@umich.edu Phone: 734-764-3297

CoE Curriculum Committee Representative: Yavuz Bozer		Print:		Date: 09/05/24
CoE Curriculum Committee Chair:		Print:		Date:
Home Department Chair: Julie Ivy		Print:	Julie Simmons Ivy	Date: 09/05/24
Cross-Listed Department Chair:		Print:	Miki Banu	Date: 09/06/24
Cross-Listed Department Chair:		Print:		Date:
Cross-Listed Department Chair:		Print:		Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description This course provides students with the analytical and management tools necessary to solve manufacturing quality problems and implement to solve manufacturing quality problems and implement effective quality systems. Topics include voice of the customer analysis, the Six Sigma problems solving methodology, process capability analysis, measurement system analysis, design of experiments, statistical process control, failure mode and effects analysis, quality function deployment, and reliability analysis.	Course Description This course provides students with the analytical and management tools necessary to solve manufacturing quality problems and implement effective quality systems. Topics include voice of the customer analysis, the Six Sigma problem solving methodology, process capability analysis, measurement system analysis, design of experiments, statistical process control, failure mode and effects of analysis, quality function deployment and reliability analysis.
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:
This is an IOE Tech Elective.

Special resources of facilities required for this course:

Supporting statement:
Students may earn a maximum of 6 credits from IOE 461, 465, and 466 and this needs to be reflected in Wolverine Access and students' audits so we must start with a CARF.

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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: 2024-05-08
Effective Term: Winter 2025

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 465	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 465
☐	☐ 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 of Experiments	Course Title (full title) Design of Experiments
☐	Abbreviated Title (20 char) Design of Experiment	Abbreviated Title (20 char) Design of Experiment
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Linear models, multicollinearity and robust regression, comparative experiments, randomized blocks and latin squares, factorial designs, confounding, mixed level fractional factories, random and mixed models, nesting and split plots, response surface methods, Taguchi contributions to experimental design.	
☐	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, 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

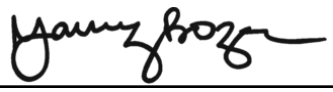
Subject: Industrial & Operations Engin Catalog: 465

☐	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

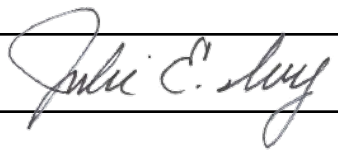
	CURRENT LISTING	**REQUESTED LISTING**
☑	Advisory Prerequisite (254 char) (Enforced)=IOE 366; C- or better or graduate standing.	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char) IOE 366; C- or better or graduate standing Minimum grade requirement: C-	Enforced Prerequisite (254 char) IOE 366; C- or better or graduate standing Minimum grade requirement: C-
☑	Credit Exclusions	Credit Exclusions Students may earn a maximum of 6 credits from IOE 461, IOE 465, and IOE 466.
☐	Course Components ☑ Lecture ☐ Seminar ☐ Recitation ☑ Lab ☐ Discussion ☐ Independent Study Graded Component ☑ ☐ ☐ ☐ ☐ ☐ Terms Typically Offered ☑ Fall ☐ Winter ☐ Spring ☐ Summer ☐ Spring/Summer	
	Cognizant Faculty Member Name: X. Jessie Yang	Cognizant Faculty Member Title: Associate Professor

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

Contact Person: Leonora Lucaj Email: lucajl@umich.edu Phone: 734-764-3297

CoE Curriculum Committee Representative: Yavuz Bozer  Print: Date: 09/05/24

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Julie Ivy  Print: Julie Simmons Ivy Date: 09/05/2024

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 Linear models, Multi-collinarity and rogust regression, comparative experiments, randomized blocks and latin squares, factorial designs, confounding, mixed level fractional factories, random and mixed models, nesting and split plots, response surface methods, Taguchi contributions to experimental design.	Course Description Linear models, multicollinearity and robust regression, comparative experiments, randomized blocks and latin squares, factorial designs, confounding, mixed level fractional factories, random and mixed models, nesting and split plots, response surface methods, Taguchi contributions to experimental design.
Class Length Full term	Class Length Full term
Contact hours (lecture): 2	Contact hours (lecture): 2
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:
This is an IOE Tech Elective.

Special resources of facilities required for this course:

Supporting statement:
Students may earn a maximum of 6 credits from IOE 461, 465, and 466 and this needs to be reflected in Wolverine Access and students' audits so we must start with a CARF.

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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: 2024-05-08
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): Industrial & Operations Engin Subject: IOE Catalog: 466	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 466
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Manufacturing- MFG- 466	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Manufacturing - MFG - 466
☐	Course Title (full title) Statistical Quality Control	Course Title (full title) Statistical Quality Control
☐	Abbreviated Title (20 char) Stat Quality Control	Abbreviated Title (20 char) Stat Quality Control
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Quality improvement philosophies, modeling process quality, statistical process control, control charts for variables and attributes, CUSUM and EWMA, short production runs, multivariate quality control, auto correlation, engineering process control economic design of charts, fill control, precontrol, adaptive schemes, process capability, specifications and tolerances, gage capability studies, acceptance sampling by attributes and variables, international quality standards.	
☐	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: Industrial & Operations Engin Catalog: 466

☐

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) IOE 366 or Stats 401; C- or better or Graduate Standing Minimum grade requirement: C-	Enforced Prerequisite (254 char) IOE 366 or Stats 401; C- or better or Graduate Standing Minimum grade requirement: C-
☑	Credit Exclusions	Credit Exclusions Students may earn a maximum of 6 credits from IOE 461, IOE 465, and IOE 466.

☐

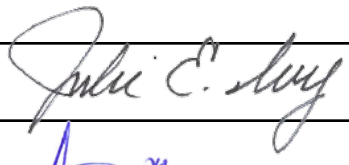
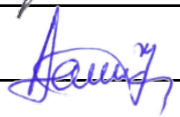
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Judy Jin Cognizant Faculty Member Title: Professor

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

Contact Person: Leonora Lucaj Email: lucajl@umich.edu Phone: 734-764-3297

CoE Curriculum Committee Representative: Yavuz Bozer		Print:	Date: 09/05/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair: Julie Ivy		Print: Julie Simmons Ivy	Date: 09/05/24
Cross-Listed Department Chair:		Print: Miki Banu	Date: 09/06/24
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Quality improvement philosophies; Modeling process quality, statistical process control, control charts for variables and attributes, CUSUM and EWMA, short production runs, multivariate quality control, auto correlation, engineering process control economic design of charts, fill control, precontrol, adaptive schemes, process capability, specifications and tolerances, gage capability studies, acceptance sampling by attributes and variables, international quality standards.	Course Description Quality improvement philosophies, modeling process quality, statistical process control, control charts for variables and attributes, CUSUM and EWMA, short production runs, multivariate quality control, auto correlation, engineering process control economic design of charts, fill control, precontrol, adaptive schemes, process capability, specifications and tolerances, gage capability studies, acceptance sampling by attributes and variables, international quality standards.
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:
This is an IOE Tech Elective.

Special resources of facilities required for this course:

Supporting statement:
Students may earn a maximum of 6 credits from IOE 461, 465, and 466 and this needs to be reflected in Wolverine Access and students' audits so we must start with a CARF.

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Ann Arbor, MI 48109-1382
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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: 2024-08-09
Effective Term: Winter 2025

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Kinesiology Subject: KINESLGY Catalog: 533	Dept (Home): Kinesiology Subject: MOVESCI Catalog: 533
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Biomedical Engineering - BIOMEDE - 533	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Biomedical Engineering - BIOMEDE - 533
☐	Course Title (full title) Neuromechanics	Course Title (full title) Neuromechanics
☐	Abbreviated Title (20 char) Neuromechanics	Abbreviated Title (20 char) Neuromechanics
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) This graduate course examines the structural and physiologic properties of muscle, as well as its force production, and overall biomechanical function. Muscle structure and neuromuscular function will be explored at the neural, protein, single fiber, and whole tissue levels.	
☐	Full Term Credit Hours Undergraduate Min: Undergraduate Max: Graduate Min: 3 Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Undergraduate Max: Graduate Min: 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: Kinesiology Catalog: 533

☐	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) Graduate Standing 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: N/A N/A	Cognizant Faculty Member Title:

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

Contact Person: Chris Mueller Email: muchris@umich.edu Phone: 734 647 8040

CoE Curriculum Committee Representative:	Rachael Schmedlen	Print: Rachael Schmedlen	Date: 8/19/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Dean M. Gates	Print: Deanna Gates	Date: 8/9/2024
Cross-Listed Department Chair:	Ariella Shikanov	Print: Ariella Shikanov	Date: 08/08/2024

Cross-Listed Department Chair: Print: Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description This graduate course examines the structural and physiologic properties of muscle, as well as its force production, and overall biomechanical function. Muscle structure and neuromuscular function will be explored at the neural, protein, single fiber, and whole tissue levels.	Course Description This graduate course examines the structural and physiologic properties of muscle, as well as its force production, and overall biomechanical function. Muscle structure and neuromuscular function will be explored at the neural, protein, single fiber, and whole tissue levels.
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:
Cross-listed dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
Kinesiology has requested an update to the course subject (KINESLGY to MOVESCI) in order to keep it in line with their curriculum standards.

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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: 2024-03-12
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): Naval Arch & Marine Engin Subject: NAVARCH Catalog: 470	Dept (Home): Naval Arch & Marine Engin Subject: NAVARCH Catalog: 470
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Manufacturing - MFG - 470	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Manufacturing - MFG- 470
☐	Course Title (full title) Foundations of Ship Design	Course Title (full title) Foundations of Ship Design
☐	Abbreviated Title (20 char) Ship Design	Abbreviated Title (20 char) Ship Design
☐	Course Description (Please limit to 80 words and attach separate sheet if necessary) Organization of ship design. Preliminary design methods for sizing and form; powering, maneuvering, seakeeping estimation; arranging; propulsion; structural synthesis; and safety and environmental risk of ships. Extensive use of design computer environment. Given owner's requirements, students individually create and report the conceptual/preliminary design for a displacement ship.	
☐	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: Naval Arch & Marine Engin Catalog: 470

☐

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) NAVARCH 321, NAVARCH 332, NAVARCH 340. Co-req: NAVARCH 310.	Advisory Prerequisite (254 char) NAVARCH 321, NAVARCH 332, NAVARCH 340. Co-req: NAVARCH 310.
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	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: Nickolas Vlahopoulos Cognizant Faculty Member Title: Professor

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

Contact Person: Email: Phone:

CoE Curriculum Committee Representative:		Print: Yulin Pan	Date: 4/10/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: David R. Dowling	Date: 4/4/24
Cross-Listed Department Chair:	ISD	Print: Mihaela Banu	Date: 04/09/2024
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Organization of ship design. Preliminary design methods for sizing and form; powering, maneuvering, seakeeping estimation; arranging; propulsion; structural synthesis; and safety and environmental risk of ships. Extensive use of design computer environment. Given owner's requirements, students individually create and report the conceptual/preliminary design for a displacement ship.	Course Description Organization of ship design. Preliminary design methods for sizing and form; powering, maneuvering, seakeeping estimation; arranging; propulsion; structural synthesis; and safety and environmental risk of ships. Extensive use of design computer environment. Given owner's requirements, students individually create and report the conceptual/preliminary design for a displacement ship.
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:

Special resources of facilities required for this course:

Supporting statement:
Removing LAB requirement to fit HLC compliance guidelines.

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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: 2024-07-18
Effective Term: Winter 2026

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 320	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 320
☐	☐ 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) Applied Mathematics for Engineering Physics	Course Title (full title) Applied Mathematics for Engineering Physics I
☑	Abbreviated Title (20 char) Applied Mathematics	Abbreviated Title (20 char) Applied Math 1
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Applied linear algebra, ordinary differential equations, systems of ordinary differential equations, Laplace transforms, basic numerical methods, differential and integral vector calculus, curvilinear coordinates. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.	
☐	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: Nuclear Engin & Radiolog Sci Catalog: 320

☐	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) Math 216 or MATH 286/MATH 396. No OP/F. Minimum grade requirement: C	Enforced Prerequisite (254 char) Math 215 or MATH285. No OP/F. 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: Brian Kiedrowski Cognizant Faculty Member Title: Associate Professor

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

Contact Person: Michelle Sonderman Email: mlwhit@umich.edu Phone: 734-936-3130

CoE Curriculum Committee Representative: Won Sik Yang Print: Won Sik Yang Date: 08/13/2024

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Todd Allen Print: Todd Allen Date: 18 July 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 Applied linear algebra, systems of ordinary differential equations, basic numerical methods, vector calculus with curvilinear coordinates, partial differential equations, and fundamentals of probability applied to applications including fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.	Course Description Applied linear algebra, ordinary differential equations, systems of ordinary differential equations, Laplace transforms, basic numerical methods, differential and integral vector calculus, curvilinear coordinates. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.
Class Length Full term	Class Length Full term
Contact hours (lecture): 4	Contact hours (lecture): 4
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:
Required course for all students in BSE NERS program.

Special resources of facilities required for this course:

Supporting statement:
The NERS department is adding an additional math course to the NERS BSE degree requirements (NERS 420). We're modifying NERS 320, as this course will be a prerequisite to NERS 420.

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: 2024-07-08
Effective Term: Fall 2026

☑	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): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 420
☐	☐ 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) Applied Mathematics for Engineering Physics II
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Applied Math II
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Fundamentals of probability, partial differential equations, complex numbers, integration in the complex plane, Fourier and Laplace transforms, special functions. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.	
☑	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) NERS 320 or graduate standing. No OP/F 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: Scott Baalrud Cognizant Faculty Member Title: Associate Professor

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

Contact Person: Michelle Sondeman Email: mlwhit@umich.edu Phone: 734-936-3130

CoE Curriculum Committee Representative: Won Sik Yang Print: Won Sik Yang Date: 08/13/2024

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Todd Allen Print: Todd Allen Date: 18 July 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 Fundamentals of probability, partial differential equations, complex numbers, integration in the complex plane, Fourier and Laplace transforms, special functions. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 4
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:
Required course for all students in the NERS BSE program. NERS 420 introduces students to concepts of mathematics used in subsequent required and elective undergraduate courses in nuclear engineering.

Special resources of facilities required for this course:

Supporting statement:
NERS 420 is meant to serve as a second course as part of a two-part sequence, with NERS 320 being the first one. The goal of this sequence is to provide engineering students with a solid background in the mathematical techniques encountered in engineering along with practical applications. Currently there is no course at UM that teaches this focused combination of topics nor do they provide useful context for engineering students.

Course Syllabus

NERS 420: Applied Mathematics for Engineering Physics II
Fall 2026
University of Michigan

Lectures:
Tuesdays 10:30am – 12:00pm, room #
Thursdays 10:30am – 12:00pm, room #
Fridays 10:30am – 11:30am, room #

Instructor:
Prof. Scott Baalrud
2966A Cooley
(734) 615-5010
baalrud@umich.edu

Instructor Office hours:
Mondays 2:00pm-3:00pm
Wednesdays 9:30am-10:30pm

Instructional Aide:
Julian Kinney
julkin@umich.edu

IA Office hours:
Mondays 5:00-7:00 pm in 1940 Cooley
Wednesdays 6:00-8:00 pm in G906 Cooley

Course website:
Canvas webpage

Course Description:
Fundamentals of probability, properties and methods of solving partial differential equations, complex numbers, integration in the complex plane, Fourier and Laplace transforms with application to solving partial differential equations, special functions. Applications of these methods to problems in fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.

Textbook:
The required text is the course notes developed by Prof. Kiedrowski that are posted to the course Canvas page. These provide all the information required to be successful in this course. However, the following textbook is also recommended:

Arfken, Weber, and Harris, *Mathematical Methods for Physicists: A Comprehensive Guide, 7th Edition*, Elsevier (2013).

Attendance:
Attending lectures is *highly* recommended, but not required.

Recording:
Video recordings of lectures will be posted on the course Canvas page.

Homework:
There will be 11 homework assignments, each due at the beginning of class on the due date (see schedule below). No late homework will be accepted. The lowest scores will be removed, so that the final homework grade will be based only on each student's top 10 scores. The purpose of allowing for a drop is that people sometimes have legitimate excuses for late or excused homework. However, accommodating these requests becomes a burden on the entire class because they must wait to see the homework solutions and questions of fairness arise. The purpose of the drop is to account for legitimate excuses for being tardy on homework: so please do not ask to hand in homework late.

Exams:
Midterm #1 Thursday, October 12
Estimated to cover material from lectures 1-15 and homework assignments 1-5.
Midterm #2 Thursday, November 16
Estimated to cover material from lectures 16-29 and homework assignments 6-9.
Final exam Monday, December 11
½ will cover material from lectures 1-29 and homework assignments 1-9
½ will cover material from lectures 30-40 and homework assignments 10-11

Midterm exams will be held during normal class hours. Students must request permission for a makeup exam at least one week before the originally scheduled exam time. Makeups will only be available for excused absences and must be planned with the instructor on a case-by-case basis. All exams will be closed book and closed notes. Calculators will not be allowed.

Grading:
Homework (total): 20%
Midterm #1: 25%
Midterm #2: 25%
Final exam: 30%

Approximate letter grades will be provided for midterm exams. A status update on approximate letter grades will be provided upon request after midterm #2 is graded.

Programming:
Some homework problems will require coding using MATLAB. Although other languages are common in engineering, the grader will need to test codes submitted for homework and it would be a large burden to allow solutions in multiple languages. We will use MATLAB because most students will have been introduced to it in introductory engineering courses. If MATLAB is new to you, there are several free online resources you can use to learn the basic syntax, such as: https://www.mathworks.com/learn/tutorials/matlab-onramp

Policy on Collaboration:
The homework for this course is designed to help you master your knowledge related to the topics covered during lecture. You may work on the homework problems with others and use online resources. However, each student must submit his or her own solutions. Copying the work of others not acceptable. It is also not acceptable to use solutions of homework assignments from previous years. Any violations of this policy will result in a grade of 0 on the assignment and will be reported to the Engineering Honor Council. Please be aware that practice is required to master the skills needed for this class, and that to do well on exams you will need to work many of these problems multiple times without help. Test your knowledge by doing the homework on your own.

Classroom Environment
Lectures, discussion, and offices hours will all provide a constructive and safe learning environment. Anyone who acts in a way that disrupts such an environment will be asked to leave the class.

Advice:
- *Read before lecture:* You will make most efficient use of your time by reading the associated book sections for a lecture before the lecture occurs. Then lecture can solidify these concepts and allow you to ask questions on any gaps in your understanding. Reading will follow the course notes in order, so reading for a subsequent lecture simply continues where the previous lecture left off.
- *Work extra problems*: Applied math takes practice. Your ability to solve problems will come primarily from your experiences in doing so.
- *Use office hours*. I am here to help!
- *Ask questions*, both of the instructor and your peers.

Student Resources:
- NERS undergraduate advising: Michelle Sonderman (mlwhit@umich.edu)
- Services for students with disabilities: https://ssd.umich.edu
- UM Counseling and Psychological Services: https://caps.umich.edu

Course Schedule:

Date	**Event**
Tuesday, August 29	First day of class
Friday, September 8	Homework 1 due
Friday, September 15	Homework 2 due
Friday, September 22	Homework 3 due
Friday, September 29	Homework 4 due
Friday, October 6	Homework 5 due
Thursday, October 12	Midterm exam 1
Tuesday, October 17	Fall study break
Friday, October 20	Homework 6 due
Friday, October 27	Homework 7 due
Friday, November 3	Homework 8 due
Friday, November 10	Homework 9 due
Thursday, November 16	Midterm exam 2
Thursday, November 23	Thanksgiving break
Friday, November 24	Thanksgiving break
Tuesday, November 28	Homework 10 due
Tuesday, December 5	Homework 11 due
Monday, December 11	Final exam (4:00pm-6:00pm), room TBD

Dates and locations are subject to change as needed.

<u>Estimated</u> Topical Schedule:

Lecture number	Dates	Topic
Lecture 1 - 10	?	Probability
Lectures 11 - 15	?	Fourier and Laplace Transforms
Lectures 16 - 22	?	Partial Differential Equations
Lectures 23 - 31	?	Complex Analysis
Lectures 32 - 35	?	Special Functions
Lectures 36 - 40	?	Special topics (asymptotic methods, group theory)

Topic Index:

5. Special Functions
    a. Bessel Function
    b. Legendre Function
    c. Gamma Function
    d. Polynomial expansions (Hermite, Laguerre and Chebyshev)

6. Special Topics
    a. Group Theory
    b. Asymptotic Methods (method of steepest descents, Pade approximates, continued fraction expansions)

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500 S. State Street
Ann Arbor, MI 48109-1382
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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: 2024-03-18
Effective Term: Winter 2025

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 471	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 471
☑	☐ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
		Electrical and Computer Engineering - EECS - 415
☐	Course Title (full title) Introduction to Plasmas and Fusion	Course Title (full title) Introduction to Plasmas and Fusion
☐	Abbreviated Title (20 char) Intro to Plasmas	Abbreviated Title (20 char) Intro to Plasmas
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Wave phenomena in plasmas. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices and applications, including fusion and plasma materials semiconductor processing. Introduction to plasma kinetic theory.	
☐	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: Nuclear Engin & Radiolog Sci Catalog: 471

☐	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) Preceded or accompanied by Physics 240 or 260	Advisory Prerequisite (254 char) Physics 240 or 260 and junior standing (or by permission).
☐	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: Ryan McBride Cognizant Faculty Member Title: Professor

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

Contact Person: Michelle Sonderman Email: mlwhit@umich.edu Phone: 734-936-3130

CoE Curriculum Committee Representative:	Fei Gao	Print: Fei Gao	Date: 18 March 2024
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Todd Allen	Print: Todd R Allen	Date: 18 March 2024
Cross-Listed Department Chair:	Shai Revzen	Print: Shai Revzen (for ECE chair)	Date: 2024-04-15
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Wave phenomena in plasmas. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices and applications, including fusion. Introduction to plasma kinetic theory.	Course Description Single particle orbits in electric and magnetic fields, moments of Boltzmann equation and introduction to fluid theory. Wave phenomena in plasmas. Diffusion of plasma in electric and magnetic fields. Analysis of laboratory plasmas and magnetic confinement devices and applications, including fusion and plasma materials semiconductor processing. Introduction to plasma kinetic theory.
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:
This is a NERS elective for the NERS BSE program.

Special resources of facilities required for this course:

Supporting statement:
NERS 471 is the introductory plasma course for NERS undergraduates that addresses plasma fundamentals and applications. Cross listing NERS 471 as EECS 415 provides this valuable learning opportunity for ECE students while receiving elective credit.

Nuclear Engineering and Radiological Sciences 471
Introduction to Plasmas and Fusion
Fall Term 2022

Instructor: Professor Ronald M. Gilgenbach
Graduate Student Instructor: Levi Welch
Grader: Ryan Revolinsky
Lectures: In person in Cooley Room G906
Faculty Lectures: Tuesdays & Thursdays, 10:30AM-11:50AM
Faculty Office Hours: after class until 1:00 or arrange phone/Zoom meetings by e-mail
Faculty Phone: 763-1261, Please leave a message if I am not in.
Faculty e-mail: rongilg@umich.edu
Graduate Student Instructor e-mail: leviw@umich.edu
GSI Discussion session: to be arranged
GSI Office Hours: to be arranged
Grader e-mail: revolins@umich.edu

Required Reading

1) F.F. Chen, Introduction to Plasma Physics and Controlled Fusion, Springer, ISBN 978-3-319-22308-7; Available in electronic format from UM Library:
https://link-springer-com.proxy.lib.umich.edu/content/pdf/10.1007/978-3-319-22309-4.pdf
2) A.A. Harms, K.F. Schoepf, G.H. Miley, and D.R. Kingdon, Principles of Fusion Energy, World Scientific, 2000, ISBN 978-981-02-4335-7
Chapters available in electronic format from UM Library:
https://ebookcentral-proquest-com.proxy.lib.umich.edu/lib/umichigan/detail.action?docID=183764#goto_toc

Optional Reading

1) J.L. Shohet, The Plasma State, Academic Press, 1971
2) T.J.M. Boyd and J.J. Sanderson, Plasma Dynamics, Thomas Nelson and Sons, 1969
3) S. Ramo, J.R. Whinnery and T. Van Duzer, Fields and Waves in Communication Electronics, (3rd Edition) 1994, Wiley, ISBN-13: 9780471585510

Grades:

Grades will be determined by the following formula:

homework assignments	*35%*
midterm exam	*30%*

final exam	*35%*
	100%

NERS471 Syllabus

Homework

You may work with each other on the homework assignments, but the solution sets that you turn in must be written up on your own (i.e., no copying!). Use of computer tools, such as MATLAB and Mathematica, are encouraged; these may be used for generating plots, solving algebraic equations, solving differential equations, etc. Problem sets that are submitted after they are due (without having made prior arrangements with me to do so) will incur an initial 10% reduction in score, plus an additional 10% reduction for each additional week that they are late (2% per weekday). Students are expected to adhere to the University of Michigan's policy on academic integrity and the Honor Code as defined by the Engineering Honor Council:

https://elc.engin.umich.edu/honor-council/

Exams:
Midterm Exam: in class, closed book and 2-notesheets allowed
Final Exam: Will be given online through Canvas. Open book and open notes; no collaboration
Starts at 1:30 PM on Wednesday, December 14

Students Requiring Accommodations: Students that have documented disabilities and require academic accommodations should make an appointment to discuss their needs with the course instructor. Students must contact the Services for Students with Disabilities:
ssd.umich.edu (Links to an external site.)
to verify their eligibility for appropriate accommodations.

- **Inclusion Statement:** It is my 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. I 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. If you have any questions or concerns regarding Diversity, Equity, and Inclusion you may contact the DEI leads in your home department www.engin.umich.edu/about/diversity/faculty/dei-department-leads/ (Links to an external site.)

In addition, I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

Student Resources: If you require additional resources please contact the Office of Student Support and Accountability, ossa.engin.umich.edu (Links to an external site.)or engin-support@umich.edu.
In addition, if you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. You can learn more about the broad range of confidential mental health services available on campus viacaps.umich.edu/mitalk (Links to an external site.)

See next page....

NERS471 Course Outline
Fall 2022
Prof. R. M. Gilgenbach
(Required Reading Assignments)

1) Introduction to Fusion and Plasma Concepts
(Chen, Ch. 1; Harms Chs. 1, 2, 3.1-3.4)
Intro to fusion and plasma applications (slides)
plasma definition, velocity distribution functions, Maxwellian distribution
Review of electricity and magnetism
Rutherford/ Coulomb Scattering
concepts of temperature
Debye shielding

2) Single Charged Particle Motion (ch. 2 of Chen)
Review of Lorentz Force and Maxwell's equations
motion of charged particles in E and B fields
guiding center theory and drift equations
adiabatic invariants
applications to magnetic mirrors

3) Introduction to Fluid Plasma Theory (ch. 3 of Chen)
Boltzmann equation and moments of Boltzmann equation
two-fluid model
single-fluid model
magnetohydrodynamic (MHD) theory

4) Plasma Waves (ch. 4 of Chen; Appendix B of Chen)
review of Maxwell's equations
classification of waves: longitudinal, transverse
dispersion relations and characteristic frequencies: plasma, cyclotron, upper hybrid, lower hybrid
waves in magnetized plasmas, extraordinary, ordinary, circularly polarized, linearly polarized
MHD waves

5) Diffusion (ch. 5 of Chen)
Diffusion and mobility in weakly ionized plasmas
collision cross section, mean free path, collision frequency
particle flux, Fick's law

diffusion coefficients: ambipolar, classical, Bohm

6) Equilibrium and Stability (Ch. 6 of Chen)

7) Introduction to Kinetic Theory (Ch. 7 of Chen)
Moments of the Boltzmann equation

8) Fusion Reactions (Ch. 1, 10 of Chen; Chs. 3-5 of Harms)
deuterium-deuterium and deuterium-tritium reactions
reaction cross sections, reaction rates
fusion power generation
plasma radiation mechanisms: bremsstrahlung, cyclotron radiation. Effect of impurities on radiation losses
ignition temperature for fusion reactors
Lawson criterion

9) Nonlinear Effects (Ch. 8 of Chen)

10) Other Plasma Applications (Ch. 9 of Chen and slides)

University of Michigan
Fall 2021 Instructor Report With Comments
NERS 471-001: Int Plasmas-Fusn
Carolyn Kuranz

9 out of 25 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)	5	4	0	0	0	0	4.6	4.2	4.2
I knew what was expected of me in this course.(Q1633)	6	3	0	0	0	0	4.8	4.5	4.4
I had a strong desire to take this course.(Q4)	5	4	0	0	0	0	4.6	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	3	6	0	0	0	3.3	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
Carolyn Kuranz seemed well prepared for class meetings.(Q230)	8	0	1	0	0	0	4.9	4.8	4.7
Carolyn Kuranz explained material clearly.(Q199)	7	2	0	0	0	0	4.9	4.7	4.7
Carolyn Kuranz treated students with respect.(Q217)	9	0	0	0	0	0	5.0	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)	8	1	0	0	0	0	4.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Carolyn Kuranz was an excellent teacher. (Q2)	8	1	0	0	0	0	4.9

The medians are calculated from Fall 2021 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 2020 Instructor Report With Comments
NERS 471-801: Int Plasmas-Fusn
Ronald Gilgenbach

11 out of 24 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)	9	1	1	0	0	0	4.9	4.6	4.5
My interest in the subject has increased because of this course. (Q1632)	8	2	1	0	0	0	4.8	4.2	4.2
I knew what was expected of me in this course.(Q1633)	8	3	0	0	0	0	4.8	4.5	4.4
Overall, this was an excellent course.(Q1)	7	4	0	0	0	0	4.7	4.4	4.3
I had a strong desire to take this course.(Q4)	5	5	1	0	0	0	4.4	4.1	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	4	6	0	0	0	3.4	2.9	2.8
How did you participate in this course? (Q1854)	7	4	0	0	0	0	4.7	4.7	4.5

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Overall, Ronald Gilgenbach was an excellent teacher.(Q2)	5	5	1	0	0	0	4.4	4.7	4.7
Ronald Gilgenbach seemed well prepared for class meetings.(Q230)	10	1	0	0	0	0	5.0	4.8	4.7
Ronald Gilgenbach explained material clearly.(Q199)	5	6	0	0	0	0	4.4	4.7	4.7
Ronald Gilgenbach treated students with respect.(Q217)	9	2	0	0	0	0	4.9	4.9	4.8

The medians are calculated from Fall 2020 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 2022 Instructor Report
NERS 471-001: Int Plasmas-Fusn
Ronald Gilgenbach

13 out of 36 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	4	2	1	0	0	4.4	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	5	4	3	0	1	0	4.1	4.2	4.2
I knew what was expected of me in this course.(Q1633)	7	3	1	2	0	0	4.6	4.6	4.4
I had a strong desire to take this course.(Q4)	6	5	1	0	1	0	4.4	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	3	8	1	0	0	3.2	3.0	2.8

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	Univ-wide Median	School/College Median
Ronald Gilgenbach seemed well prepared for class meetings.(Q230)	9	3	1	0	0	0	4.8	4.8	4.8
Ronald Gilgenbach explained material clearly.(Q199)	7	1	4	1	0	0	4.6	4.7	4.7
Ronald Gilgenbach treated students with respect.(Q217)	11	1	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)	7	1	4	0	1	0	4.6

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Ronald Gilgenbach was an excellent teacher. (Q2)	7	3	1	2	0	0	4.6

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 upper division with enrollment of 16 to 74 in College of Engineering.

University of Michigan
Fall 2023 Instructor Report
NERS 471-001: Int Plasmas-Fusn
Carolyn Kuranz

13 out of 37 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	6	0	0	1	0	4.4	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	4	5	1	3	0	0	4.0	4.2	4.2
I knew what was expected of me in this course.(Q1633)	8	5	0	0	0	0	4.7	4.4	4.5
I had a strong desire to take this course.(Q4)	6	4	3	0	0	0	4.4	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)	0	6	5	1	0	1	3.5	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
Carolyn Kuranz seemed well prepared for class meetings.(Q230)	10	2	0	1	0	0	4.9	4.7	4.8
Carolyn Kuranz explained material clearly.(Q199)	8	3	1	1	0	0	4.7	4.6	4.7
Carolyn Kuranz treated students with respect.(Q217)	11	2	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)	4	4	4	0	1	0	3.9

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, Carolyn Kuranz was an excellent teacher. (Q2)	8	3	1	1	0	0	4.7

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 upper division 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: 2024-04-06
Effective Term: Winter 2025

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Statistics Subject: Stats Catalog: 570	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 570
☐	☑ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Industrial and Operations Engineering - IOE - 570	
☐	Course Title (full title) Experimental Design	Course Title (full title) Experimental Design
☑	Abbreviated Title (20 char) Design of Experiment	Abbreviated Title (20 char) Experimental Design
☑	Course Description (Please limit to 80 words and attach separate sheet if necessary) Design principles, review of analysis of variance, block designs, interactions effects, factorial and fractional factorial experiments, incomplete and unreplicated designs, data analysis techniques and case studies, response surface methodology, variance reduction and robust parameter design.	
☑	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, 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: Industrial & Operations Engin Catalog: 570

☐

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) STATS 500 or background in regression and Graduate standing.	Advisory Prerequisite (254 char) Background in regression at the level of STATS 413 or IOE 366, and Graduate standing.
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

Course Components / Graded Component

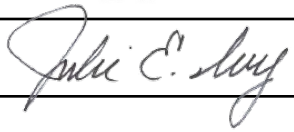
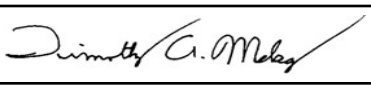
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Raed Kontar Cognizant Faculty Member Title: Assistant Professor

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

Contact Person: Leonora Lucaj Email: lucajl@umich.edu Phone: 734-764-3297

CoE Curriculum Committee Representative: Yavuz Bozer		Print: Yuvuz Bozer	Date: 05/07/24
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print:Liza Levina	Date: 5/9/24
Cross-Listed Department Chair:		Print: Julie Ivy	Date: 05/07/24
Cross-Listed Department Chair:		Print:	Date:
LSA Curriculum Committee:		Print: Timothy McKay	Date: 5/10/24

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Basic design principles, review of analysis of variance, block designs, two-level and three-level factorial and fractional factorial experiments, designs with complex aliasing, data analysis techniques and case studies, basic response surface methodology, variation reduction and introductory robust parameter designs.	Course Description Design principles, review of analysis of variance, block designs, interactions effects, factorial and fractional factorial experiments, incomplete and unreplicated designs, data analysis techniques and case studies, response surface methodology, variance reduction and robust parameter design.
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:
Cross-listed dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The Statistics department was initially the primary department for this course, but they have agreed to transfer oversight to Industrial & Operations Engineering, with Raed Al Kontar as the cognizant faculty member. Statistics will designate the Master's in Applied Statistics program director as their point of contact. At the beginning of the term, Raed will send the syllabus to the designated point of contact to address any questions, concerns, or recommendations and will share student feedback at the end of the semester. Any concerns related to the Statistics department that arise during the term can also be resolved through this designated point of contact. Such collaborative communication can contribute significantly to enhancing the overall course quality, given the substantial number of Statistics students enrolled.