UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, September 12, 2023

Attending: Achilleas Anastasopoulos, Jack Baker, Miki Banu, Robert Bordley, Yavuz Bozer, Chris Fidkowski, Fei Gao, Brent Gillepsie, Saadet Albayrak Guralp, Amir Kamil, Leena Lalwani, Xiaogan Liang, Cameron Louttit, Frank Marsik, Radoslaw Michalowski, Eric Rutherford, Anchal Sareen, Ben Spector, Roxanne Walker

Support Staff: Mercedes Carmona, Betsy Dodge, Matthew Faunce

Call to Order: 1:36 PM

Adjourned: 2:18 PM

Agenda:

1. Approval of 8.29.2023 Meeting Minutes (Page 4) - **APPROVED**
2. Voting for CoE Curriculum Committee Chair for 2023-2024
    a. Xiaogan Liang nominated and unanimously voted upon by Curriculum Committee to be the chair for the next academic year.
3. HLC Annual Audit Process (Page 12)
    a. Engineering RO's Office breaks down HLC Annual Audit Report, created by University Registrar Office, by department and unit by matching previous term's courses that did not meet the CoE Policy for the Assignment of Credit Hours or did not cancel previous sections that were not in compliance.
    b. Spreadsheets, sent by Xiaogan last Friday September 8, were sent to Department Undergraduate and Graduate Chairs, UA's, and Curriculum Maintainers and given a one month deadline to correct courses found in the report that are not in compliance
        i. It is the responsibility of the UG and Grad. Chairs to speak to their departments regarding the report to review the information and send back a completed spreadsheet.
            1. The spreadsheet will be used to confirm that courses for the following term comply with the CoE Policy for the Assignment of Credit Hours.
                a. Courses that can be easily fixed can be done within the department and marked in the spreadsheet.
                b. Courses that cannot easily be fixed will need to input that information in the form of a questions and recorded in the spreadsheet. This will later be addressed by the CCC.
                c. The CCC will meet and discuss at their next scheduled meeting the spreadsheets' questions, course categories, and consult with curriculum experts if needed.
                d. If needed, the CoE Policy for the Assignment of Credit Hours will then be updated based on the results of these questions and discussions.
    c. A member inquired if the departments from the report have met the requirements for labs and hours. Xiaogan said yes and most followed the CoE Policy for the Assignment of Credit Hours. There were some courses that did not follow the policy and it was logged in the spreadsheet.
    d. After Xiaogan showed the spreadsheet referenced to the report that needs to be updated by departments, some CCC members asked if they could receive access to the spreadsheet and be included in emails.
        i. CoE RO to follow up for department members to receive information
4. ISD DENG Modification of Existing Engineering Program Proposal (Page 14) – Action Item - **APPROVED**
    a. Admission tracks modifications requested to the current Doctor of Engineering in Manufacturing (D Eng in MFG):

i. Admitted directly to the D. Eng in MFG without a relevant master's degree must complete the Master of Engineering in Manufacturing (M Eng in MFG requirements along with an "Embedded Master"
    1. A student may count up to 18 letter-graded (A-E) credits from the 30 credit M Eng in MFG toward the 18 letter-graded (A-E) credits.
        a. Excluded courses: MFG 990, 995, 590, 503, ELI Courses
    2. At least 6 credits of letter graded (including the grade S-Satisfactory) graduate coursework registered under Graduate Engineering.
    3. Students completing the M Eng in MFG requirements while also meeting the D Eng in MFG requirements have the option to receive the M Eng in MFG degree and discontinue from the D Eng in MFG and only complete M Eng in MFG.

ii. Admitted with a master's degree in the same or relevant field from another institution – Not a U of M Degree (master's in engineering, business)
    1. Manufacturing Program Committee or the Program Director will validate the relevance of the existing master degree
    2. Fulfill 18 letter-graded credits (A-E) and 6 additional credits

iii. Admitted with a master's degree in the same or relevant field from U of M (i.e., change of program students) (M Eng in MFG, master's in engineering, business)
    1. Fulfill 18 credits with at least 6 credits letter-graded (included the grade S-Satisfactory)
    2. Program committee together with program director will analyze and decide how many letter-graded credits (A-#) from U of M master may be counted toward the D Eng in MFG program (maximum of 2 course from U of M master may be counted)

b. Amends to current D Eng in MFG double-counting and transfer credit rules:
    1. No double counting restriction between M Eng in MFG and D Eng in MFG
    2. A student may transfer up to 6 approved credits (Non-U of M Credits)
    3. Rackham PhD Transfer of credit rules applied.
        a. These credits do not appear on a transcript, although meeting the degree requirement with Non U of M credits, and will not count toward overall 18 letter-graded (A-E) credits.
        b. The student will need to take additional credits to meet the D Eng in MFG 18 letter-graded A-E credits.

c. A member inquired if the same director is who evaluates both the M Eng in MFG and D Eng in MFG programs. Miki said the Program Director is the same for both programs and completes student evaluations.

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	Is Course on LSA Course Guide?	APPROVED	NOTES & REVISIONS	TABLED
26	IOE	316	MOD	Change to Enforced Prerequisite.	FT 2024	C-	YES	APPROVED		
29	IOE	431	NEW		WT 2024	NO	NO	APPROVED		
42	IOE	435	NEW		FT 2024	C-	NO	APPROVED	Cross listed with ROB 435. Member will check why Non-Rackham students excluded.	
66	IOE	562	DEL		WT 2024	NO	YES	APPROVED	Cross listed with STATS 535.	
69	NERS	441	MOD	Change to Enforced Prerequisite.	FT 2024	C	YES	APPROVED		

EECS CARFs with Subject Changes to ECE or CSE – Bulk Review

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	Is Course on LSA Course Guide?	APPROVED	NOTES & REVISIONS	TABLED
72	EECS	513	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
75	EECS	517	MOD		FT 2024	NO	YES	APPROVED	Cross listed with NERS 578.	
78	EECS	524	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 524.	
81	EECS	530	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 530.	
84	EECS	532	MOD		FT 2024	NO	YES	APPROVED	Cross listed with CLIMATE 587 and SPACE 587.	
87	EECS	537	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 537.	
90	EECS	540	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 540.	
93	EECS	541	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 541.	
96	EECS	546	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 546.	
99	EECS	552	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 552.	
102	EECS	560	MOD		FT 2024	NO	YES	APPROVED	Cross listed with AEROSP 550, CEE 571, and MECHENG 564.	
105	EECS	562	MOD		FT 2024	NO	YES	APPROVED	Cross listed with AEROSP 551.	
108	EECS	569	MOD		FT 2024	NO	YES	APPROVED	Cross listed with MFG 564.	
111	EECS	586	MOD		FT 2024	B+	YES	APPROVED		
114	EECS	596	MOD	Change to Course Description and Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	Is Course on LSA Course Guide?	APPROVED	NOTES & REVISIONS	TABLED
117	EECS	600	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED	Cross listed with IOE 600.	
120	PSYCH	643	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 643.	
124	PSYCH	644	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 644.	
127	EECS	662	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED	Cross listed with AEROSP 672 and MECHENG 662.	
130	PSYCH	740	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 695.	

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, August 29, 2023

Attending: Achilleas Anastasopoulos, Jack Baker, Robert Bordley, Yavuz Bozer, Chris Fidkowski, Fei Gao, Odest Chad Jenkins, Amir Kamil, Leena Lalwani, Xiaogan Liang, Emmanuelle Marquis, Frank Marsik, Eric Rutherford, Saadet Albayrak Guralp, Roxanne Walker

Support Staff: Mercedes Carmona, Betsy Dodge, Matthew Faunce

Call to Order: 1:33 PM

Adjourned: 2:05 PM

Agenda:

1. Approval of 4.4.2023 Meeting Minutes (Page 9) – **APPROVED**
2. LSA Course Guide added to CARF Summaries Table
    a. In the CARF Summaries Table (see below), this section is added with the reasoning as if new CoE Course CARFs are interested in being included in the LSA Course Guide, they must be able to meet an LSA requirement to qualify. This section in the table is to monitor if new, deleted, or existing courses are in the LSA Course Guide.
    b. An inquiry to the LSA Course Guide support staff is waiting for a response. We will update the committee when a response is received.
3. 8.29.2023 Agenda Inconsistencies
    a. During the lack of access experienced across the university, the last agenda was not accurate in the CARF Summaries for the EECS CARFs Bulk Review. If you would like an updated version of the agenda, please email carmonam@umich.edu.

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
11	ECE	527	NEW		WT 2024	C	ADD	CONDITIONAL APPROVAL	Permission of instructor needs to be moved to Add Consent (checkbox checked) in the Grading Basis and removed from the Enforced Prerequisite listing.	
25	EECS	453	MOD	Change to Credit Exclusions	WT 2024	C	YES	APPROVED		

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
28	EECS	461	MOD	Change to Enforced Prerequisite	WT 2024	C	YES	CONDITIONAL APPROVAL	Updating Contact Hours (Page 3) for Lab to 2 Hours.	
31	IOE	310	MOD	Change to Enforced Prerequisite	WT 2024	C-	YES	APPROVED		
34	IOE	333	MOD	Change to Enforced and Advisory Prerequisites	WT 2024	C-	YES	APPROVED		
37	IOE	366	MOD	Change to Enforced Prerequisite	WT 2024	C-	YES	APPROVED		
40	IOE	422	DEL		WT 2024		REMOVE	APPROVED		
43	IOE	474	MOD	Change to Enforced and Advisory Prerequisites	WT 2024	C-	YES	APPROVED		
46	ROB	450	NEW		WT 2024	C	ADD	CONDITIONAL APPROVAL	Make change to Course Description, “Primary goal is to challenge students…”	
53	CHEM	511	MOD	Change to Advisory Prerequisites	WT 2024	NO	YES	APPROVED	Cross listed with MATSCIE 510.	

EECS CARFs with Subject Changes to ECE or CSE – Bulk Review

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
56	EECS	500	MOD		FT 2024	NO	YES	APPROVED		
59	EECS	501	MOD		FT 2024	C	YES	APPROVED		
62	EECS	502	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
65	EECS	503	MOD		FT 2024	NO	YES	APPROVED		
68	EECS	505	MOD	Change to Credit Exclusion.	FT 2024	C	YES	APPROVED		
71	EECS	506	MOD		FT 2024	C	YES	APPROVED		
74	EECS	508	MOD		FT 2024	C	YES	APPROVED		
77	EECS	509	MOD	Change to Course Description and Course Credit Type.	FT 2024	NO	YES	APPROVED		
80	EECS	511	MOD		FT 2024	NO	YES	APPROVED		
83	EECS	512	MOD		FT 2024	NO	YES	APPROVED		
86	EECS	514	MOD		FT 2024	NO	YES	APPROVED		
89	EECS	515	MOD		FT 2024	NO	YES	APPROVED		
92	BIOMEDE	516	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 516.	
95	SPACE	595	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 518.	

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
98	NERS	575	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 519.	
101	EECS	520	MOD		FT 2024	NO	YES	APPROVED		
104	EECS	521	MOD		FT 2024	NO	YES	APPROVED		
107	EECS	525	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
110	EECS	526	MOD		FT 2024	NO	YES	APPROVED		
113	EECS	528	MOD		FT 2024	NO	YES	APPROVED		
116	EECS	529	MOD		FT 2024	NO	YES	APPROVED		
119	EECS	531	MOD		FT 2024	NO	YES	APPROVED		
122	EECS	533	MOD		FT 2024	NO	YES	APPROVED		
125	EECS	534	MOD		FT 2024	NO	YES	APPROVED		
128	EECS	535	MOD		FT 2024	NO	YES	APPROVED		
131	EECS	536	MOD		FT 2024	C	YES	APPROVED		
134	EECS	538	MOD		FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 550 and PHYSICS 650.	
137	EECS	539	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 551 and PHYSICS 651.	
140	EECS	544	MOD		FT 2024	NO	YES	APPROVED		
143	EECS	550	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
146	EECS	551	MOD	Change to Credit Exclusion.	FT 2024	NO	YES	APPROVED		
149	EECS	554	MOD		FT 2024	NO	YES	APPROVED		
152	EECS	555	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
155	EECS	556	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
158	EECS	557	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
161	EECS	558	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
164	EECS	559	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
167	MECHENG	561	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 561	
170	EECS	563	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
173	EECS	564	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
176	EECS	565	MOD	Change to Advisory Prerequisite and Credit Exclusion.	FT 2024	NO	YES	APPROVED		
179	EECS	566	MOD		FT 2024	NO	YES	APPROVED		
182	EECS	572	MOD		FT 2024	NO	YES	APPROVED		
185	EECS	574	MOD		FT 2024	NO	YES	APPROVED		
188	EECS	575	MOD		FT 2024	NO	YES	APPROVED		
191	EECS	576	MOD		FT 2024	NO	YES	APPROVED		

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
194	EECS	582	MOD		FT 2024	NO	YES	APPROVED		
197	EECS	583	MOD		FT 2024	NO	YES	APPROVED		
200	EECS	584	MOD		FT 2024	NO	YES	APPROVED		
203	EECS	587	MOD		FT 2024	NO	YES	APPROVED		
206	EECS	588	MOD		FT 2024	NO	YES	APPROVED		
209	EECS	589	MOD		FT 2024	NO	YES	APPROVED		
212	EECS	590	MOD		FT 2024	NO	YES	APPROVED		
215	EECS	591	MOD	Change to Course Components.	FT 2024	NO	YES	APPROVED		
218	EECS	592	MOD		FT 2024	NO	YES	APPROVED		
221	EECS	593	MOD		FT 2024	NO	YES	APPROVED		
224	EECS	595	MOD		FT 2024	NO	YES	APPROVED	Cross listed with LING 541 and SI 561.	
227	EECS	598	MOD	Change to Course Description.	FT 2024	NO	YES	APPROVED		
230	EECS	599	MOD	Change to Course Description.	FT 2024	NO	YES	APPROVED		
233	EECS	601	MOD		FT 2024	NO	YES	APPROVED		
236	EECS	602	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
239	EECS	605	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
243	EECS	620	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
246	EECS	631	MOD	Change to Advisory Prerequisite and Course Components.	FT 2024	NO	YES	APPROVED		
249	EECS	633	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
252	EECS	634	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED	Cross listed with APPPHYS 611 and PHYSICS 611.	
255	PHYSICS	542	MOD		FT 2024	NO	YES	APPROVED	Cross listed with EECS 638.	
258	EECS	650	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
261	EECS	659	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
264	EECS	670	MOD	Change to Advisory Prerequisite.	FT 2024	NO	YES	APPROVED		
267	EECS	692	MOD	Change to Enforced Prerequisite	FT 2024	C	YES	APPROVED		
270	EECS	698	MOD	Change to Course Description, Grading Basis, Advisory Prerequisite, and Course Components.	FT 2024	NO	YES	APPROVED		
273	EECS	699	MOD	Change to Course Title and Abbreviated Title.	FT 2024	NO	YES	APPROVED		
276	EECS	700	MOD	Change to Course Description.	FT 2024	NO	YES	APPROVED		
279	EECS	720	MOD		FT 2024	NO	YES	APPROVED		
282	EECS	730	MOD	Change to Course Description.	FT 2024	NO	YES	APPROVED		
285	EECS	735	MOD		FT 2024	NO	YES	APPROVED		
288	EECS	750	MOD	Change to Course Description.	FT 2024	NO	YES	APPROVED		

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	IS COURSE ON LSA COURSE GUIDE?	APPROVED	NOTES & REVISIONS	TABLED
291	EECS	755	MOD		FT 2024	NO	YES	APPROVED		
294	EECS	760	MOD	Change to Course Description.	FT 2024	NO	YES	APPROVED		
297	EECS	765	MOD		FT 2024	NO	YES	APPROVED		
300	EECS	820	MOD		FT 2024	NO	YES	APPROVED		
303	EECS	990	MOD	Change to Course Components.	FT 2024	NO	YES	APPROVED		
306	EECS	995	MOD		FT 2024	NO	YES	APPROVED		

HLC Annual Audit Process

1. At the beginning of each term, the Engineering RO's office will break down the HLC Annual Audit Report by department and unit, with the matching previous term's courses that did not meet the CoE Policy for the Assignment of Credit Hours or did not cancel the sections that did not meet (eg. FA 23 will send the WN 23 courses that failed to meet the minimum number of credit hours or did not cancel sections that did not meet, so that WN 24 courses can be brought into compliance before the academic freeze for WN 24 course scheduling). Please note, if the course is cross-listed with another course, inside or outside of the College of Engineering, despite who is the home unit, it is expected that the department/unit will communicate with the cross-listed department/unit to find solutions and report back on the supplied spreadsheet.

2. This spreadsheet will be sent to the Undergraduate and Graduate Chairs, UA's and Curriculum Maintainers with a one-month deadline (so that the work is complete on those courses in the future, prior to the Academic Freeze and prior to backpacking).
    a. The CCC Chair should send out the spreadsheet and message
    b. The CoE RO Office should draft the communication
    c. The CCC Chair will respond to follow up questions that come from departments with CoE RO Office assisting with drafting responses.

3. It is the Undergraduate and Graduate Chair's responsibility to engage with their departmental faculty, CoE Curriculum Committee Member, their Curriculum Maintainers, their departmental CC Chairs, and program committees to review the information and send back the complete spreadsheet.

4. The Undergraduate and Graduate Chairs will use the spreadsheet to confirm that their courses for the following term comply with our credit hour policy.
    a. The CCC Chair (with support from CoE RO) will follow up if spreadsheet is completed incorrectly or not complete

5. Those courses that can be easily fixed will be done (eg. cancel courses with zero enrollment, submit a CARF modification to the CoE CCC, update the Maintain Schedule

of Classes tile in MPathways to provide the proper number of contact hours/week) and marked in the spreadsheet.

6. Those courses that can't be easily fixed, the Chairs will need to distill that information into questions and record it in the spreadsheet, so that will be addressed by the CCC.
    a. The CCC Chair (with support of CoE RO Office) will respond to questions submitted to the CCC, summarize the questions to the CCC members and respond to Chairs

7. The CCC will meet and discuss a response at their next scheduled meeting and utilize the submitted questions, identified course categories and if needed, reference the CoE Policy for the Assignment of Credit Hours and consult with curriculum experts if needed (Mike Solomon, Vice Provost for Academic Affairs and Dean of Rackham, Christine Gerdes, Special Counsel to the Provost)
    a. CCC Chair (with support from CoE RO Office) is responsible for reaching out to the curriculum experts

8. The CoE Curriculum Committee will update our CoE Policy for the Assignment of Credit Hours based on the results of these questions.
    a. The CCC will identify what behaviors count as contact hours (eg. asynchronous, online modules in CANVAS) as part of the CoE Policy for the Assignment of Credit Hours. Information will be shared with ADUE/OGPE Office to confirm

Curriculum Committee College Rules state that the committee can reach out to Associate Deans for further support.

COLLEGE OF ENGINEERING
INTEGRATIVE SYSTEMS + DESIGN
UNIVERSITY OF MICHIGAN
SI North Building, 1075 Beal Avenue, Ann Arbor, MI 48109-2112
http://isd.eng.umich.edu

MEMORANDUM
TO: Xiaogan Liang, Chair, College of Engineering Curriculum Committee

FROM: Diann Brei, Chair Integrative Systems + Design

DATE: May 2023

REGARDING: Modification of Existing Engineering Program

Requested Date for Change to Take Effect: Winter 2024

Currently, the Integrative Systems + Design (ISD) Division, Doctor of Engineering in Manufacturing (D Eng in Mfg) program requires the following:

- Completion of a BSE degree in any field of engineering and an MSE degree , or a Master of Business Administration
- Completion of the D Eng in Mfg degree requires 18 credits of letter-graded coursework beyond a master degree (including the grade of S - Satisfactory) registered as a "Graduate Engineering" student while in residence on the Ann Arbor Campus

To keep in alignment with Rackham, we are requesting to include the following D Eng in Mfg admission tracks:

1. Admitted directly to the D. Eng. in Mfg without a relevant master's degree must complete the Master of Engineering in Manufacturing (M Eng in Mfg) requirements along the way with an "Embedded Master"

- Apply directly to the D Eng in Mfg program without a relevant master's
- Fulfill the M Eng in Mfg 30 credit requirement among which is up to 18 letter-graded A-E credits will be counted toward the D Eng in Mfg 18 letter-graded A-E credit requirement. (Courses that will not count toward the D Eng in Mfg 18 letter-graded A-E credit requirement: MFG 503, MFG 990, MFG 995, MFG 590, ELI courses) At least 6 credits of letter graded (included the grade S-Satisfactory) graduate coursework registered under Graduate Engineering.
- Students completing the M Eng in Mfg requirements while meeting the D Eng in Mfg requirements have the option to receive the M Eng in Mfg degree.
- A student meeting the M Eng in Mfg requirements along the way of completing the D Eng in Mfg have the option to request to discontinue from the D Eng in Mfg and only complete the M Eng in Mfg.

2. Admitted with a master's degree in the same field or relevant field from another Institution - Not a U-M degree. (master's in engineering, business)

- The Manufacturing Program Committee or the Program Director will validate the relevance of the existing master.
- Fulfill 18 letter-graded credits (A-E) and 6 additional credits

3. Admitted with a master's degree in the same field or a relevant field from the University of Michigan (i.e. change of program students) (M Eng in Mfg, master's in engineering, business)

- Fulfill 18 credits; at least 6 credits letter graded (included the grade S-Satisfactory) graduate coursework registered under Graduate Engineering. The program committee together with the Program director will analyze and decide how many letter-graded credits (A-E) from the U-M master may be counted toward the D Eng in Mfg program (a maximum of two courses from the U-M master may be counted).

To keep in alignment with Rackham, we are requesting to amend current D.Eng double-counting and transfer credit rules to match Rackham:

- No double-counting restriction between M Eng and D Eng. A student may count up to 18 letter-graded A-E credits from the 30 credit M Eng in Mfg toward the 18 letter-graded (A-E) credits. (Courses that will not count toward the 18 letter-graded (A-E) credits: MFG 990, MFG 995, MFG 590, MFG 503, ELI courses)
- A student may transfer up to 6 approved credits (Non U-M credits)
- Rackham PhD Transfer of credit rules: While credits earned at another institution cannot be transferred to a doctoral program, students may seek approval from their program to use credits earned elsewhere (Non U-M credits) to satisfy certain degree requirements. These credits do not appear on the transcript. Though the student is meeting the degree requirements with the (Non U-M credits), the credits will not count toward the overall 18 letter-graded (A-E credits) The student will need to take additional credits to meet the D Eng in Mfg 18 letter-graded A-E credits.

Plan for Transitioning Existing Students

Most current D.Eng. students have a relevant master's, so there will be no change to their requirements. There is one student who was admitted to the D.Eng program in Fall 2023 with a relevant masters, whom we would plan to apply double counting rules in Winter 2024, if approved.

Doctor of Engineering in Manufacturing *(D. Eng. in Mfg.)*

OVERVIEW:

The Doctor of Engineering in Manufacturing (D. Eng. in Mfg.) is a graduate professional degree in engineering for students who have already earned a BSE degree and an MSE degree in any field of engineering (e.g., Aerospace, Chemical, Civil and Environmental, Electrical Engineering and Computer Science, Industrial and Operations, Materials Science, Mechanical, Naval Architecture and Marine) or a Master of Business Administration.

The Doctor of Engineering in Manufacturing (D. Eng. in Mfg.) is motivated by the need for technical leaders in the manufacturing arena who have depth in their own engineering disciplines, breadth across engineering disciplines, breadth beyond engineering, the ability to lead project teams, and the skills to carry out high quality engineering research and development.

Following the completion of the 18 letter-graded (A-E) coursework (including the 12 credits of Qualifying Coursework) requirement, a student is required to complete a preliminary examination to test his/her knowledge of the primary and supporting field. After advancing to candidacy, each student must complete an original practice-oriented dissertation that is supervised by a dissertation committee as a requirement of the degree.

Continuous Enrollment is required in the Fall and Winter semesters from matriculation to degree completion. 18 letter-graded (A-E) credit hours (not pass/fail) are required beyond the student's master degree. At least 12 credit hours of the 18 credit hours must be taken at the Ann Arbor Campus. Students must maintain a cumulative GPA of 3.3/4 (B+) and must obtain at least a 3.5/4 GPA average toward the Qualifying Coursework requirement.

ADMISSIONS:

Applicants must meet the following requirements:

- Have at least one degree (BS or MS) in Engineering from an ABET-accredited institution in the US (or international equivalent). A bachelor's degree of technology or engineering technology is not accepted.
- Have a relevant master degree from an Institution/University outside of U-M), (e.g., Master's in Engineering or Business), **or**
- Have a relevant master degree from within U-M, **or**
- You may apply directly to the D Eng in Mfg program without having a relevant master degree. With this option, D. Eng in Mfg students will complete the M Eng in Mfg requirements along the way of completing the D Eng in Mfg requirements
- Applicants should have relevant industry-related working/internship experience by the beginning of the first semester of enrollment.
- An online application is required. In addition, a one-page statement of purpose, a one-page personal statement, one-page resume, 3 letters of recommendation, and official undergraduate and graduate transcripts (if applicable) are required.
- An applicant for the D. Eng. in Mfg. must have an advisor assigned as part of the final admission decision. After the admission committee reviews the application files, and if the applicant meets the admission requirements, the admissions committee will work with the student to identify a faculty in the College of Engineering (CoE), Ann Arbor, who is willing to be the advisor for the applicant's dissertation research. It is important that the D. Eng. candidate work with a faculty

advisor who is familiar with the student's area of interest and can help him/her select courses and find the necessary resources for a world class original research project. In some cases dissertations may be co-chaired by two faculty members.

- A full program funding plan is required at the time of admission. Funding depends on various factors but could include funding as a Graduate Student Research Assistant by advisor, Graduate Student Instructor or Fellowship by ISD, student initiated scholarship, employer, etc.
- Applicants whose native language is not English must demonstrate English proficiency and are required to provide an official score report from either the Test of English as a Foreign Language (TOEFL), IBT, the International English Language Testing Systems (IELTS), the Michigan Language Assessments (MET), or the Examination for the Michigan Certificate of Proficiency in English (ECPE). If a student received a bachelor's degree from a college or university where the language of instruction is exclusively English, the English proficiency requirement MAY be waived.
- The GRE is not required when applying to the D. Eng. in Mfg.

CURRICULUM AND TRAINING:

D Eng in Mfg requires 18 letter-graded (A-E) credits
Qualifying Coursework. *Courses elected as MFG 590, MFG 990, MFG 503, MFG 995 research elections cannot be used to fulfill the letter-graded (A-E) requirements*
(Up to 6 credits may be 400 level)

Residency and Coursework Requirements

For D Eng in Mfg students admitted directly to the program without a master degree:

- The student must complete the 30 credit M Eng in Mfg course work requirements.
  - Though the M Eng in Mfg requirements must be met, it is optional for the student to decide if s/he wants to be admitted to the M Eng in Mfg program in order to obtain the M Eng in Mfg degree.
  - A M Eng in Mfg student may request to transfer up to six (6) credits from an accredited institution other than the University of Michigan. Up to one-half (1/2) the minimum number of credit hours required for a master's degree program may be transferred to a student's record from a combination of credits from a non-University of Michigan school (up to six (6) non U-M credits, along with credits completed in another University of Michigan School or College, e.g., School of Public Health. Please note: Credits for a transfer course are applied to a student's transcript and do affect the overall number of credits taken, but the grade for a transfer course is not applied to the student's transcript and does not affect the student's overall U-M GPA.
  - M Eng in Mfg may be completed online, hybrid, or on-campus
- The student must meet at least 18 letter-graded (A-E) credits toward the D Eng in Mfg course work requirements.
  - The student may count up to 18 letter-graded (A-E) credits from the M Eng in Mfg toward D Eng in Mfg requirements.
  - The courses being counted toward both programs must meet both the M Eng in Mfg and D Eng in Mfg course work requirements.

  - If there are not at least 18 letter graded (A-E) credits taken for the M Eng in Mfg that will also meet the D Eng in Mfg in Mfg course work requirements, additional courses will need to be taken in order to meet the D Eng in Mfg requirements.
- At least 6 credits of the letter graded (A-E) graduate credits

For D Eng in Mfg students with a Relevant Master's outside of U-M Residency requirements:
At least 18 credits of letter-graded (A-E) graduate coursework registered as a Graduate Engineering student while in residence on the Ann Arbor Campus. Courses elected as MFG 590, MFG 990, MFG 503, MFG 995 research elections cannot be used to fulfill the residency requirement. For the first year in the D Eng in Mfg program (first Fall and Winter terms), the student must be enrolled as a full-time on-campus student in Ann Arbor.

For students entering with a Master's degree from the University of Michigan
At least 6 credits of letter-graded (A-E) graduate coursework registered as a Graduate Engineering student while in residence on the Ann Arbor campus. Courses elected as visit (audit) do not meet this requirement, nor do MFG 590, MFG 990, MFG 995)

For Students who completed the SUGS Program:
At least 6 credits of letter-graded (including the grade S-Satisfactory) graduate coursework registered as a Graduate Engineering student while in residence on the Ann Arbor campus. Courses elected as visit (audit) do not meet this requirement, nor do MFG 590, MFG 990, and MFG 995. Additional credits of letter-graded graduate coursework equal to or greater than the number of credits double-counted in the SUGS program.

Transfer requirements:
Of the required 18 letter-graded (A-E) credit hours, a student may transfer up to 6 approved credits. Approved transfer credits may come from an accredited institution other than the University of Michigan, credits completed in another University of Michigan School or College, e.g., School of Public Health, or from graduate level courses taken at U-M before enrolling in the D. Eng. In Mfg. program. Transfer courses must be courses that do not count toward another degree or certificate

Courses cannot be transferred if:

- Credits from the course applied toward another degree or certificate.
- The course was taken more than five (5) years before beginning the present graduate program.
- A grade below "B" was earned. *A grade of "B-"or lower will not be accepted for a transfer course.*
- Transfer of credit will not be applied on a student's University of Michigan record unless the student has a cumulative U-M GPA of at least 3.0/4 "B"

For students directly admitted to the D. Eng in Mfg without a Master's
The curriculum requirements for both the M Eng in Mfg and the D Eng in Mfg must be met.

Select courses that will meet both the D Eng in Mfg and M Eng in Mfg requirements.

- **Up to 18 U-M letter-graded A-E credits taken as a Graduate Engineering student may count between the M Eng in Mfg and the D Eng.**

- **Though a student may count up to 6 credits of 400-level courses toward the M Eng in Mfg, only courses taken at 500 level and above will be considered to count toward both M Eng in Mfg and D Eng in Mfg.**

M Eng in Mfg Curriculum requirements
Integrative Science (6-9 Credits)

- **Required: (3 credits)** - ISD 599 MFG 599 Smart Manufacturing Systems *(ISD 599 MFG 599 SMS taken as a required course toward the M Eng in Mfg may be considered to also count toward the D Eng in Mfg Qualifying Coursework - of at least 3 credits letter-graded (A-E) minor Engineering requirement or as an elective count toward the ISD 5*

Course offerings (select 3 - 6 Credits) from across the following Integrative Systems course offering categories: Global Engineering, Innovation & Entrepreneurship, Integrative Thinking, Model-Based Systems & Design, Socio-Technology *(500 level and above course/s approved to take in the M Eng in Mfg Integrative System area may considered to also count toward the D Eng in Mfg to meet the Qualifying Coursework - at least 3 credit letter-graded (A-E) minor Engineering requirement or as an Engineering Elective.*

Program Core: Select 6 credits from across the following categories: Automation and Process Control; Computer Aided Engineering (CAE) and Materials; Industrial Data Analytics; Supply Chain and Product Lifecycle Mgmt; Sustainable Mfg * Circular Economy
(500 level and above letter-graded (A-E) courses approved to take in Program Core area may be considered to also count toward the D Eng in Mfg to meet the Qualifying Coursework "at least 9 credits letter graded (A-E) Engineering Core courses to enhance depth in his/her engineering discipline or as an Engineering Electives.

Career Pathways: Select 9 credits from one of following categories: Additive Manufacturing; Digital Manufacturing; Manufacturing Automation; Production Systems and Quality Engineering; Smart Manufacturing *(500 level and above letter-graded (A-E) courses approved to take n the M Eng in Mfg Career Pathways may be considered to also count toward the D Eng in Mfg to meet the Qualifying Coursework of at least 9 credits letter graded (A-E) Engineering Core courses to enhance depth in his/her engineering discipline or as an Engineering Electives.*

Immersive Practice (3 - 6 Credits) (MFG 503 Project)
By the completion of the first two semesters of enrollment, complete a minimum of 18 letter-graded A-E credits that will apply to both the M Eng in Mfg and D Eng in Mfg curriculum requirements 12 letter-graded (A-E) credits

At least 9 letter-graded (A-E) credits in Engineering Core Courses to enhance depth in his/her engineering discipline.

At least 3 letter-graded (A-E) credits in minor engineering courses to gain breadth across engineering disciplines

Must obtain at least a 3.5/4 GPA on 12-credit Qualifying coursework.

Electives 6 letter-graded A-E credits in elective courses to gain breadth beyond engineering disciplines and/or to gain breadth beyond engineering.

GPA requirement
Must maintain at least 3.5/4 for the 12 credit of Qualifying coursework
For overall 18 letter-graded A-E credits, must maintain overall 3.¾ GPA

Qualifying Coursework Evaluation
The grades that students receive in the Qualifying Coursework will be averaged to determine Qualifying Coursework GPA (QC-GPA):
≥3.5 – Pass
≥3.3 – <3.5 – Conditional Pass
<3.3 Fail

Conditional Pass: If Qualifying Coursework Evaluation is ≥3.3 – <3.5, the student's advisor will provide a detailed report evaluating the student's research performance with a recommendation to "Pass" or "Fail". Then, the D. Eng. In Mfg. Program Committee will make a vote for the final decision.

Fail: If Qualifying Coursework Evaluation is <3.3 by the end of first two semesters (first fall and Winter semesters), the student will be allowed to request to add one more qualifying course to increase this QC-GPA by the end of third semester.

MFG 990 Pre-candidacy and MFG 995 Candidacy Research
Research involves active, student-directed inquiry into an engineering topic. Conducting research requires combining knowledge gained in the classroom with the ability to read the scientific literature, identify critical knowledge gaps, structure complex problems, formulate and test hypotheses, analyze and interpret data, and present and discuss technical results. Engineering research also requires significant experimental, computational, and analytical skills. A student learns these core skills as s/he pursues the research topic.

Many of these skills cannot be learned in the classroom setting, but instead must be developed in the laboratory, library, and conference room as the student actively interacts with faculty, other students, and researchers around the world. Independent, non-classroom based learning and problem solving is a core aspect of the D. Eng. in Mfg. degree. Upon completion of the dissertation the student should be an international expert in a technical area. Dissemination of new knowledge at technical conferences and in peer-reviewed archival publications is an important part of research.

Students at the pre-candidacy and candidacy stages will work with their D. Eng. advisor to determine the number of MFG 990 pre-candidate or MFG 995 Candidate research credits to enroll in during the fall and winter semesters. **At least 6 MFG 990 pre-candidate credits must be completed before moving to candidacy.**

Responsible Conduct of Research and Scholarship Training (RCRS)
All D. Eng. In Mfg. students are required to complete training in the responsible conduct of research and scholarship before advancing to candidacy – ideally in the first year of the D. Eng. program. Find the RCRS program overview and description of the four required workshops at this link. Find the RCRS workshop schedules at this link.

GSI Oral English Test (OET) OET is used to review the English proficiency of international students. Passing the exam is a requirement for international PhD students and is necessary to ensure satisfactory progress while simultaneously confirming the ability of that student to be an effective GSI. All international students must pass the OET by the end of their 3rd semester of enrollment after admission in order to be considered making satisfactory progress toward their degree. International students whose undergraduate education was taught exclusively in English may be exempt from the OET. Must be taken before moving to candidacy. Upon successful completion of this requirement, the student will then be eligible to hold a GSI position.

Preliminary Examination

After passing the Qualifying Coursework requirement, students are encouraged to complete the Preliminary Exam by the end of the 2nd year in the graduate program.

A student will work with his/her D. Eng. in Mfg. advisor to form his/her dissertation committee, prepare a bio-sketch, Research proposal, PowerPoint presentation List of Qualifying Exam Coursework and a brief report explaining how the Qualifying Exam coursework matches the research proposal topic and future research plans.

Once the dissertation committee is approved and the required documents are approved by the D. Eng. in Mfg. advisor and Manufacturing Committee, the student will work with his/her D. Eng. in Mfg. advisor to schedule the Preliminary Exam and will inform the Program's Graduate Coordinator of the scheduled exam.

In attendance at the exam will be the student and Dissertation Committee. The student will present a 40-50 minute oral presentation regarding the proposed research topic, methodologies and expected contributions, preliminary research results, work plan, and timeline followed by a 30-minute questions and answers.

All of the following areas will be considered by the Dissertation Committee when determining the outcome of pass/fail (proposed topic and its significance, methodological soundness, preliminary research and progress and the applications, future research plans, communication).

If the exam is not passed, the student may petition the committee to take one more prelim exam within one year; however the intention is that decisions be final and that second chances should be rare. Once the student passes the Preliminary Exam, the College of Engineering Registrar will submit a request to the College of Engineering for the student to advance to Candidacy.

Dissertation Committee and Defense

A manufacturing relevant, engineering-practice oriented dissertation is a requirement of the degree, and is supervised by a dissertation committee.

Constitution of the Committee

Function of the Committee: The dissertation committee is charged with the supervision of a student's dissertation activities including the Preliminary Examination and the dissertation defense. It is also expected that this committee will meet regularly with the student to monitor progress towards completion of the dissertation. All members of the committee must read the dissertation and submit their written evaluations to the College of Engineering Registrar.

Constitution of the Dissertation Committee:

- "**Graduate Faculty**" are tenure or tenure-track instructional faculty holding an "unmodified" (i.e., not visiting, adjunct, etc.) appointment at the University of Michigan as Professor, Associate Professor, or Assistant Professor with an earned Doctorate from an accredited institution.
- Dissertation Committees must have at least four members, three of whom are members of Graduate Faculty and up to two of whom are relevant to the doctoral program.

Furthermore, each committee:

- Must have a sole chair or two co-chairs
- Must have a cognate member who is familiar with the standards for doctoral research from a program other than the student's home relevant department/program.
- May include a University Faculty member who is not Graduate Faculty, a University staff member, or a qualified individual outside the University to provide expertise in the candidate's discipline

Students will meet with the Manufacturing Graduate Coordinator to discuss detailed requirements for the Dissertation Committee requirements and approval process.

The Dissertation Defense

The student must defend his/her work at an oral examination that is open to the public. The examination consists of an oral presentation of the dissertation followed by an oral examination led by the dissertation committee. At least four of the committee members must be present at the dissertation defense. The student must give the dissertation to the committee at least two weeks prior to the dissertation defense.

Sample of meeting D Eng in Mfg Requirements when admitted with a relevant Master's from outside U-M

D Eng in Mfg Curriculum Requirements

Qualifying Coursework (At least 12 Credits Graded A-E)

At least 9 credits letter graded (A-E) Engineering Core Courses to enhance the depth in engineering discipline. (Select 500 level or above courses) Some options may be that the courses come from the **Manufacturing Career-Pathways** or **Program Core** courses that are listed in the Master of Engineering in Manufacturing curriculum or from the student's relavant engineering department core courses that are considered as qualifying coursework.

Semester	Course Number	Course Name	Credits
Winter 2022	ISD 599 MFG 599 (MECHENG 599)	Fundamentals of Smart Additive Manufacturing	3
Winter 2022	MECHENG 577 (MATSCI 521)	Materials in Design	3
Fall 2021	MFG 605 (TO 605)	Manufacturing and Supply Operations	3

At least 3 credits (1 course) letter graded (A-E) Minor Engineering Course (500 level or above) Select courses that Gain Breadth across engineering Discipline. Some options may be that the courses come from **Integrative Science** courses that are listed in the Master of Engineering in Manufacturing curriculum. This will help students gain breadth across multiple disciplines.

Semester	Course Number	Course Name	Credits
Fall 2021	MFG 535 (IOE 533)	Human Factors in Engineering Systems	3

A **student must obtain a GPA of 3.5/4 or greater in the Qualifying Coursework for a pass.** Chek with the D. ENg. Pocedures for definition of Pass or Fail.

Electives (At least 6 letter-graded A-E Credits)

Semester	Course Number	Course Name	Credits
Winter 2022	PUBPOL 564	Gov't Regualtions of Industry & Environment	3
Winter 2022	MFG 466 (IOE 466)	Statistical Quality Control	3
		Overall 3.3/4 minimum GPA required	

18 credits enrolled under "Graduate Engineering" Enrollment

In this sample, the student applied to and was admitted to the D Eng in Mfg without a Master's and enrolled in all credits under "Graduate Engineering" enrollment.

Sample of meeting the

Integrative Science (9-12 Credits) (A-E)

Integrative Science - Required Course (3 Credits)

Semester	Course Number	Course Name	Category	Credits
Winter 2022	ISD 599 MFG 599	Smart Manufacturing Systems	Integrative Science	3
Integrative Science - Course Offerings (6-9 Credits) (If completing 6 credits in Immersive Practice, select 6 credits here) Select courses from any of the following Integrative Science Categories)				
Winter 2022	Pubpol 564	Socio-Technology	Government Regulation of Industry and Environment	3
Fall 2021	MFG 535 (IOE 533)	Human Factors in Engineering Systems	Model-Based Systems and Design	3

Program Core (6 Credits)

Semester	Course Number	Course Name	Category	Credits
Winter 2022	ISD 599 MFG 599 (MECHENG 599)	Fundamentals of Smart Additive Manufacturing	Sustainable Manufacturing and Circular Economy	3
Winter 2022	MECHENG 577 (MATSCI 521)	Materials in Design	Sustainable Manufacturing and Circular Economy	3

Career Pathways (9 Credits)

Semester	Course Number	Course Name	Category	Credits
Fall 2021	MFG 605 (TO 605)	Manufacturing and Supply Op	Production Systems and Quality Engineering	3
Fall 2021	MFG 587 (MECHENG 587)	Global Manufacturing	Production Systems and Quality Engineering	3
Winter 2022	MFG 466 (IOE 466)	Statistical Quality Control	Production Systems and Quality Engineering	3

Immersive Practice (3-6 Credits)

Semester	Course Number	Course Name	Category	Credits
Spring/Summer 2022	MFG 503	Manufacturing Project		3
Winter 2022	MFG 503	Manufacturing Project		3

30 credits of enrollment under "Graduate Engineering"

I

Qualifying Coursework (At least 12 Credits Graded A-E)

At least 9 credits letter graded (A-E) Engineering Core Courses to enhance the depth in engineering discipline. (Select 500 level or above courses) Some options may be that the courses come from the **Manufacturing Career-Pathways** or **Program Core** courses that are listed in the Master of Engineering in Manufacturing curriculum or from the student's relavant engineering department core courses that are considered as qualifying coursework.

Semester	Course Number	Course Name	Credits	Details
Winter 2022	ISD 599 MFG 599 (MECHENG 599)	Fundamentals of Smart Additive Manufacturing	3	Also counts Program Core in M Eng in Mfg
Winter 2022	MECHENG 577 (MATSCI 521)	Materials in Design	3	Also counts toward Program Core in M Eng in Mfg
Fall 2021	MFG 605 (TO 605)	Manufacturing and Supply Operations	3	Also counts toward Career Pathway in M Eng in Mfg

At least 3 credits (1 course) letter graded (A-E) Minor Engineering Course
(500 level or above) Select courses that Gain Breadth across engineering Discipline. Some options may be that the courses come from **Integrative Science** courses that are listed in the Master of Engineering in Manufacturing curriculum. This will help students gain breadth across multiple disciplines.

Semester	Course Number	Course Name	Credits	Details
Fall 2021	MFG 535 (IOE 533)	Human Factors in Engineering Systems	3	Also counts toward Integrative Science in M Eng in Mfg
A **student must obtain a GPA of 3.5/4 or greater in the Qualifying Coursework for a pass.** Chek with the D. ENg. Pocedures for definition of Pass or Fail.				

Electives (At least 6 letter-graded A-E Credits)

Gain Breadth across engineering disciplines and/or to gain breadth beyond engineering.

Semester	Course Number	Course Name	Credits	Details
Winter 2022	PUBPOL 564	Gov't Regualtions of Industry & Environment	3	Also counts toward Integrative Science in ME
Winter 2022	MFG 466 (IOE 466)	Statistical Quality Control	3	Also counts toward Career Pathways in M Eng in Mfg
3.3/4 minimum GPA required				

Mfg Curriculum requirements was approved to also count toward the D Eng in Mfg curriculum requirement.

For this sample student, the student was admitted to the D Eng in Mfg with a relevant U-M Master's degree from the Rackham Mechanical Engineering Department. and registered for most of his courses under "Rackham"enrollment. In the left column, this shows courses the student took toward the MSE in Mechanical Engineering. In the right column, this shows the courses that the student was approved to count toward the D. Eng in Mfg curriculum that were taken toward the student's MSE in Mechanical Engineering.
The student registered for most of the courses under "Rackham" enrollment, and at least 6 credits of letter graded (included the grade S-Satisfactory) graduate coursework registered under Graduate Engineering.

Sample of Courses that a student in the University of Michigan MSE in Mechanical Engineering (ME) might count toward his/her MSE in ME degree *(This is just an estimation and may not reflect an actual MSE ME student's curriculum.)*
(F21) MFG 553 (MECHENG 553) Microelectro Syst (3 Cr)
(W22) ISD 555 MFG 555 (MECHENG 555) Design Optimization (3 Cr)
(F21) MFG 563 (NAVARCH 562) Marine Sys Productn (3 Cr)
(F21) MFG 587 (MECHENG 587) Global Manufacturing (3 Cr)
(W22) IOE 466 Stat Quality Control (3 Cr)
(F21) MECHENG 505 FEM in MEAM (3 Cr)
(F21) IOE 515 Stochastic Proc (3 Cr)
(W22) ME 542 Vehicle Dyn (3 Cr)
MATH 417 Matrix Algebra (3 Cr)
MFG 462 Mar Structure Constr (3 Cr)
30 credits of enrollment under "Rackham" enrollment

Courses taken toward the M Eng in Mfg requirements that will count toward the D Eng in Mfg

18 Letter-graded A-E Requirements

Student may request to count up to 6 credits of 400 level courses as electives that are approved as graduate level by the home department.

(Up to 18 letter-graded (A-E) credits from a relevant U-M program may be approved to count toward the D Eng in Mfg 18 letter-graded A-E Requirements)

Qualifying Coursework (At least 12 Credits Graded A-E)

At least 9 credits letter graded (A-E) Engineering Core Courses to enhance the depth in engineering discipline. (Select 500 level or above courses) Some options may be that the courses come from the **Manufacturing Career-Pathways** or **Program Core** courses that are listed in the Master of Engineering in Manufacturing curriculum or from the student's relavant engineering department core courses that are considered as qualifying coursework.

Semester	Course Number	Course Name	Credits	Details
Fall 2021	MFG 553 (MECHENG 553)	Microelectro Syst	3	Also meets Program Core area in the M Eng in Mfg
Winter 2022	ISD 555 MFG 555 (MECHENG 555)	Design Optimization	3	Also meets Program Core area in the M Eng in Mfg
Fall 2021	MFG 563 NAVARCH 562)	Marine Sys Productn	3	Requires MFG Program Committee Approval

At least 3 credits (1 course) letter graded (A-E) Minor Engineering Course
(500 level or above) Select courses that Gain Breadth across engineering Discipline. Some options may be that the courses come from **Integrative Science** courses that are listed in the Master of Engineering in Manufacturing curriculum. This will help students gain breadth across multiple disciplines.

Semester	Course Number	Course Name	Credits	Details
Fall 2021	MFG 587 (MECHENG 587)	Global Manufacturing	3	Also meets Integrative Science Area in M Eng in Mfg
A **student must obtain a GPA of 3.5/4 or greater in the Qualifying Coursework for a pass.** Check with the D. ENg. Pocedures for definition of Pass or Fail.				

Electives (At least 6 letter-graded A-E Credits)

Semester	Course Number	Course Name	Credits	Details
Fall 2021	IOE 515	Stochastic Proc	3	Requires MFG Program Committee Approval
Winter 2022	MFG 466 (IOE 466)	Statistical Quality Control	3	Also meets Career Pathway in M Eng in Mfg
			3.3/4 minimum GPA required	

The above 6 Courses taken toward the MSE in ME under "Rackham" enrollment were approved by MFG Committee to count

At least 6 Credits (letter graded includes S/U) of courses enrolled under

Semester	Course Number	Course Name	Credits	Details
Fall 2022	TO 605/MFG 605	Manufacturing & Supply Operatic	3	Also meets Integrative Science area in M Eng in Mfg
Winter 2023	ISD 599/MFG 599	Smart Manufacturing Systems	3	Required in M Eng in Mfg in Integratvie Science

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: 2023-04-26
Effective Term: Fall 2024

☑	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: 316	Dept (Home): Industrial & Operations Engin Subject: IOE Catalog: 316
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☐	Course Title (full title) INTRODUCTION TO MARKOV PROCESSES	Course Title (full title) INTRODUCTION TO MARKOV PROCESSES
☐	Abbreviated Title (20 char) Intr Markov Proc	Abbreviated Title (20 char) Intr Markov Proc
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Introduction to discrete Markov Chains and continuous Markov processes, including transient and limiting behavior. The Poisson/Exponential process. Applications to reliability, maintenance, inventory, production, simple queues and other engineering problems.	
☐	Full Term Credit Hours Undergraduate Min: 3 Graduate Min: Undergraduate Max: 3 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: Industrial & Operations Engin Catalog: 316

☐

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 265 or STATS 265) and (MATH 214 or 216 or 256 or 286 or 316); (C- or better) Minimum grade requirement: C-	Enforced Prerequisite (254 char) (IOE 265 or STATS 265) and (MATH 214 or 216 or 256 or 286 or 316 or ROB 101); (C- or better) Minimum grade requirement: C-
☐	Credit Exclusions	Credit Exclusions

☐

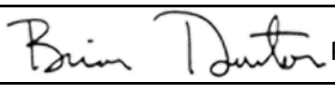
Course Components	Graded Component
☑ Lecture	☐
☐ Seminar	☐
☐ Recitation	☐
☑ Lab	☑
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Xiuli Chao 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: Yavuz Bozer	Date:05/12/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair: Brian Denton		Print: Brian Denton	Date: 05/11/23
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 Introduction to discrete Markov Chains and continuous Markov processes, including transient and limiting behavior. The Poisson/Exponential process. Applications to reliability, maintenance, inventory, production, simple queues and other engineering problems.	Course Description Introduction to discrete Markov Chains and continuous Markov processes, including transient and limiting behavior. The Poisson/Exponential process. Applications to reliability, maintenance, inventory, production, simple queues and other engineering problems.
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:
Degree Requirement

Special resources of facilities required for this course:

Supporting statement:
Cognizant Faculty & the Undergrad Program Committee have agreed after various discussions that ROB 101 should be treated as equivalent to Math 214 as an acceptable prerequisite for IOE 316. Many other Departments have already accepted this exception.

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: 2023-06-15
Effective Term: Winter 2024

☑	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): Industrial & Operations Engin Subject: IOE Catalog: 431
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Human-Centered and User Experience Design
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Hum-Ctr & Usr Ex Des
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) Introduction to the core principles of human-centered and user experience design. Students learn user research techniques like interviews and observations, explore ideation and concept development through sketching and prototyping, and master the art of user testing to gather valuable feedback for iterative design improvements.	
☑	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: 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

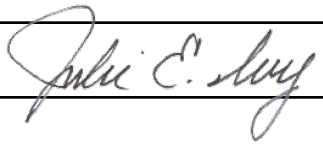
	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char) IOE 333 or equivalent
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

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

Cognizant Faculty Member Name: 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: Yavuz Bozer	Date: 9/8/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair: Julie Ivy		Print: Julie Ivy	Date: 9/8/23
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 Introduction to the core principles of human-centered and user experience design. Students learn user research techniques like interviews and observations, explore ideation and concept development through sketching and prototyping, and master the art of user testing to gather valuable feedback for iterative design improvements.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
This course fulfills a 400-level technical elective in the "C" group.

Special resources of facilities required for this course:

Supporting statement:
Human-centered and user experience design has emerged as a crucial discipline in the digital age. Human factors professionals need to adapt to the changing landscape. Including a UXD course acknowledges the importance of designing products and systems that optimize user satisfaction and engagement. User experience designer is one of the major occupations for HFE graduates. Attached is the syllabus for the proposed course when it was taught as IOE 491. If approved, the permanent course will follow the same syllabus with only minor changes.

There is no overlap with existing IOE courses.

IOE 491: UI/UX Design
Fall Term, 2020
M, W 12-130pm

Course Webpage: Accessible through Canvas:

Instructor:	Professor:	X. Jessie Yang, Ph.D.
	Office:	1640 IOE
	Phone:	734-763-0541 (office)
	Office Hours:	Monday & Wednesday 1-1:30pm
	Email Address:	xijyang@umich.edu
Instructional Assistant:		Jiaxi (Rosemary) Chen
	Email Address:	jiaxich@umich.edu

Reference book

- The Field Guide to Human-Centered Design, IDEO.org (2015), ISBN-10: 0991406311 ISBN-13: 978-0991406319 (https://www.designkit.org/resources/1)
- T2. The Design of Everyday Things: Revised and Expanded Edition (2013), Don Norman, ISBN-10: 9780465050659 ISBN-13: 978-0465050659
- T3. Emotional Design: Why We Love (or Hate) Everyday Things Don Norman, Basic Books; 1 edition (2005), ISBN-10: 0465051367 ISBN-13: 978-0465051366

Course Objectives

1. Understand relevance and importance of User Experience (UX) Design and Human-Centered (HC) Design in society and industry
2. Recognize and identify UX & HC design problems
3. Develop basic concepts, tools, processes, and methods to solve UX and HC design problems

Course Outcomes

1. Given a problem setting, critically discuss the appropriateness of potential design methodologies such as contextual design, scenario-based design, and etc.
2. Gather useful information about users and activities through observation, interview and systematic inquiry.
3. Use and apply classic design standards, guidelines, and patterns.
4. Employ selected design methods at a basic level of competence: card sorting, scenarios of use, personas, storyboarding, sketching, and usability evaluation.
5. Create a low-fidelity prototype for a small system and plan and perform a usability evaluation.

Grades will be based on a weighted average of the following activities:

Component	Description	Weight
Reading	Most weeks, there will be assigned readings. You will be responsible for raise two questions related to the readings and other students, the IA and the instructor will help answer the questions. All questions to assigned readings are to be submitted through Canvas website by 11:59pm 1 day before the class.	20%
Individual Assignment	To get you familiar with the latest UX & HC design issues, practices and principles, you will complete an individual assignment during the course.	25%
Group Project 3 presentations (10%/each presentation) + Report (20%)	This group project forms the spine of the course, applying all of the UX and HC design techniques to a real-world design project, working in teams. The topic for the projects will be up to the teams, but suggestions will be made by the instructor. Regardless of the topic, the project will consist of the following components: 1. Project Declaration 2. User Research & Personas 3. Ideation & Sketching 4. Prototype & Evaluation 5. Design Specification 6. Presentation & Summary For this project, each team will have 3 project presentations that will be rated by both the instructor, the other students and your teammates. At the end of the course, each team will submit a report following the CHI Extended Abstracts Format. https://chi2020.acm.org/authors/chi-proceedings-format/#EAF	50%
In-class participation	Active participation is an important aspect of your learning. Your participation grade is based on your participation in the class-activities (e.g., quizzes).	5%
Total		100%

Numerical Range Grade

97-100%	**A+**	87-89.9%	**B-**	77-79.9%	**C+**	67-69.9%	**D+**
93-96.9%	**A**	83-86.9%	**B**	73-76.9%	**C**	63-66.9%	**D**
90-92.9%	**A-**	80-82.9%	**B-**	70-72.9%	**C-**	60-62.9%	**D-**

Individual Assignment

Each of your will choose a UX & HC topic and write a literature review report on the topic. Undergraduate students are expected to review 5 papers on the topic and graduate students 10 papers. A list of potential topics is available at: https://docs.google.com/spreadsheets/d/1lr54NcR4txYciKxOVuZw96-38QkT2SQ8nsWO3clKREI/edit?usp=sharing. You can also choose your own topic, as long as they are related to UX & HC design. Please discuss with the instructor if you decide to choose your own topic.

Group Project

You will form teams (4 or 5 people/team) and perform a group project during the course. In the project, you will choose a topic of interest to the team and apply the UX and HC design techniques learned in the class to a real-world design project. Please be creative in the topics!

Good example: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/153797/chi20e-sub1381-cam-i15.pdf?sequence=1&isAllowed=y

Quizzes

There will be multiple choices questions after some classes. The questions could be in the form of multiple choices questions or open answer questions.

Tentative Course Outline and Schedule

We will have normal lectures, guest lectures, and in-person sessions.

1. Lectures: Lectures will be pre-recorded and you can watch it asynchronously.
2. Guest Lectures: We expect to have several UX designers from various companies to deliver guest lectures during the course. The exact date of the guest lectures will be announced at least 1 week beforehand.
3. In-person Sessions: In-person sessions will occur during the usual class time (M, W 12-130pm). The in-person sessions will be used to discuss your individual assignments. Each of you will have 1-on-1 meetings with the instructor on a rolling basis (10-15 minutes/meeting). For the 1-on-1s, you can choose to come to the class or to meet on zoom. The in-person sessions will begin from the second week onward and the schedule will be announced later in Week 1.

Date or Week	Content	Group Project + Individual Assignment
Week 1 (08/31, 09/02	Syllabus & Intros; What is UX and HC Design?	
Week 2 (09/07, 09/09)	UX & HC Design Process	• 09/07 Group project: get to know your teammates and brainstorm ideas • 1st individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 3 (09/14, 09/16)	User Research I	• Group project: on-demand meeting with instructor to discuss your group project • 09/16 Group project declaration: email the instructor your team composition and the project title • 1st individual assignment 1-on-1 meeting with instructor
Week 4 (09/21, 09/23)	User Research II	• 1st individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 5 (09/28, 09/30)	Scenario-based Design	• Group project: on-demand meeting with instructor to discuss your group project • 09/30 individual assignment declaration: email the instructor your assignment title
Week 6 (10/05, 10/07): Group Project Presentation 1 (No Reading Assignment) Meet Synchronous on Zoom		
Week 7 (10/12, 10/14)	Ideation & Sketching	• Group project: on-demand meeting with instructor to discuss your group

		project • 2nd individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 8 (10/19, 10/21)	Prototyping	• 2nd individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 9 (10/26, 10/28)	Evaluation	• Group project: on-demand meeting with instructor to discuss your group project • 2nd individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 10 (11/2, 11/4)	Specifications	• 3rd individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 11 (11/9, 11/11): **Group Project Presentation 2 (No Reading Assignment)** **Meet Synchronous on Zoom**		
Week 12 (11/16, 11/18)	Special Topics on UX & HC Design	• Group project: on-demand meeting with instructor to discuss your group project • 3rd individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 13 (11/23, 11/25)	Special Topics on UX & HC Design	• 3rd individual assignment 1-on-1 meeting with instructor (check your schedule)
Week 14 (11/30, 12/02): **Group Project Final Presentation (Meet Synchronous on Zoom)** **Group Project final report due 12/02 5pm**		
Week 15 (12/07): No class **Individual Assignment final report due at 12/07 5pm**		

Note: Syllabus is subject to change and please refer to CANVAS for the latest update

Class Rules and Policies

1. All questions to assigned readings are to be submitted through Canvas website by 11:59pm 1 day before the class.

2. if you are unable to attend class or submit work (questions, presentation, and etc.) or meeting with the instructor on time due to illness or family emergency, notify the Course Instructor before the critical deadline, and be prepared to: (i) provide verification if asked and (ii) make up work promptly and honestly. A make-up assignment can be arranged for legitimate reasons (e.g. attending a conference). A general rule: A make-up assignment is expected to be more difficult.

3. You MUST follow the Honor Code requirements at all times.

4. All grade disputes must be addressed to the instructor along with a written explanation. Disputes will only be accepted if submitted within one week from the date that the graded is released on Canvas. Refer to the "Appendix – Handy Tips and Suggestions from the GSI" for details.

University of Michigan Disability Statement
The University of Michigan is committed to providing equal opportunity for participation in all programs, services and activities. Request for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G664 Haven Hall. The SSD phone number is 734-763-3000. Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation (VISA) form. Please present this form to the IOE465 Instructor or GSI at the start of the term or at least two weeks prior to the accommodation date (homework, exam, etc…).

College of Engineering General Honor Code Policy Statement
All students in the class are presumed to be decent and honorable, and all students in the class are bound by the College of Engineering Honor Code*. You may not seek to gain an unfair advantage over your fellow students; you may not consult, look at, or possess the unpublished work of another without their permission; and you must appropriately acknowledge your use of another's work. Any violation of the honor policies appropriate to each piece of course work will be reported to the Honor Council, and if guilt is established penalties may be imposed by the Honor Council and Faculty Committee on Discipline. Such penalties can include, but are not limited to, letter grade deductions or expulsion from the University. If you have any questions about this course policy, please consult the Course Instructor.

* Please read the UM College of Engineering Honor Code
http://www.engin.umich.edu/students/honorcode/code/index.html

Honor Code Policies Specific to IOE491

1. Lecture videos and notes

You may share lecture notes with another student in this class, but you may not distribute them in public domain without written permission from the Course Instructor. You may not distribute or share lecture videos without written permission from the Course Instructor.

2. Individual Assignment (Limited collaboration)

You may discuss your assignment with your fellow students at the conceptual level, but must complete the assignment, from draft to final form, on your own. Copying or comparing with another student's work, in any form or at any length, is forbidden. Plagiarism is strictly forbidden.

3. Participation: In-class activities and group project

The extent and quality of your participation in classroom discussions, activities and group project count toward your final grade.

University of Michigan
Fall 2020 Instructor Report With Comments
IOE 491 008 - IOE 491 881
X Jessie Yang

26 out of 32 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)	15	9	2	0	0	0	4.6	4.6	4.5
My interest in the subject has increased because of this course. (Q1632)	14	6	4	2	0	0	4.6	4.2	4.2
I knew what was expected of me in this course.(Q1633)	14	4	7	1	0	0	4.6	4.5	4.4
Overall, this was an excellent course.(Q1)	14	7	3	2	0	0	4.6	4.4	4.3
I had a strong desire to take this course.(Q4)	13	7	6	0	0	0	4.5	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	16	5	0	0	3.0	2.9	2.8
How did you participate in this course? (SA=Attended most synchronously, A=Attended most asynchronously, N=Attended most in person, D=Attended some in person and some online) (Q1854)	7	14	1	4	0	0	4.1	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, X Jessie Yang was an excellent teacher.(Q2)	16	7	1	1	0	0	4.7	4.7	4.7
X Jessie Yang seemed well prepared for class meetings.(Q230)	16	7	2	0	0	0	4.7	4.8	4.7
X Jessie Yang explained material clearly.(Q199)	16	6	4	0	0	0	4.7	4.7	4.7
X Jessie Yang treated students with respect.(Q217)	21	4	1	0	0	0	4.9	4.9	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median
The textbook made a valuable contribution to the course. (Q64)	3	2	9	0	3	8	3.1	3.9
Grades were assigned fairly and impartially. (Q365)	14	8	1	3	0	0	4.6	4.6

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median
X Jessie Yang gave clear explanations. (Q201)	13	7	4	0	1	0	4.5	4.6
X Jessie Yang made good use of examples and illustrations. (Q202)	16	8	1	1	0	0	4.7	4.7
X Jessie Yang appeared to have a thorough knowledge of the subject. (Q207)	21	4	1	0	0	0	4.9	4.9
X Jessie Yang was willing to meet and help students outside class. (Q219)	22	3	1	0	0	0	4.9	4.7
X Jessie Yang used class time well. (Q229)	18	6	1	1	0	0	4.8	4.6

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 2021 Instructor Report Without Comments
IOE 491-008: Spec Top Ind Engr
X Jessie Yang

10 out of 34 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	0	0	0	0	4.7	4.5	4.5
My interest in the subject has increased because of this course. (Q1632)	5	4	1	0	0	0	4.5	4.2	4.2
I knew what was expected of me in this course.(Q1633)	5	5	0	0	0	0	4.5	4.5	4.4
I had a strong desire to take this course.(Q4)	5	3	2	0	0	0	4.5	4.0	4.1
As compared with other courses of equal credit, the workload for this course was (SA=Much Lighter, A=Lighter, N=Typical, D=Heavier, SD=Much Heavier). (Q891)	1	1	7	1	0	0	3.1	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
X Jessie Yang seemed well prepared for class meetings.(Q230)	8	2	0	0	0	0	4.9	4.8	4.7
X Jessie Yang explained material clearly.(Q199)	8	1	1	0	0	0	4.9	4.7	4.7
X Jessie Yang treated students with respect.(Q217)	9	1	0	0	0	0	4.9	4.9	4.8

Responses to questions about the course:

	SA	A	N	D	SD	N/A	Your Median
Overall, this was an excellent course. (Q1)	6	3	0	1	0	0	4.7
Examinations covered the important aspects of the course. (Q356)	3	0	1	0	1	5	4.7

Responses to questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median
Overall, X Jessie Yang was an excellent teacher. (Q2)	7	2	1	0	0	0	4.8
X Jessie Yang stressed important points in lectures/discussions. (Q203)	8	2	0	0	0	0	4.9
X Jessie Yang appeared to have a thorough knowledge of the subject. (Q207)	9	1	0	0	0	0	4.9
X Jessie Yang acknowledged all questions insofar as possible. (Q216)	9	1	0	0	0	0	4.9
X Jessie Yang encouraged constructive criticism. (Q218)	9	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.

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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: 2023-06-28
Effective Term: Fall 2024

☑	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): Industrial & Operations Engin Subject: IOE Catalog: 435		
☑	☐ Course is Cross-Listed with Other Departments			☑ Course is Cross-Listed with Other Departments		
	Department	Subject	Catalog Number	Department	Subject	Catalog Number
				Robotics - ROB - 435		
☑	Course Title (full title)			Course Title (full title) Quantifying Human Motion Through Wearable Sensors		
☑	Abbreviated Title (20 char)			Abbreviated Title (20 char) Quant Hum Mot		
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) Hands-on introduction to inertial measurement units (IMUs) for measuring human motion. Includes random processes, autocorrelation, cross-correlation, Fourier transforms, orientation representations, reference frames, and filters (low-pass, high-pass, Kalman). These concepts are applied to estimating biomechanical measures (e.g., body angles, gait phases, positions) and selecting metrics to support decision making.					
☑	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
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration

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

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

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

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) (ROB 101 OR MATH 214) AND IOE 265 AND (IOE 333 OR ROB 204) or graduate standing. Minimum grade requirement: C-
☐	Credit Exclusions	Credit Exclusions

☑

Course Components

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

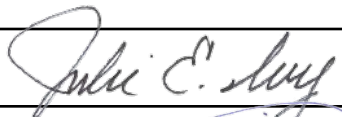
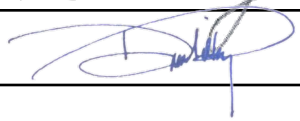
Terms Typically Offered
- ☐ Fall
- ☑ Winter
- ☐ Spring
- ☐ Summer
- ☐ Spring/Summer

Cognizant Faculty Member Name: Leia Stirling

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: Yavuz Bozer	Date: 9/8/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair: Julie Ivy		Print: Julie Ivy	Date: 9/8/23
Cross-Listed Department Chair:		Print: Dawn Tilbury	Date: 9-11-23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description	Course Description Hands-on introduction to inertial measurement units (IMUs) for measuring human motion strategies. Includes random processes, autocorrelation, cross-correlation, Fourier transforms, orientation representations, reference frames, and filters (low-pass, high-pass filters, Kalman). These concepts are applied to estimating biomechanical measures (e.g., body joint angles, torso posture, phases of gait, positions) and selecting metrics to support decision making reliant on human movement.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:
This will be part of the IOE Tech Electives, in Group C.

Special resources of facilities required for this course:

Supporting statement:

Course Number Selection: IOE 435/ROB 435 was proposed since the course could have the same number in both departments. The proposed course teaches students tools to process data that has been collected from motion sensors.

Course Justification: The original IOE 491 one course justification is provided as an Appendix to this Statement. In brief, this course does not overlap with current IOE courses and expands student's ability to perform ergonomic assessments. From a Robotics perspective, this course will build on their signal processing and filtering skills with applications to quantifying human performance, which will support assessments of human-robot interactions. This course has attracted students from IOE, Robotics, Mechanical Engineering, Computer Science, and Kinesiology during the first two offerings.

Syllabus from offerings: The syllabus from the two initial offerings and from the proposed permanent course are included as attachments with this submission.

Please refer to the next page for additional information.

Appendix: Original Course Justification Statement

IOE 491: Quantifying Human Motion Through Wearable Sensors

Prof. Leia Stirling
Proposed September 2019

Why is this course needed?

There is a growing interest to use wearable technology to assess human performance outside a laboratory environment. These measures in operationally relevant locations (e.g., in outdoor environments, hospitals, factories, warehouses) permits understanding of task strategies and work processes, as well as musculoskeletal risk factors. Commercial wearable sensors include fitness trackers and smart watches, which can provide information to users on their heart rates, step counts, and GPS localization. Statista[1] estimates the global revenue for wearable sensors was valued at $26.43 billion U.S. Dollars in 2018 and is expected to grow to $73.27 billion U.S. Dollars by 2022. In 2018, there were an estimated 174.26 million units of wearable devices shipped worldwide. Haghi et al.[2] summarize the opportunities for wearable sensors for healthcare monitoring, while Seshadri et al.[3] provide a review of using wearable sensing for monitoring athletes. Wearables are also starting to be used in workplace environments for monitoring physical fatigue[4] and optimizing warehouse tasks.[5] The IOE department has strength in Ergonomics and a course in wearable sensors as related to human motion would support educational outcomes and prepare students for integrating wearable motion sensors in a variety of operational domains.

The use of wearable technology for measuring human motion has several complexities that must be considered, including how estimations of position and posture are affected by signal noise and sensor placement. The course will focus on using Inertial Measurement Units (IMUs), which contain tri-axial accelerometers, gyroscopes, and magnetometers. To use these sensors, the course will provide learning objectives to build the skill-set needed to work with the measured signals in a biomechanically relevant manner. Topic areas will include:

- Cognitive Task Analysis: Techniques and methods for understanding the important decision making factors for a task. These methods will be related to defining metrics of motor performance.
- Probability and Statistics: Random processes, autocorrelation, cross-correlation, power spectral density, Nyquist Frequency

[1] https://www.statista.com/statistics/610447/wearable-device-revenue-worldwide/
[2] M. Haghi, K. Thurow, I. Habil, R. Stoll, and M. Habil, "Wearable Devices in Medical Internet of Things," *Heal. Informatics Res.*, vol. 23, no. 1, pp. 4–15, 2017.
[3] D. R. Seshadri, R. T. Li, J. E. Voos, J. R. Rowbottom, C. M. Alfes, C. A. Zorman, and C. K. Drummond, "Wearable sensors for monitoring the internal and external workload of the athlete," npj Digit. Med., vol. 2, no. 1, 2019.
[4] Z. Sedighi Maman, M. A. Alamdar Yazdi, L. A. Cavuoto, and F. M. Megahed, "A data-driven approach to modeling physical fatigue in the workplace using wearable sensors," *Appl. Ergon.*, 2017.
[5] A. Diete, T. Sztyler, L. Weiland, and H. Stuckenschmidt, "Exploring a multi-sensor picking process in the future warehouse," *UbiComp 2016 Adjun. - Proc. 2016 ACM Int. Jt. Conf. Pervasive Ubiquitous Comput.*, pp. 1755–1758, 2016.

- Dynamics: Fourier transforms, reference frames, orientation representations, equations of motion
- IMU analysis: Direct estimation, drift correction, filters (low-pass, high-pass, Kalman)
- Biomechanics applications: Aligning IMUs to body reference frames, estimating body joint angles, estimating torso postures, detecting phases of gait

Pre-requisites for this course will be MATH 215, IOE 265, IOE 333, and/or permission of instructor. These topics will be presented in a manner that is approachable to students that have not had any dynamics or controls courses.

In context with the ABET requirements, this course will map to the criteria as follows:

(a) an ability to apply knowledge of mathematics, science, and engineering. The course provides learning objectives aligned with applying mathematical methods to biomechanics problems.

(b) an ability to design and conduct experiments, as well as to analyze and interpret data. Assignments within the course include the collection of data from wearable sensors and the interpretation of these data.

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. The course will provide students with a realistic understanding of the applicability of sensors for specific biomechanics problems. The course will include ethical considerations when using human data, as well as considerations of how the sensors can be used to inform health and safety.

(d) an ability to function on multidisciplinary teams. The course will not explicitly focus on multidisciplinary teams, but will present techniques that space engineering disciplines that are integrated to use wearable sensors.

(e) an ability to identify, formulate, and solve engineering problems. The course provides open-ended problems that require students to formulate a solution and test the solution in an engineering context, specifically related to biomechanics.

(f) an understanding of professional and ethical responsibility. The course includes a lecture on the ethics of using personal human data.

(g) an ability to communicate effectively. The course includes final project presentations that will provide an opportunity for oral communication skills, as well as problem sets that require written communication.

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. We do not specifically focus on global, economic, or environmental questions explicitly. The course will consider education related to societal concerns of health monitoring and ethics of data monitoring.

(i) *a recognition of the need for, and an ability to engage in life-long learning*. The final project in the course requires the use of methods in the class to develop an outreach activity. As part of the course, students will also receive a lecture on outreach and education planning to support their final project development.

(j) *a knowledge of contemporary issues.* As highlighted, wearable sensors are a growing market with many opportunities for students.

(k) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.* The course includes techniques from several core engineering disciplines that will be integrated by students in the context of wearable sensors.

How does this course improve the undergraduate curriculum?
The course will introduce IOE students to key concepts in dynamics and signal processing in the context of biomechanics applications. The course will build the students theoretical understanding of wearable sensors, as well as demonstrate how these methods are applied to biomechanics. The course provides continued experiences in communication, and will apply engineering ethical questions for consideration in the context of human motion sensing.

How does the course meet the needs of our students and society?
This course provides a foundation for students to use new technologies that are being integrated across industry and government to aid in operational decision making. It is important that our students not use these technologies as black boxes, but understand the limitations and benefits of these systems. This understanding will lead to more informed decision making.

IOE 491: Quantifying Human Motion Through Wearable Sensors
Winter 2020

Faculty	Professor Leia Stirling (she/her/hers)	leias@umich.edu Industrial & Operations Engineering G634 IOE Building 734-647-6828 (office) Office hours: Fri. 3 – 4 pm, or by appointment
GSI	Michael Potter (he/him/his)	mvpotter@umich.edu Office hours: Tues. 4 – 6 pm, 2858 IOE Building

Course Meetings

This course meets two times each week:

Mondays/Wednesdays, 12:00 – 1:30 pm, Room 1680 IOE

You are expected to attend all three class hours each week. Class will begin promptly at 12 pm and finish at 1:20 pm.

Pre-requisites

MATH 215, IOE 265, IOE 333, and/or permission of instructor

Course Web Site

The course Canvas site will contain the following items, among others:

- Announcements
- Lecture slides
- Links to assignments
- Required and supplementary reading

Catalog Description

Quantifying Human Motion Through Wearable Sensors
This course introduces the use of inertial measurement units for measuring human motion strategies. Includes cognitive task analysis, random processes, autocorrelation, cross-correlation, power spectral density, Fourier transforms, orientation representations, reference frames, filters (low-pass, high-pass filters, Kalman). These concepts are applied to estimating biomechanical measures (e.g., body joint angles, torso posture, phases of gait, positions). (*3 credits*)

Course Objectives

IOE 491 will integrate engineering concepts to the measurement of human motion strategies. Specifically, the objectives of the course are to:

1. Provide a set of tools for measuring human motion using wearable sensors.
2. Provide methods for defining metrics of human motion strategy for task-specific decision making.

Course Outcomes

Upon completion of this course, you should be able to:

1. Identify and describe ethical considerations for human monitoring.
2. Give examples of tools used for work analysis and apply these tools to biomechanics performance for a specified task.
3. Describe the phases of gait.
4. Express the relationship between position, velocity, and acceleration for fixed and moving reference frames using state space notation.
5. Describe the relationship between a Fourier Transform of a signal and the time domain of the signal, including how a low and high pass filter affects these signals.
6. Calculate descriptors of random processes (e.g., autocorrelation, cross-correlation between two signals, Nyquist Frequency) and describe their importance.
7. Describe the similarities and differences between Euler angles, Direction Cosine Matrices, and quaternions, and convert between these rotational representations.
8. Calculate a velocity and position from an acceleration signal, implementing a zero-velocity update in estimates of position.
9. Describe the Kalman filter loop, including the form of the dynamics model and observation model in state space form for estimating IMU orientation, and the measures that are necessary to iterate an estimate.
10. Describe methods for aligning IMUs to biomechanical reference frames.
11. Use an IMU to estimate biomechanical measures (e.g., joint angles, torso posture, phases of gait).
12. Give example considerations for effective science communication using the Aurbach et al. categories.

Textbook

There is no required textbook for this course. Reading materials from a variety of sources will be made available on Canvas.

Tentative Schedule

Date	Lecture	Topic	Reading	Assignments
Jan 8	1	Course introduction		
Jan 13	2	Human monitoring ethics	Ethics in Engineering Chapter 2	HW1 assigned
Jan 15	3	Defining metrics of performance	Beyer and Holtzblatt (Chapter 3, 6)	
Jan 22	4	Equations of motion	Chapter excerpts from Greenwood	HW1 due
Jan 27	5	Equations of motion		HW2 assigned

Jan 29	6	Human motion review *Guest: Dr. Stephen Cain*	Chapter excerpts from Perry and Burnfield	
Feb 3	7	Reference frame representations *Guest: Dr. Rachel Vitali*	Diebel (2006)	HW2 due HW3 assigned
Feb 5	8	Probability	Chapter excerpts from Devore	
Feb 10	9	Probability		HW3 due HW4 assigned
Feb 12	10	Fourier transforms		
Feb 17	11	Filters		HW4 due
Feb 19	12	Filters		
Feb 24	13	**Mid-Term Exam**		
Feb 26	14	Drift correction methods	Ojeda and Borenstein (2007)	HW5 assigned
Mar 9	15	Kalman filters	Chapter excerpts from Brown and Hwang	Final project teams defined
Mar 11	16	Kalman filters		HW5 due HW6 assigned
Mar 16	17	IMU orientation estimation		
Mar 18	18	Planning Outreach Activities *Guest: Dr. Elyse Aurbach*	Aurbach et al. (2019)	HW6 due
Mar 23	19	Aligning IMU frames to body reference frames *Guest: Dr. Rachel Vitali*	Picerno (2017)	
Mar 25	20	Principal component analysis (PCA) for estimating body axes	Shlens (2014)	HW7 assigned Final project proposals due
Mar 30	21	In-class project workshop		
Apr 1	22	Estimating joint angles		HW7 due HW8 assigned
Apr 6	23	Estimating torso orientation		
Apr 8	24	Detecting falls	Mubashir et al. (2013)	
Apr 13	25	A return to defining metrics and ethics		HW8 due
Apr 15	26	Final Project Presentations		
Apr 20	27	Final Project Presentations		

Grading

The grading scheme for undergraduate and graduate students is the same. However, graduate students are required to complete additional components within the assignments and for the final project.

Item	Points
Assignments	40
Mid-term Exam	20
Final Project	20
Final Exam	20
Total Points	**100**

Assignments

Students may discuss the assignments together, but each student must do his/her/their own work and turn in his/her/their own assignment. Assignments are due at the beginning of class. Late assignments will only be accepted with permission from the instructor.

Exams

There will be two exams in the course, a mid-term and final exam. Exams are taken individually and are closed notes. A single piece of paper (standard 8.5" x 11") may be used to create a reference sheet that can be brought to the mid-term exam. The paper may have information on the front and back. For the final exam, you may use two reference sheets (two pieces of standard paper).

Final Project

Students will be placed in groups of 3 – 5 people. Students should identify a concept from class that can be applied to an area of mutual interest within the team and related to measuring human motion. Teams must provide a proposed topic by the date stated in the schedule. For the project, your team will develop an outreach activity following the communication skills outlined in Aurbach et al. 2019. Final projects include a written and oral component and will be described in more detail during the term.

Diversity, Equity, and Inclusion

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

I am dedicated to helping each of you achieve all that you can in this class. I may, either in lecture or smaller interactions, accidentally use language that creates offense or discomfort. Should I do this, please contact me and help me understand and avoid making the same mistake again.

Academic integrity	The College of Engineering Honor Code is a statement of ethical standards by which the faculty and students of the College of engineering conduct themselves. Both undergraduate and graduate students are bound by the provisions of the Honor Code; ignorance of it is no excuse to infringe upon it. You are expected to read and abide by the Honor Code: http://elc.engin.umich.edu/wp-content/uploads/sites/19/2019/03/Honor-Code-Pamphlet-2018.pdf
Accommodations	The University of Michigan is committed to providing equal opportunity for participation in all programs, services and activities. Request for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G664 Haven Hall. The SSD phone number is 734-763-3000 and webpage is http://ssd.umich.edu/. Once your eligibility for an accommodation has been determined you will be issued a verified individual services accommodation (VISA) form. Please present this form to me at the beginning of the term, or at least two weeks prior to the need for the accommodation (test, project, etc…). Any information you provide is private and confidential and will be treated as such.
Student well-being	University of Michigan is committed to advancing the mental health and wellbeing of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, contact Counseling and Psychological Services (CAPS) at (734) 764-8312 and https://caps.umich.edu/ during and after hours, on weekends and holidays, or through its counselors physically located in schools on both North and Central Campus. You may also consult University Health Service (UHS) at (734) 764-8320 and https://www.uhs.umich.edu/mentalhealthsvcs, or for alcohol or drug concerns, see www.uhs.umich.edu/aodresources. For a listing of other mental health resources available on and off campus, visit: http://umich.edu/~mhealth/.

IOE 491: Quantifying Human Motion Through Wearable Sensors
Fall 2022

Faculty	Professor Leia Stirling (she/her/hers)	leias@umich.edu Industrial & Operations Engineering G634 IOE Building 734-647-6828 (office) Office hours: Wed 1:30 – 2:30 pm, or by appointment
GSI	Hannah Larson (she/her/hers)	hmlarson@umich.edu Office hours: Tues. 3 – 4 pm, Thurs. 12 – 1 pm 2858 IOE Building
Course Meetings	This course meets two times each week: Mondays/Wednesdays, 12:00 – 1:30 pm, Room 1680 IOE	
Pre-requisites	MATH 215, IOE 265, IOE 333, and/or permission of instructor	
Course Web Site	The course Canvas site will contain the following items, among others: • Announcements • Weekly calendar • Lecture slides and recordings • Links to assignments • Required and supplementary reading • Link to Piazza discussion board	
Catalog Description	*Quantifying Human Motion Through Wearable Sensors* This course introduces the use of inertial measurement units for measuring human motion strategies. Includes cognitive task analysis, random processes, autocorrelation, cross-correlation, power spectral density, Fourier transforms, orientation representations, reference frames, filters (low-pass, high-pass filters, Kalman). These concepts are applied to estimating biomechanical measures (e.g., body joint angles, torso posture, phases of gait, positions). (*3 credits*)	
Course Objectives	IOE 491 will integrate engineering concepts to the measurement of human motion strategies. Specifically, the objectives of the course are to: 1. Provide a set of tools for measuring human motion using wearable sensors. 2. Provide methods for defining metrics of human motion strategy for task-specific decision making.	

Course Outcomes

Upon completion of this course, you should be able to:

1. Identify and describe ethical considerations for human monitoring.
2. Give examples of tools used for work analysis and apply these tools to biomechanics performance for a specified task.
3. Describe the phases of gait.
4. Express the relationship between position, velocity, and acceleration for fixed and moving reference frames using state space notation.
5. Describe the relationship between a Fourier Transform of a signal and the time domain of the signal, including how a low and high pass filter affects these signals.
6. Calculate descriptors of random processes (e.g., autocorrelation, cross-correlation between two signals, Nyquist Frequency) and describe their importance.
7. Describe the similarities and differences between Euler angles, Direction Cosine Matrices, and quaternions, and convert between these rotational representations.
8. Calculate a velocity and position from an acceleration signal, implementing a zero-velocity update in estimates of position.
9. Describe the Kalman filter loop, including the form of the dynamics model and observation model in state space form for estimating IMU orientation, and the measures that are necessary to iterate an estimate.
10. Describe methods for aligning IMUs to biomechanical reference frames.
11. Use an IMU to estimate biomechanical measures (e.g., joint angles, torso posture, phases of gait).
12. Give example considerations for effective science communication using the Aurbach et al. categories.

Textbook

There is no required textbook for this course. Reading materials from a variety of sources will be made available on Canvas.

Tentative Schedule

Date	Lecture	Topic	Reading	Assignments
Aug 29	1	Course introduction		
Aug 31	2	Human movement	Chapter excerpts from Perry and Burnfield	HW1 assigned
Sept 7	3	Defining metrics of performance	Beyer and Holtzblatt (Chapter 3, 6)	
Sept 12	4	Defining metrics of performance		

Sept 14	5	Human monitoring ethics	Ethics in Engineering Chapter 2	HW1 due HW2 assigned
Sept 19	6	Integrating new technologies in industry *Guest: Dr. Bob Fox*		
Sept 21	7	Reference frame representations	Diebel (2006)	HW2 due HW3 assigned
Sept 26	8	Reference frame representations		
Sept 28	9	Equations of Motion		
Oct 3	10	Probability	Chapter excerpts from Devore	
Oct 5	11	Fourier transforms		HW3 due
Oct 10	12	**Midterm**		
Oct 12	13	Planning Outreach Activities *Guest: Dr. Elyse Aurbach*	Aurbach et al. (2019)	
Oct 19	14	Filters		HW4 assigned
Oct 24	15	Filters		Final project teams defined
Oct 26	16	Drift correction methods	Ojeda and Borenstein (2007)	
Oct 31	17	Kalman filters	Welch and Bishop (2006)	
Nov 2	18	IMU orientation estimation		HW4 due HW5 assigned
Nov 7	19	Aligning IMU frames to body reference frames	Vitali (2020)	
Nov 9	20	Principal component analysis (PCA) for estimating body axes	McGrath et al. (2018)	Final project proposals due
Nov 14	21	In-class workshop for final project		HW 5 due
Nov 16	22	Estimating joint angles and torso orientation	Shlens (2014)	HW 6 assigned
Nov 21	23	Risk analysis and defining new policies *Guest: Adam Finkel*		
Nov 28	24	In-class workshop and peer review		
Nov 30	25	Further examples of defining metrics for decision making	Mubashir et al. (2013)	Peer review forms due HW6 due
Dec 5	26	Final Project Presentations		
Dec 7	27	Final Project Presentations		

Grading

The grading scheme for undergraduate and graduate students is the same. However, graduate students are required to complete additional components within the assignments and for the final project.

Item	Points
Assignments	50
Mid-term Exam	15
Final Project	35
Total Points	**100**

Assignments

Students may discuss the assignments together, but each student must do their own work and turn in their own assignment. Assignments are due at the beginning of class. Late assignments will only be accepted with permission from the instructor.

Exams

There will be one midterm exam in the course. The exam is taken individually and is open book. The exam is "take-home" in that you may complete them during the days they are assigned. Exams must be completed individually. There is no discussion permitted during the exams. Solutions must be uploaded to Canvas by the stated due date.

Final Project

Students will be placed in groups of 3 – 4 people. Students should identify a concept from class that can be applied to an area of mutual interest within the team and related to measuring human motion. Teams must provide a proposed topic by the date stated in the schedule. For the project, your team will develop a public engagement activity following the communication skills outlined in Aurbach et al. 2019. Final projects include a written and oral component and will be described in more detail during the term.

Diversity, Equity, and Inclusion

At U-M Industrial and Operations Engineering (IOE), we value all people and are committed to promoting diversity, equity and inclusion (DEI) in its fullest form for everyone in our community and beyond. We advance scientific and mathematical methods and develop engineering technologies to help solve human-centered local and global challenges; meaning we impact people, processes, and systems through generating and analyzing data across a range of applications. Not only does incorporating DEI principles make our solutions more powerful, applicable, and ethical, promoting and fostering DEI is a core value of the IOE community and leadership. At U-M IOE we view DEI as interwoven with our research, teaching and community involvement.

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All

members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

I am dedicated to helping each of you achieve all that you can in this class. I may, either in lecture or smaller interactions, accidentally use language that creates offense or discomfort. Should I do this, please contact me and help me understand and avoid making the same mistake again.

Academic integrity	The College of Engineering Honor Code is a statement of ethical standards by which the faculty and students of the College of engineering conduct themselves. Both undergraduate and graduate students are bound by the provisions of the Honor Code; ignorance of it is no excuse to infringe upon it. You are expected to read and abide by the Honor Code: http://elc.engin.umich.edu/wp-content/uploads/sites/19/2019/03/Honor-Code-Pamphlet-2018.pdf
Accommodations	The University of Michigan is committed to providing equal opportunity for participation in all programs, services and activities. Request for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G664 Haven Hall. The SSD phone number is 734-763-3000 and webpage is http://ssd.umich.edu/. Once your eligibility for an accommodation has been determined you will be issued a verified individual services accommodation (VISA) form. Please present this form to me at the beginning of the term, or at least two weeks prior to the need for the accommodation (test, project, etc…). Any information you provide is private and confidential and will be treated as such.
Student well-being	Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being on the Well-being for U-M Students website. You can also search for additional resources on that website.
Reporting Concerns and Misconduct	The Department of Industrial and Operations Engineering is dedicated to providing an environment that is inclusive, supportive, and respectful. If we fall short, we want to hear from you.

	Use our website to learn about ways to report concerns or misconduct anonymously, confidentially, or formally, and know that you will be heard, you will be taken seriously, and the U-M IOE community will stand behind you https://sites.google.com/umich.edu/report-concerns-and-misconduct/
Title IX Statement & Resources	Violence and harassment based on sex and gender are civil rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources here: • Sexual Assault and Prevention Center (SAPAC) 24-hour confidential crisis line 734-936-3333, sapac.umich.edu • Counseling and Psychological Services (CAPS) 734-764-8312, caps.umich.edu • University of Michigan Police (DPSS) 734-763-1131 (or 911 for emergency), dpss.umich.edu • Office of Student Conflict Resolution 724-936-6308, oscr.umich.edu

IOE 468/ROB 468: Quantifying Human Motion Through Wearable Sensors
Winter 2025

Faculty	Professor Leia Stirling (she/her/hers)	leias@umich.edu Industrial & Operations Engineering G634 IOE Building 734-647-6828 (office) Office hours: TBD or by appointment
GSI	TBD	

Course Meetings

This course meets two times each week:

TBD

Pre-requisites

MATH 215 OR ROB 101, IOE 265, IOE 333 OR ROB 204, and/or permission of instructor

Course Web Site

The course Canvas site will contain the following items, among others:

- Announcements
- Weekly calendar
- Lecture slides and recordings
- Links to assignments
- Required and supplementary reading
- Link to Piazza discussion board

Catalog Description

Quantifying Human Motion Through Wearable Sensors
Hands-on introduction to inertial measurement units (IMUs) for measuring human motion strategies. Includes random processes, autocorrelation, cross-correlation, Fourier transforms, orientation representations, reference frames, and filters (low-pass, high-pass filters, Kalman). These concepts are applied to estimating biomechanical measures (e.g., body joint angles, torso posture, phases of gait, positions) and selecting metrics to support decision making reliant on human movement. (*3 credits*)

Course Objectives

This course will integrate engineering concepts to the measurement of human motion strategies. Specifically, the objectives of the course are to:

1. Provide a set of tools for measuring human motion using wearable sensors.
2. Provide methods for defining metrics of human motion strategy for task-specific decision making.

Course Outcomes

Upon completion of this course, you should be able to:

1. Describe the phases of gait.
2. Express the relationship between position, velocity, and acceleration for fixed and moving reference frames using state space notation.
3. Describe the relationship between a Fourier Transform of a signal and the time domain of the signal, including how a low and high pass filter affects these signals.
4. Calculate descriptors of random processes (e.g., autocorrelation, cross-correlation between two signals, Nyquist Frequency) and describe their importance.
5. Describe the similarities and differences between Euler angles, Direction Cosine Matrices, and quaternions, and convert between these rotational representations.
6. Calculate a velocity and position from an acceleration signal, implementing a zero-velocity update in estimates of position.
7. Describe and implement the Kalman filter loop, including the form of the dynamics model and observation model in state space form for estimating IMU orientation, and the measures that are necessary to iterate an estimate.
8. Describe methods for aligning IMUs to biomechanical reference frames.
9. Use an IMU to estimate biomechanical measures (e.g., joint angles, torso posture, phases of gait).
10. Identify and describe ethical considerations for human monitoring.
11. Give examples of tools used for work analysis and apply these tools to biomechanics performance to define relevant metrics for a specified task.

Textbook

There is no required textbook for this course. Reading materials from a variety of sources will be made available on Canvas.

Tentative Schedule **(based on WN 24 dates)**

Date	Lecture	Topic	Reading	Assignments
Jan 10	1	Course introduction		
Jan 15	--	**No Class**		
Jan 17	2	Human movement	Chapter excerpts from Perry and Burnfield	HW1 assigned
Jan 22	3	Reference frame representations	Diebel (2006)	

Jan 24	4	Reference frame representations		HW 1 due, HW2 assigned
Jan 29	5	Equations of Motion		
Jan 31	6	Random Processes and Fourier Transforms		
Feb 5	7	Random Processes and Fourier Transforms		HW 2 due, HW 3 assigned
Feb 7	8	Filters		
Feb 12	9	Filters		
Feb 14	10	Kalman Filters	Welch and Bishop (2006)	HW 3 due, HW4 assigned
Feb 19	11	Kalman Filters		
Feb 21	12	Extended Kalman Filter for IMU Orientation		HW 4 due, HW5 assigned
Feb 26	--	**No Class**		
Feb 28	--	**No Class**		
March 4	13	Extended Kalman Filter for IMU Orientation		
March 6	14	Personal Dead Reckoning	Ojeda and Borenstein (2007)	
March 11	15	IMU Alignment	Vitali (2020)	HW 5 due, HW 6 assigned
March 13	16	Principal component analysis (PCA) for estimating body axes	McGrath et al. (2018)	
March 18	17	Estimating joint angles and torso orientation	Shlens (2014)	HW 6 due, HW 7 assigned
March 20	18	Estimating joint angles and torso orientation		
March 25	19	Defining metrics of performance		
March 27	20	Defining metrics of performance		HW 7 due, HW 8 assigned
April 1	21	Reliability and Validity of Metrics		
April 3	22	In-class workshop for final project		
April 8	23	Human monitoring ethics		HW 8 due
April 10	24	In-class workshop and peer review		
April 15	25	Further examples of defining metrics for decision making	Mubashir et al. (2013)	
April 17	26	Final Project Presentations		Final presentations due
April 22	27	Final Project Presentations		

Grading

The grading scheme for undergraduate and graduate students is the same. Each assignment is worth 10% of the grade, with the final project worth 20% of the final grade.

Item	Points
Assignments	80
Final Project	20
Total Points	**100**

Assignments

Students may discuss the assignments together, but each student must do their own work and turn in their own assignment. Assignments are due at the beginning of class. Late assignments will only be accepted with permission from the instructor.

Exams

There are no exams for this class.

Final Project

Students will be placed in groups of 3 – 4 people. Students should identify a concept from class that can be applied to an area of mutual interest within the team and related to measuring human motion. Teams must provide a proposed topic by the date stated in the schedule. For the project, your team will either develop a public engagement activity or perform a study. Final projects include a written and oral component and will be described in more detail during the term.

Diversity, Equity, and Inclusion

At U-M Industrial and Operations Engineering (IOE), we value all people and are committed to promoting diversity, equity and inclusion (DEI) in its fullest form for everyone in our community and beyond. We advance scientific and mathematical methods and develop engineering technologies to help solve human-centered local and global challenges; meaning we impact people, processes, and systems through generating and analyzing data across a range of applications. Not only does incorporating DEI principles make our solutions more powerful, applicable, and ethical, promoting and fostering DEI is a core value of the IOE community and leadership. At U-M IOE we view DEI as interwoven with our research, teaching and community involvement.

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

I am dedicated to helping each of you achieve all that you can in this class. I may, either in lecture or smaller interactions, accidentally use language that creates

	offense or discomfort. Should I do this, please contact me and help me understand and avoid making the same mistake again.
Academic integrity	The College of Engineering Honor Code is a statement of ethical standards by which the faculty and students of the College of engineering conduct themselves. Both undergraduate and graduate students are bound by the provisions of the Honor Code; ignorance of it is no excuse to infringe upon it. You are expected to read and abide by the Honor Code: http://elc.engin.umich.edu/wp-content/uploads/sites/19/2019/03/Honor-Code-Pamphlet-2018.pdf
Accommodations	The University of Michigan is committed to providing equal opportunity for participation in all programs, services and activities. Request for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G664 Haven Hall. The SSD phone number is 734-763-3000 and webpage is http://ssd.umich.edu/. Once your eligibility for an accommodation has been determined you will be issued a verified individual services accommodation (VISA) form. Please present this form to me at the beginning of the term, or at least two weeks prior to the need for the accommodation (test, project, etc…). Any information you provide is private and confidential and will be treated as such.
Student well-being	Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being on the Well-being for U-M Students website. You can also search for additional resources on that website.
Reporting Concerns and Misconduct	The Department of Industrial and Operations Engineering is dedicated to providing an environment that is inclusive, supportive, and respectful. If we fall short, we want to hear from you. Use our website to learn about ways to report concerns or misconduct anonymously, confidentially, or formally, and know that you will be heard, you will be taken seriously, and the U-M IOE community will stand behind you https://sites.google.com/umich.edu/report-concerns-and-misconduct/
Title IX Statement & Resources	Violence and harassment based on sex and gender are civil rights offenses subject to the same kinds of accountability and the same kinds of support

applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources here:

- Sexual Assault and Prevention Center (SAPAC) 24-hour confidential crisis line 734-936-3333, sapac.umich.edu
- Counseling and Psychological Services (CAPS) 734-764-8312, caps.umich.edu
- University of Michigan Police (DPSS) 734-763-1131 (or 911 for emergency), dpss.umich.edu
- Office of Student Conflict Resolution 724-936-6308, oscr.umich.edu

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500 S. State Street
Ann Arbor, MI 48109-1382
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Fax: 734.936.3148
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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: 2023-06-27
Effective Term: Winter 2024

☑	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: 562			Dept (Home): Subject: Catalog:		
☐	☑ Course is Cross-Listed with Other Departments			☐ Course is Cross-Listed with Other Departments		
	Department	Subject	Catalog Number	Department	Subject	Catalog Number
	Statistics - STATS - 535					
☐	Course Title (full title) RELIABILITY			Course Title (full title)		
☐	Abbreviated Title (20 char) RELIABILITY			Abbreviated Title (20 char)		
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Covers the important reliability concepts and methodology that arise in modeling, assessing and improving product reliability and in analyzing field and warranty data. Topics are selected from the following: Basic reliability concepts, common parametric models for component reliability, censoring schemes, analysis of time-to-failure data, accelerated testing for reliability assessment, modeling and analyzing repairable systems reliability, analysis of warranty and field-failure data, maintenance policies and availability improvement through experimentation.					
☐	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: Industrial & Operations Engin Catalog: 562

☐

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) IOE 316 and IOE 366 or Stats 425 and 426 Minimum grade requirement:	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char)	Enforced Prerequisite (254 char)
☐	Credit Exclusions none	Credit Exclusions

☐

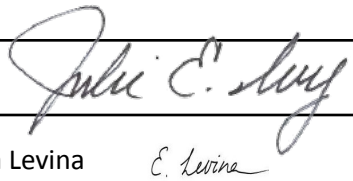
Course Components / Graded Component
- ☑ Lecture / ☑
- ☐ Seminar / ☐
- ☐ Recitation / ☐
- ☐ Lab / ☐
- ☐ Discussion / ☐
- ☐ Independent Study / ☐

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

Cognizant Faculty Member Name: Yavuz Bozer 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: Yavuz Bozer	Date: 9/8/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair: Julie Ivy		Print: Julie Ivy	Date: 9/8/23
Cross-Listed Department Chair: Liza Levina		Print: Liza Levina	Date: 8/31/2023
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description Reliability concepts and methodology for modeling, assessing and improving product reliability: common models for component and system reliability; analysis of field and warranty data; component reliability inference; repairable systems; accelerated stress testing for reliability assessment; reliability improvement through experimental design.	Course Description
Class Length Full term	Class Length
Contact hours (lecture): 3	Contact hours (lecture):
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:
Since IOE 562 has not been taught in years, and there are no plans to offer it again in the foreseeable future, we would like to delete the course and remove it from the curriculum.

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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: 2023-08-22
Effective Term: Fall 2024

☑	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: 441	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 441
☐	☐ Course is Cross-Listed with Other Departments	☐ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐		
☐	Course Title (full title) Nuclear Reactor Theory I	Course Title (full title) Nuclear Reactor Theory I
☐	Abbreviated Title (20 char) Nucl React I	Abbreviated Title (20 char) Nucl React I
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) An introduction to the theory of nuclear fission reactors including neutron transport theory, the P1 approximation, diffusion theory, criticality calculations, reactor kinetics, neutron slowing down theory, and numerical solution of the diffusion equation.	
☐	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: Nuclear Engin & Radiolog Sci Catalog: 441

☐	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) NERS 312 and NERS 320. No OP/F. Minimum grade requirement: C	Enforced Prerequisite (254 char) NERS 312 and NERS 320 (No OP/F); or graduate standing. Minimum grade requirement: C
☐	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: Won Sik Yang 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: 8/23/2023

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Print: Todd R Allen Date: 23 Aug 2023

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 An introduction to the theory of nuclear fission reactors including neutron transport theory, the P1 approximation, diffusion theory, criticality calculations, reactor kinetics, neutron slowing down theory, and numerical solution of the diffusion equation.	Course Description An introduction to the theory of nuclear fission reactors including neutron transport theory, the P1 approximation, diffusion theory, criticality calculations, reactor kinetics, neutron slowing down theory, and numerical solution of the diffusion equation.
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 the BSE in NERS program.

Special resources of facilities required for this course:

Supporting statement:
Adding "or graduate standing" to list of prerequisites.

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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: 2023-06-13
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 513	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 513
☐	☐ 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) Flat Panel Displays	Course Title (full title) Flat Panel Displays
☐	Abbreviated Title (20 char) Flat Pan Displ	Abbreviated Title (20 char) Flat Pan Displ
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Introduction and fundamentals to the passive, active, reflective and emissive flat panel display technologies. This course will discuss the physics, operating principles, properties and technology of the flat panel displays.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 513

☐

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) EECS 423, EECS 512 or/and permission of instructor.	Advisory Prerequisite (254 char) EECS 423, ECE 512 or/and permission of instructor.
☐	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: Jerzy Kanicki Cognizant Faculty Member Title:

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

Contact Person: Punam Vyas Email: vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative:  Print: Achilleas Anastasopoulos Date:6/13/23

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair:  Print: Heath Hofmann Date:6/13/23

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 Introduction and fundamentals to the passive, active, reflective and emissive flat panel display technologies. This course will discuss the physics, operating principles, properties and technology of the flat panel displays.	Course Description Introduction and fundamentals to the passive, active, reflective and emissive flat panel display technologies. This course will discuss the physics, operating principles, properties and technology of the flat panel displays.
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:
Free Elective

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-06-26
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 517	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 517
☐	☑ 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 - 578	Nuclear Engineering & Radiological Sciences - NERS - 578
☐	Course Title (full title) Physical Processes in Plasmas	Course Title (full title) Physical Processes in Plasmas
☐	Abbreviated Title (20 char) Phys Proc in Plas	Abbreviated Title (20 char) Phys Proc in Plas
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Plasma physics applied to electrical gas discharges used for material processing. Gas kinetics; atomic collisions; transport coefficients; drift and diffusion; sheaths; Boltzmann distribution function calculation; plasma simulation; plasma diagnostics by particle probes, spectroscopy and electromagnetic waves; analysis of commonly used plasma tools for materials processing.	
☐	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: Elec Engin & Computer Sci 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) EECS 330	Advisory Prerequisite (254 char) EECS 330
☐	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: Mark Kushner Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/14/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Heath Hofmann	Date: 7/14/23
Cross-Listed Department Chair:		Print: Todd R Allen	Date: 10 Aug 2023
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Plasma physics applied to electrical gas discharges used for material processing. Gas kinetics; atomic collisions; transport coefficients; drift and diffusion; sheaths; Boltzmann distribution function calculation; plasma simulation; plasma diagnostics by particle probes, spectroscopy and electromagnetic waves; analysis of commonly used plasma tools for materials processing.	Course Description Plasma physics applied to electrical gas discharges used for material processing. Gas kinetics; atomic collisions; transport coefficients; drift and diffusion; sheaths; Boltzmann distribution function calculation; plasma simulation; plasma diagnostics by particle probes, spectroscopy and electromagnetic waves; analysis of commonly used plasma tools for materials processing.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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: 2023-07-24
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 524	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 524
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 524	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 524
☐	Course Title (full title) Organic Electronic Devices and Applications	Course Title (full title) Organic Electronic Devices and Applications
☐	Abbreviated Title (20 char) Org Elec Devices	Abbreviated Title (20 char) Org Elec Devices
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Organic semiconductors optical/electrical properties, how organics are deposited/patterned to achieve thin-film device structures, device physics, engineering and applications (light emission from OLEDs, various structures/adaptations for high efficiency displays/lighting), organic thin-film transistor physics, applications and organic solar cells: status, efficiency limits, reliability, as an energy harvesting technology.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 524

☐

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

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

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

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

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☐	Enforced Prerequisite (254 char) Permission of Instructor or Graduate Standing Minimum grade requirement:	Enforced Prerequisite (254 char) Permission of Instructor or Graduate Standing 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: Stephen Forrest Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date:7/24/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print:Heath Hofmann	Date:7/24/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Cagliyan Kurdak	Date: 8/14/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:

Course Description
Organic semiconductors optical/electrical properties, how organics are deposited/patterned to achieve thin-film device structures, device physics, engineering and applications (light emission from OLEDs, various structures/adaptations for high efficiency displays/lighting), organic thin-film transistor physics, applications and organic solar cells: status, efficiency limits, reliability, as an energy harvesting technology.

Class Length
Full term

Contact hours (lecture):
3

Contact hours (recitation)

Contact hours (lab)

Requested:

Course Description
Organic semiconductors optical/electrical properties, how organics are deposited/patterned to achieve thin-film device structures, device physics, engineering and applications (light emission from OLEDs, various structures/adaptations for high efficiency displays/lighting), organic thin-film transistor physics, applications and organic solar cells: status, efficiency limits, reliability, as an energy harvesting technology.

Class Length
Full term

Contact hours (lecture):
3

Contact hours (recitation)

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:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

Course Approval Request Form

Office of the Registrar, University of Michigan

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

☑ CHECK APPROPRIATE BOXES FOR ALL CHANGES

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

Date of Submission: 2023-06-23
Effective Term: Fall 2024

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

	CURRENT LISTING	REQUESTED LISTING
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 530	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 530
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 530	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 530
☐	Course Title (full title) Electromagnetic Theory I	Course Title (full title) Electromagnetic Theory I
☐	Abbreviated Title (20 char) Electromag Thry I	Abbreviated Title (20 char) Electromag Thry I
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Maxwell's equations, constitutive relations and boundary conditions. Potentials and the representation of electromagnetic fields. Uniqueness, duality, equivalence, reciprocity and Babinet's theorems. Plane, cylindrical, and spherical waves. Waveguides and elementary antennas. The limiting case of electro- and magneto-statics.	
☐	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: Elec Engin & Computer Sci Catalog: 530

☐ 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) PHYSICS 438 or EECS 330	Advisory Prerequisite (254 char) PHYSICS 438 or EECS 330
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

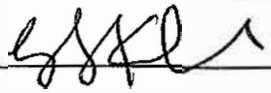
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Kamal Sarabandi Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/27/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date: 7/27/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Caglayan KurdaK	Date: 8/14/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:

Course Description
Maxwell's equations, constitutive relations and boundary conditions. Potentials and the representation of electromagnetic fields. Uniqueness, duality, equivalence, reciprocity and Babinet's theorems. Plane, cylindrical, and spherical waves. Waveguides and elementary antennas. The limiting case of electro- and magneto-statics.

Class Length
Full term

Contact hours (lecture):
3

Contact hours (recitation)

Contact hours (lab)

Requested:

Course Description
Maxwell's equations, constitutive relations and boundary conditions. Potentials and the representation of electromagnetic fields. Uniqueness, duality, equivalence, reciprocity and Babinet's theorems. Plane, cylindrical, and spherical waves. Waveguides and elementary antennas. The limiting case of electro- and magneto-statics.

Class Length
Full term

Contact hours (lecture):
3

Contact hours (recitation)

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:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-05-24
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 532	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 532
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐	Climate & Meteorology - CLIMATE - 587 Space Institute - SPACE - 587	Climate & Meteorology - CLIMATE - 587 Space Institute - SPACE - 587
☐	Course Title (full title) Microwave Remote Sensing	Course Title (full title) Microwave Remote Sensing
☐	Abbreviated Title (20 char) M-Waves Rem Sens	Abbreviated Title (20 char) M-Waves Rem Sens
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Theory, systems and applications of active and passive microwave remote sensing: radiative transfer; blackbody radiation; microwave radiometry; atmospheric propagation and emission; radiometer receivers; surface and volume scattering and emission; radar systems; resolution techniques; calibration; synthetic aperture radar; scatterometers; applications to meteorology, oceanography and hydrology	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 532

☐ 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) EECS 330, Graduate Standing	Advisory Prerequisite (254 char) EECS 330, 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: Fawwaz Ulaby Cognizant Faculty Member Title:

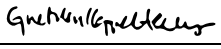
SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED (Please Print AND Sign Name)

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

CoE Curriculum Committee Representative:  Print: Achilleas Anastasopoulos Date: 7/27/23

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair:  Print: Heath Hofmann Date:7/27/23

Cross-Listed Department Chair:  Print: Gretchen Keppel-Aleks Date: 16 Aug 2023

Cross-Listed Department Chair:  Print: Gretchen Keppel-Aleks Date: 16 Aug 2023

Cross-Listed Department Chair: Print: Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Theory, systems and applications of active and passive microwave remote sensing: radiative transfer; blackbody radiation; microwave radiometry; atmospheric propagation and emission; radiometer receivers; surface and volume scattering and emission; radar systems; resolution techniques; calibration; synthetic aperture radar; scatterometers; applications to meteorology, oceanography and hydrology	Course Description Theory, systems and applications of active and passive microwave remote sensing: radiative transfer; blackbody radiation; microwave radiometry; atmospheric propagation and emission; radiometer receivers; surface and volume scattering and emission; radar systems; resolution techniques; calibration; synthetic aperture radar; scatterometers; applications to meteorology, oceanography and hydrology
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

Course Approval Request Form

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ro.umich.edu

☑ CHECK APPROPRIATE BOXES FOR ALL CHANGES

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

Date of Submission: 2023-06-26
Effective Term: Fall 2024

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

	CURRENT LISTING	REQUESTED LISTING
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 537	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 537
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 537	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 537
☐	Course Title (full title) Classical Optics	Course Title (full title) Classical Optics
☐	Abbreviated Title (20 char) Classical Optics	Abbreviated Title (20 char) Classical Optics
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) 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.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 537

☐ 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) EECS 330 or 334	Advisory Prerequisite (254 char) EECS 330 or 334
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

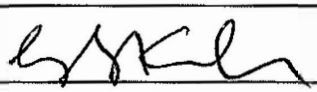
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Theodore Norris Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/14/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date: 7/14/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Cagliyan Kurdak	Date: 8/14/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course 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.	Course 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.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

Course Approval Request Form

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☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-06-26
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 540	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 540
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Applied Physics - APPPHYS - 540	Applied Physics - APPPHYS - 540
☐	Course Title (full title) Applied Quantum Mechanics	Course Title (full title) Applied Quantum Mechanics
☐	Abbreviated Title (20 char) Appl Quant Mech I	Abbreviated Title (20 char) Appl Quant Mech I
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) 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.	
☐	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: Elec Engin & Computer Sci Catalog: 540

☐

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) Permission of instructor	Advisory Prerequisite (254 char) Permission of instructor
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

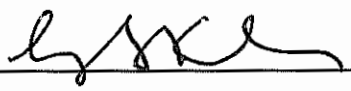
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Mackillo Kira Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/27/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Heath Hofmann	Date: 7/27/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Cagliyan Kurdak	Date: 8/14/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course 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.	Course 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.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-06-26
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 541	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 541
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Applied Physics - APPPHYS - 541	Applied Physics - APPPHYS - 541
☐	Course Title (full title) Applied Quantum Mechanics II	Course Title (full title) Applied Quantum Mechanics II
☐	Abbreviated Title (20 char) Appl Qntm Mech II	Abbreviated Title (20 char) Appl Qntm Mech II
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Continuation of nonrelativistic quantum mechanics. Advanced angular momentum theory, second quantization, non-relativistic quantum electrodynamics, advanced scattering theory, density matrix formalism, reservoir 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: Elec Engin & Computer Sci Catalog: 541

☐ 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) APPPHYS 540	Advisory Prerequisite (254 char) APPPHYS 540
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

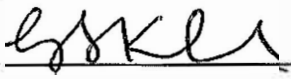
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Mackillo Kira Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/19/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date: 7/19/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Cagliyan Kurdak	Date: 8/1/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

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

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
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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: 2023-08-10
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 546	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 546
☐	☑ Course is Cross-Listed with Other Departments Department | Subject | Catalog Number Applied Physics - APPPHYS - 546	☑ Course is Cross-Listed with Other Departments Department | Subject | Catalog Number Applied Physics - APPPHYS - 546
☐	Course Title (full title) Ultrafast Optics	Course Title (full title) Ultrafast Optics
☐	Abbreviated Title (20 char) Ultrafast Optics	Abbreviated Title (20 char) Ultrafast Optics
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Propagation of ultrashort optical pulses in linear and nonlinear media, and through dispersive optical elements. Laser mode-locking and ultrashort pulse generation. Chirped-pulse amplification. Experimental techniques for high time resolution. Ultrafast Optoelectronics. Survey of ultrafast high field interactions.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 546

☐ 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) APPPHYS 537	Advisory Prerequisite (254 char) APPPHYS 537
☐	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: Ted Norris Cognizant Faculty Member Title:

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

Contact Person: Punam Vyas Email: vyas@umich.edu Phone:647-1754

CoE Curriculum Committee Representative:		Print:Achilleas Anastasopoulos	Date:8/10/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print:Heath Hofmann	Date:8/10/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Cagliyan Kurdak	Date: 8/25/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Propagation of ultrashort optical pulses in linear and nonlinear media, and through dispersive optical elements. Laser mode-locking and ultrashort pulse generation. Chirped-pulse amplification. Experimental techniques for high time resolution. Ultrafast Optoelectronics. Survey of ultrafast high field interactions.	Course Description Propagation of ultrashort optical pulses in linear and nonlinear media, and through dispersive optical elements. Laser mode-locking and ultrashort pulse generation. Chirped-pulse amplification. Experimental techniques for high time resolution. Ultrafast Optoelectronics. Survey of ultrafast high field interactions.
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:
Other

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-05-24
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 552	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 552
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 552	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Applied Physics - APPPHYS - 552
☐	Course Title (full title) Fiber Optics: Internet to Biomedical Applications	Course Title (full title) Fiber Optics: Internet to Biomedical Applications
☐	Abbreviated Title (20 char) Fib Opt:Intrnt Biomd	Abbreviated Title (20 char) Fib Opt:Intrnt Biomd
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) This course covers the basics of fibers and applications in fields as diverse as high power and broadband lasers, bio-medical diagnostics and therapeutics, telecommunications, and internet communications. Propagation, optical amplification, and nonlinearities in fibers are discussed, and examples include transmission systems and lasers. Biomedical applications include dermatology, cardiology, and ophthalmology	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 552

☐	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

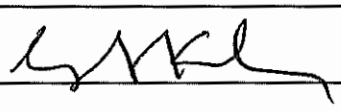
	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char) Any ONE of EECS 334,429,434,529,537,538,539 or permission of instructor	Advisory Prerequisite (254 char) Any ONE of EECS 334,429,434 or ECE 529,537,538,539 or permission of instructor
☐	Enforced Prerequisite (254 char) Minimum grade 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: Mohammed Islam Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/22/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date: 7/22/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print: Cagliyan Kurdak	Date: 8/14/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description This course covers the basics of fibers and applications in fields as diverse as high power and broadband lasers, bio-medical diagnostics and therapeutics, telecommunications, and internet communications. Propagation, optical amplification, and nonlinearities in fibers are discussed, and examples include transmission systems and lasers. Biomedical applications include dermatology, cardiology, and ophthalmology	Course Description This course covers the basics of fibers and applications in fields as diverse as high power and broadband lasers, bio-medical diagnostics and therapeutics, telecommunications, and internet communications. Propagation, optical amplification, and nonlinearities in fibers are discussed, and examples include transmission systems and lasers. Biomedical applications include dermatology, cardiology, and ophthalmology
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:
Tech Elective

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

Course Approval Request Form

Office of the Registrar, University of Michigan

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☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-07-24
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 560	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 560
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Aerospace Engineering - AEROSP - 550, Civil & Environmental Engineering - CEE - 571, Mechanical Engineering - MECHENG - 564	Aerospace Engineering - AEROSP - 550, Civil & Environmental Engineering - CEE - 571, Mechanical Engineering - MECHENG - 564
☐	Course Title (full title) Linear Systems Theory	Course Title (full title) Linear Systems Theory
☐	Abbreviated Title (20 char) Lin Systems Theory	Abbreviated Title (20 char) Lin Systems Theory
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Linear spaces and linear operators. Bases, subspaces, eigenvalues and eigenvectors, canonical forms. Linear differential and difference equations. Mathematical representations: state equations, transfer functions, impulse response, matrix fraction and polynomial descriptions. System-theoretic concepts: causality, controllability, observability, realizations, canonical decomposition, stability.	
☐	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: Elec Engin & Computer Sci Catalog: 560

☐

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

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

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

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

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char) Grad Standing	Advisory Prerequisite (254 char) Grad 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: James Freudenberg Cognizant Faculty Member Title:

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

Contact Person:Punam Vyas Email: vyas@umich.edu Phone:647-1754

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date:7/24/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date:7/24/23
Cross-Listed Department Chair:	Carlos Cesnik	Print: Carlos E. S. Cesnik	Date: 8/11/23
Cross-Listed Department Chair:		Print: Yafeng Yin	Date: 8/16/23
Cross-Listed Department Chair:		Print: Kazuhiro Saitou	Date: 8/28/23

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Linear spaces and linear operators. Bases, subspaces, eigenvalues and eigenvectors, canonical forms. Linear differential and difference equations. Mathematical representations: state equations, transfer functions, impulse response, matrix fraction and polynomial descriptions. System-theoretic concepts: causality, controllability, observability, realizations, canonical decomposition, stability.	Course Description Linear spaces and linear operators. Bases, subspaces, eigenvalues and eigenvectors, canonical forms. Linear differential and difference equations. Mathematical representations: state equations, transfer functions, impulse response, matrix fraction and polynomial descriptions. System-theoretic concepts: causality, controllability, observability, realizations, canonical decomposition, stability.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation) 1	Contact hours (recitation) 1
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

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

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-06-27
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 562	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 562
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐	Aerospace - AEROSPACE - 551	Aerospace - AEROSPACE - 551
☐	Course Title (full title) Nonlinear Systems and Control	Course Title (full title) Nonlinear Systems and Control
☐	Abbreviated Title (20 char) Nl Sys&Con	Abbreviated Title (20 char) Nl Sys&Con
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Introduction to the analysis and design of nonlinear systems and nonlinear control systems. Stability analysis using Liapunov, input-output and asymptotic methods. Design of stabilizing controllers using a variety of methods: linearization, absolute stability theory, vibrational control, sliding modes and feedback linearization.	
☐	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: Elec Engin & Computer Sci Catalog: 562

☐

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) Graduate standing	Advisory Prerequisite (254 char) 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: Dimitra Panagou Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/19/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date: 7/19/23
Cross-Listed Department Chair:	Carlos Cesnik	Print: Carlos E. S. Cesnik	Date: 8/11/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Introduction to the analysis and design of nonlinear systems and nonlinear control systems. Stability analysis using Liapunov, input-output and asymptotic methods. Design of stabilizing controllers using a variety of methods: linearization, absolute stability theory, vibrational control, sliding modes and feedback linearization.	Course Description Introduction to the analysis and design of nonlinear systems and nonlinear control systems. Stability analysis using Liapunov, input-output and asymptotic methods. Design of stabilizing controllers using a variety of methods: linearization, absolute stability theory, vibrational control, sliding modes and feedback linearization.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

Course Approval Request Form

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ro.umich.edu

☑ CHECK APPROPRIATE BOXES FOR ALL CHANGES

Action Requested

☐ New Course
☑ Modification of Existing Course
☐ Deletion of Existing Course

Date of Submission: 2023-05-22
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 569	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 569
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Manufacturing - MFG - 564	Manufacturing - MFG - 564
☐	Course Title (full title) Production Systems Engineering	Course Title (full title) Production Systems Engineering
☐	Abbreviated Title (20 char) Prod. Syst. Eng.	Abbreviated Title (20 char) Prod. Syst. Eng.
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Production Systems Engineering (PSE) investigates fundamental laws that govern production systems and utilizes them for analysis, design, and continuous improvement. The topics covered include quantitative methods for analysis and design, improvability, measurement-based management, and the PSE Toolbox. The skills acquired will make students marketable as engineering managers of manufacturing organizations.	
☐	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: Elec Engin & Computer Sci Catalog: 569

☐

Grading Basis
- ☑ Graded (A – E)
- ☐ Credit/No Credit
- ☐ Satisfactory/Unsatisfactory
- ☐ Pass/Fail
- ☐ Business Administration Grading
- ☐ Not for Credit
- ☐ Not for Degree Credit
- ☐ Degree Credit Only

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

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

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

☐

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

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

Cognizant Faculty Member Name: Seymon Meerkov Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/27/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print: Heath Hofmann	Date: 7/27/23
Cross-Listed Department Chair:	ISD-MFG Patrick C. Hammett	Print: PATRICK HAMMETT	Date: 8/15/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Production Systems Engineering (PSE) investigates fundamental laws that govern production systems and utilizes them for analysis, design, and continuous improvement. The topics covered include quantitative methods for analysis and design, improvability, measurement-based management, and the PSE Toolbox. The skills acquired will make students marketable as engineering managers of manufacturing organizations.	Course Description Production Systems Engineering (PSE) investigates fundamental laws that govern production systems and utilizes them for analysis, design, and continuous improvement. The topics covered include quantitative methods for analysis and design, improvability, measurement-based management, and the PSE Toolbox. The skills acquired will make students marketable as engineering managers of manufacturing organizations.
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:
Tech Elective

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-06-02
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 586	Dept (Home): Computer Science and Engineering Subject: CSE Catalog: 586
☐	☐ 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 and Analysis of Algorithms	Course Title (full title) Design and Analysis of Algorithms
☐	Abbreviated Title (20 char) Algorithms	Abbreviated Title (20 char) Algorithms
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Design of algorithms for nonnumeric problems involving sorting, searching, scheduling, graph theory, and geometry. Design techniques such as approximation, branch-and-bound, divide-and-conquer dynamic programming, greed, and randomization applied to polynomial and NP-hard problems. Analysis of time and space utilization.	
☐	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: Elec Engin & Computer Sci Catalog: 586

☐

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) EECS 281 or 403	Advisory Prerequisite (254 char) EECS 281 or 403
☐	Enforced Prerequisite (254 char) EECS 376 (B+ or better, No OP/F); or Graduate Standing Minimum grade requirement:	Enforced Prerequisite (254 char) EECS 376 (B+ or better, No OP/F); or Graduate Standing Minimum grade requirement:
☐	Credit Exclusions No credit to a student who has taken EECS 477	Credit Exclusions No credit to a student who has taken EECS 477

☐

Course Components / Graded Component

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

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

Cognizant Faculty Member Name: Quentin Stout Cognizant Faculty Member Title:

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

Contact Person: Punam Vyas Email: vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 6/6/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Emily Mower Provost	Date: 6/6/23
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 Design of algorithms for nonnumeric problems involving sorting, searching, scheduling, graph theory, and geometry. Design techniques such as approximation, branch-and-bound, divide-and-conquer dynamic programming, greed, and randomization applied to polynomial and NP-hard problems. Analysis of time and space utilization.	Course Description Design of algorithms for nonnumeric problems involving sorting, searching, scheduling, graph theory, and geometry. Design techniques such as approximation, branch-and-bound, divide-and-conquer dynamic programming, greed, and randomization applied to polynomial and NP-hard problems. Analysis of time and space utilization.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab) 2	Contact hours (lab) 2

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

1210 LSA Building
500 S. State Street
Ann Arbor, MI 48109-1382
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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: 2023-08-10
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 596	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 596
☐	☐ 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) Master of Engineering Team Project	Course Title (full title) Master of Engineering Team Project
☐	Abbreviated Title (20 char) M Eng Proj	Abbreviated Title (20 char) M Eng Proj
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) To be elected by ECE students pursuing the Master of Engineering degree. Students are expected to work in project teams. May be taken more than once up to a total of 6 credit hours.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 1 Undergraduate Max: Graduate Max: 6	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 596

☐

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) Enrollment in the Manuf. Eng. program in EECS.	Advisory Prerequisite (254 char) Enrollment in the Manuf. Eng. program in ECE.
☐	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: Punam Vyas Cognizant Faculty Member Title:

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

Contact Person: Punam Vyas Email: vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date:8/10/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Heath Hofmann	Date:8/10/23
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 To be elected by EECS students pursuing the Master of Engineering degree. Students are expected to work in project teams. May be taken more than once up to a total of 6 credit hours.	Course Description To be elected by ECE students pursuing the Master of Engineering degree. Students are expected to work in project teams. May be taken more than once up to a total of 6 credit hours.
Class Length Full term	Class Length Full term
Contact hours (lecture):	Contact hours (lecture):
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab) 2-12	Contact hours (lab) 2-12

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:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-07-26
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 600	Dept (Home): Electrical & Computer Engineering Subject: ECE Catalog: 600
☐	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
☐	Industrial & Operations Engineering - IOE - 600	Industrial & Operations Engineering - IOE - 600
☐	Course Title (full title) Function Space Methods in System Theory	Course Title (full title) Function Space Methods in System Theory
☐	Abbreviated Title (20 char) Func Meth Sys Thry	Abbreviated Title (20 char) Func Meth Sys Thry
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Introduction to the description and analysis of systems using function analytic methods. Metric spaces, normed linear spaces, Hilbert spaces, resolution spaces. Emphasis on using these concepts in systems problems.	
☐	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: Elec Engin & Computer Sci Catalog: 600

☐

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) EECS 400 or Math 419	Advisory Prerequisite (254 char) (ECE 551 or Math 419) or Math 451
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

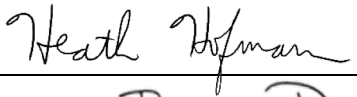
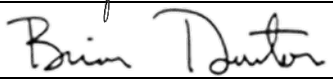
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Laura Balzano Cognizant Faculty Member Title:

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

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

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date: 7/26/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Heath Hofmann	Date: 7/26/23
Cross-Listed Department Chair:		Print: Brian Denton	Date: 8/11/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Introduction to the description and analysis of systems using function analytic methods. Metric spaces, normed linear spaces, Hilbert spaces, resolution spaces. Emphasis on using these concepts in systems problems.	Course Description Introduction to the description and analysis of systems using function analytic methods. Metric spaces, normed linear spaces, Hilbert spaces, resolution spaces. Emphasis on using these concepts in systems problems.
Class Length Full term	Class Length Full term
Contact hours (lecture): 3	Contact hours (lecture): 3
Contact hours (recitation)	Contact hours (recitation)
Contact hours (lab)	Contact hours (lab)

Additional Info:

Submitted by:
Home dept

Describe how this course fits with the degree requirements:

Special resources of facilities required for this course:

Supporting statement:
The EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

EECS 400 does not exist anymore. Students benefit from prior linear algebra (ECE 551 or Math 419)
and prior analysis on the real line (math 451) courses.

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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: 2023-06-06
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Psychology Subject: PSYCH Catalog: 643	Dept (Home): Psychology Subject: PSYCH Catalog: 643
☑	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Elec Eng Comp Sci - EECS -643	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Comp Sci and Eng - CSE - 643
☐	Course Title (full title) Theory of Neural Computation	Course Title (full title) Theory of Neural Computation
☐	Abbreviated Title (20 char) Thry Neural Comp	Abbreviated Title (20 char) Thry Neural Comp
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) This is a graduate course introducing computational models of information processing in mammalian central nervous system. Following a brief overview, the course will examine: (1) Biological principles governing brain computation (e.g., population coding, computation maps, adaptive plasticity, self-organization and modularization, etc.); (2) Mechanisms underlying single neuron computation, via either passive membrane properties (equivalent cylinder model and cable equation for dendrites; integrate-and-fire or Lapique model) or active membrane properties (Hodgkins-Huxley dynamics; F-N reduced system and phase-space analysis); (3) Architectures of artificial neural network (connectionism), including models of simple perception, multi-layered feed-forward network (with supervised, back-propagated error correction learning rule), associative network (Hopfield network and Boltman machine with unsupervised, Hebbian learning rule), and reinforcement (partially supervised) learning algorithms.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 2 Undergraduate Max: Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Psychology Catalog: 643

☐

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) Graduate standing and permission of instructor.	Advisory Prerequisite (254 char) Graduate standing and permission of instructor.
☐	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: Emily Mower Provost Cognizant Faculty Member Title:

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

Contact Person:Punam Vyas Email:vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative: Print: Amir Kamil Date: 6/19/23

CoE Curriculum Committee Chair: Print: Date:

Home Department Chair: Print Priti Shah Date: 07/18/23

Cross-Listed Department Chair: Print: Emily Mower Provost Date: 6/19/23

Cross-Listed Department Chair: Print: Date:

Cross-Listed Department Chair: Print: Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	**Requested:**
Course Description This is a graduate course introducing computational models of information processing in mammalian central nervous system. Following a brief overview, the course will examine: (1) Biological principles governing brain computation (e.g., population coding, computation maps, adaptive plasticity, self-organization and modularization, etc.); (2) Mechanisms underlying single neuron computation, via either passive membrane properties (equivalent cylinder model and cable equation for dendrites; integrate-and-fire or Lapique model) or active membrane properties (Hodgkins-Huxley dynamics; F-N reduced system and phase-space analysis); (3) Architectures of artificial neural network (connectionism), including models of simple perception, multi-layered feed-forward network (with supervised, back-propagated error correction learning rule), associative network (Hopfield network and Boltman machine with unsupervised, Hebbian learning rule), and reinforcement (partially supervised) learning algorithms.	Course Description This is a graduate course introducing computational models of information processing in mammalian central nervous system. Following a brief overview, the course will examine: (1) Biological principles governing brain computation (e.g., population coding, computation maps, adaptive plasticity, self-organization and modularization, etc.); (2) Mechanisms underlying single neuron computation, via either passive membrane properties (equivalent cylinder model and cable equation for dendrites; integrate-and-fire or Lapique model) or active membrane properties (Hodgkins-Huxley dynamics; F-N reduced system and phase-space analysis); (3) Architectures of artificial neural network (connectionism), including models of simple perception, multi-layered feed-forward network (with supervised, back-propagated error correction learning rule), associative network (Hopfield network and Boltman machine with unsupervised, Hebbian learning rule), and reinforcement (partially supervised) learning algorithms.
Class Length Full term	Class Length Full term
Contact hours (lecture): 2 - 4	Contact hours (lecture): 2 - 4
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 EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-06-07
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Psychology Subject: PSYCH Catalog: 644	Dept (Home): Psychology Subject: PSYCH Catalog: 644
☑	☑ Course is Cross-Listed with Other Departments	☑ Course is Cross-Listed with Other Departments
	Department / Subject / Catalog Number	Department / Subject / Catalog Number
	Elec Eng Comp Sci - EECS - 644	Elec Eng Comp Sci - CSE - 644
☐	Course Title (full title) Computational Modeling of Cognition	Course Title (full title) Computational Modeling of Cognition
☐	Abbreviated Title (20 char) Comp Mod of Cogn	Abbreviated Title (20 char) Comp Mod of Cogn
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) This course will examine computational models of human cognitive processes. Course goals include learning about important computational models of specific cognitive domains and evaluating the appropriateness and utility of different computational approaches to substantive problems in cognition.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 2 Undergraduate Max: Graduate Max: 4	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Psychology Catalog: 644

☐

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) Graduate standing.	Advisory Prerequisite (254 char) Graduate standing.
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐

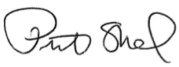
Course Components	Graded Component
☑ Lecture	☑
☐ Seminar	☐
☐ Recitation	☐
☐ Lab	☐
☐ Discussion	☐
☐ Independent Study	☐

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

Cognizant Faculty Member Name: Thad Polk Cognizant Faculty Member Title:

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

Contact Person:Punam Vyas Email: vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date: 6/19/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Priti Shah	Date: 07.17.2023
Cross-Listed Department Chair:		Print: Emily Mower Provost	Date: 6/19/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description This course will examine computational models of human cognitive processes. Course goals include learning about important computational models of specific cognitive domains and evaluating the appropriateness and utility of different computational approaches to substantive problems in cognition.	Course Description This course will examine computational models of human cognitive processes. Course goals include learning about important computational models of specific cognitive domains and evaluating the appropriateness and utility of different computational approaches to substantive problems in cognition.
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 EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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Course Approval Request Form

Office of the Registrar, University of Michigan

☑ **CHECK APPROPRIATE BOXES FOR ALL CHANGES**

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

Date of Submission: 2023-07-13
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☑	Dept (Home): Elec Engin & Computer Sci Subject: EECS Catalog: 662	Dept (Home): Elec Engin & Computer Sci Subject: ECE Catalog: 662
☐	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Aerospace Engineering - AEROSP - 672, Mechanical Engineering - MECHENG - 662	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Aerospace Engineering - AEROSP - 672, Mechanical Engineering - MECHENG - 662
☐	Course Title (full title) Advanced Nonlinear Control	Course Title (full title) Advanced Nonlinear Control
☐	Abbreviated Title (20 char) Adv Nl Cont	Abbreviated Title (20 char) Adv Nl Cont
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Geometric and algebraic approaches to the analysis and design of nonlinear control systems. Nonlinear controllability and observability, feedback stabilization and linearization, asymptotic observers, tracking problems, trajectory generation, zero dynamics and inverse systems, singular perturbations, and vibrational control.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Elec Engin & Computer Sci Catalog: 662

☐

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) EECS 562/Aero. Eng. 551 or Mech. Eng. 648.	Advisory Prerequisite (254 char) ECE 562/Aero. Eng. 551 or Mech. Eng. 648.
☐	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: Semyon Meerkov Cognizant Faculty Member Title:

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

Contact Person: Punam Vyas Email:vyas@umich.edu Phone:647-1754

CoE Curriculum Committee Representative:		Print: Achilleas Anastasopoulos	Date:7/13/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Heath Hofmann	Print:Heath Hofmann	Date:7/13/23
Cross-Listed Department Chair:	Carlos Cesnik	Print: Carlos E. S. Cesnik	Date: 8/11/23
Cross-Listed Department Chair:		Print: Kazuhiro Saitou	Date: 8/28/23
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Geometric and algebraic approaches to the analysis and design of nonlinear control systems. Nonlinear controllability and observability, feedback stabilization and linearization, asymptotic observers, tracking problems, trajectory generation, zero dynamics and inverse systems, singular perturbations, and vibrational control.	Course Description Geometric and algebraic approaches to the analysis and design of nonlinear control systems. Nonlinear controllability and observability, feedback stabilization and linearization, asymptotic observers, tracking problems, trajectory generation, zero dynamics and inverse systems, singular perturbations, and vibrational control.
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 EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.

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: 2023-06-07
Effective Term: Fall 2024

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Psychology Subject: PSYCH Catalog: 740	Dept (Home): Psychology Subject: PSYCH Catalog: 740
☑	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Elec Eng Comp Scie - EECS - 695	☑ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number Computer Science Engineering - CSE - 695
☐	Course Title (full title) Neural Models and Psychological Processes	Course Title (full title) Neural Models and Psychological Processes
☐	Abbreviated Title (20 char) Neural Models	Abbreviated Title (20 char) Neural Models
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Consideration of adaptively and biologically oriented theories of human behavior. Emphasis on both the potential breadth of application and intuitive reasonableness of various models. There is a bias toward large theories and small simulations.	
☐	Full Term Credit Hours Undergraduate Min: Graduate Min: 3 Undergraduate Max: Graduate Max: 3	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Rackham Graduate Student	
☐	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: Psychology Catalog: 740

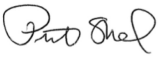
☐	Grading Basis ☑ Graded (A – E) ☐ Credit/No Credit ☐ Satisfactory/Unsatisfactory ☐ Pass/Fail ☐ Business Administration Grading ☐ Not for Credit ☐ Not for Degree Credit ☐ Degree Credit Only Add Consent ☐ Department Consent ☐ Instructor Consent ☑ No Consent Drop Consent ☐ Department Consent ☐ Instructor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

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char) Graduate standing and permission of instructor.	Advisory Prerequisite (254 char) Graduate standing and permission of instructor.
☐	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: Emily Mower Provost Cognizant Faculty Member Title:

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

Contact Person: Punam Vyas Email: vyas@umich.edu Phone: 647-1754

CoE Curriculum Committee Representative:		Print: Amir Kamil	Date:6/19/23
CoE Curriculum Committee Chair:		Print:	Date:
Home Department Chair:		Print: Priti Shah	Date: 07.17.2023
Cross-Listed Department Chair:		Print: Emily Mower Provost	Date:6/19/23
Cross-Listed Department Chair:		Print:	Date:
Cross-Listed Department Chair:		Print:	Date:

DEPARTMENTAL/COLLEGE USE ONLY

Current:	Requested:
Course Description Consideration of adaptively and biologically oriented theories of human behavior. Emphasis on both the potential breadth of application and intuitive reasonableness of various models. There is a bias toward large theories and small simulations.	Course Description Consideration of adaptively and biologically oriented theories of human behavior. Emphasis on both the potential breadth of application and intuitive reasonableness of various models. There is a bias toward large theories and small simulations.
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 EECS department is moving most 500-level and above courses to separate CSE and ECE subject codes to free up course numbers, and to better reflect which division is the home for each course.