UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, February 25, 2020

Attending: Ed Durfee, Eric Rutherford, Won Sik Yang, Gretchen Keppel-Aleks, Emmanuelle Maqruis, Susan Montgomery, Saadet Albayrak, Dale Karr, Ken Powell, Christina Rice, Yavuz Bozer, Leung Tsang. Supporting Staff; Betsy Dodge, Alyiah Al-Bonijim. Guests; Bryan Enochs, Kerri Wakefield, Matthew Faunce

Call to Order: 1:36

Adjourned: 2:45

AGENDA

1. 2.11.20 Meeting Minutes: APPROVED
2. Modification of AEROSP Undergraduate Curriculum *[Ken Powell presented*]: CONDITIONALLY APPROVED. Based on edits needed for numerous CARFS. Dale Karr reported that this will go faculty meeting as information item only. This modification has a Fall 2020 effective term.
3. CoE Dual Degree Admissions Policy Proposal *[Kerri Wakefield and Bryan Enochs presented]:* Members discussed admissions policies with regards to GPA and deadlines. Dale Karr and Susan Montgomery agreed this was not a CC decision.
4. LSA Proposal to Increase Credit Requirement for CoE/LSA MDDP's *[Matthew Faunce presented]*: LSA's request to increase number of credits from 128 to 150. No objections from members, said changes were reasonable
5. Email Voting Protocol *[D.Karr, time allowing]:* Committee members felt it was necessary for entire committee to exchange comments during email vote. Ken Powell suggested using Google docs. Dale Karr suggested a session or time frame to share comments.

CARF SUMMARIES

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	APPROVED	NOTES & REVISIONS	TABLED
12	AEROSP	200	NEW	No changes to enforced prerequisites	FA 2020		X		
24	AEROSP	201	MOD	Enforced prerequisites removed	FA 2020	-	X	Change prerequisites from enforced to advisory	
28	AEROSP	215	MOD	Enforced prerequisites removed	FA 2020		X	Change prerequisites from enforced to advisory	

33	AEROSP	225	MOD	Enforced prerequisites removed	FA 2020		X	Change prerequisites from enforced to advisory	
38	AEROSP	285	Deletion		FA 2020		X		
41	AEROSP	315	MOD	Enforced prerequisites removed	FA 2020		X	Change prerequisites from enforced to advisory	
45	AEROSP	325	MOD	Enforced prerequisites removed	FA 2020		X	Change prerequisites from enforced to advisory	
50	AEROSP	335	MOD	Enforced Prerequisites removed	FA 2020		X	Change prerequisites from enforced to advisory	
50	AEROSP	350	NEW	Enforced Prerequisites removed	FA 2020		X		
55	AEROSP	567	NEW	Enforced prerequisites removed	FA 2020		X	Change course credit type to include Undergraduate Engineering and change instructor consent	
70	MECHENG	516	NEW	Change to class title	FA 2020		X		
73	CHE	296	NEW	New special topics course	FA 2020		X	Conditionally approved pending title change of CHE 496 and CARF submission	
76	NERS	320	MOD	Course description and title updated	FA 2020		X	Include changes to sample schedule	

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, February 25, 2020

Attending:

Call to Order:

Adjourned:

AGENDA

1. 2.11.20 Meeting Minutes Approval
2. Modification of AEROSP Undergraduate Curriculum
3. CoE Dual Degree Admissions Policy Proposal
4. LSA Proposal to Increase Credit Requirement for CoE/LSA MDDP's
5. Email Voting Protocol (D.Karr, time allowing)

CARF SUMMARIES

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70	MECHENG	516	MOD	Change to class title	FA 2020				
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76	NERS	320	MOD	Course description and title updated	FA 2020				

UNIVERSITY OF MICHIGAN
College of Engineering
Curriculum Committee Meeting
Tuesday, February 11 – Email Vote Email Vote

Attending:

Call to Order:

Adjourned:

AGENDA

1. 02.28.20 Meeting Minutes Approval

CARF SUMMARIES

PAGE	SUBJECT	COURSE #	ACTION	SUMMARY	EFFECTIVE TERM	MIN. GRADE REQ. FOR ENF. PREPREQ	APPROVED	NOTES & REVISIONS	TABLED
4	BIOMEDE	479	MOD	Modification to enforced prerequisites	WN 2021	C-	X	Revision was made to include honor courses for enforced prerequisites after confusion of handwritten edits	
7	NAVARCH	515	NEW	No changes to prerequisites	FA 2020		X	There was an abstention and a no vote. No vote due to "approval of a course that is not a part of a program change and was not	

								offered twice previously as a special topics course. This would violate a previous precedent and set a new precedent. Recommends discussion". Abstention due to course last being taught in Winter 2014. Recommended discussion of an upper limit on how old the first offering of a course can be.	
24	SPACE	371	NEW	change to enforced prerequisites	WN 2021	C-	X	One abstaining vote One comment from yes voter – class is very small and there are few data points in teaching evaluation	

Curriculum Committee Member Comments:

Ed Durfee: "I believe that by approving NA515 the committee is violating previous precedent (thus establishing a new precedent) by approving as a permanent course a course that is not part of a program change and was not offered *twice* previously as a special topics course. In fact, arguably it has *never* been previously offered as a special topics course in its planned form (to appeal to students from across engineering programs). While the committee of course is able to set a new precedent, I don't think we should do so without a discussion."

Christina Rice: I agree the CARFs meet the requirements for approval so vote yes based on that - I think hearing people discuss courses gives us a better feel but we also aren't commenting on content directly.

Yavuz Bozer:

1. Bio Med 479, a modification: Course numbers were written by hand into the CARF. Is the proposed change as follows: (math 216 or math 286 or math 396) and Biomed 331? If the answer is no, then I don't understand what the intended prereq structure is. If the answer is yes, then my vote is yes BUT I don't understand why the supporting statement is left blank. The department should at least explain to the CCC in one or two sentences why this change is required.

2. Nav Arch 515, new course:
I'm going to abstain. It was last taught in Winter 2014! Is there an upper limit on how old the first offering can be before it is proposed as a new course? If there is no upper limit, we should discuss placing an upper limit. I personally think 6 years is too long.

3. Space 371, new course:
Small class; very few data points in the teaching evaluation but I'll vote "yes."

Kenneth G. Powell
Arthur F. Thurnau Professor
Undergraduate Program Chair, Aerospace Engineering
Graduate Program Chair, Scientific Computing

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The University of Michigan

To: College of Engineering Curriculum Committee
From: Ken Powell, Aero Curriculum Committee
Re: Aerospace Engineering Curriculum Revision

The Aero faculty have approved a change to our curriculum, which we are forwarding for college approval. The basic goals of this change are:

- Introduce a professionalism thread in our sophomore curriculum;
- Require a junior-level Aerospace Computing course that covers computer science fundamentals, computing for simulation, and embedded systems;
- Raise the number of technical elective credits from 7 to 9.

In order to make this work, we are:

- Deleting our 1-credit sophomore seminar, Aero 285
- Introducing a required 2-credit Introduction to the Aerospace Enterprise, Aero 200
- Changing Aero 201 (Introduction to Aerospace Engineering) from 3 credits to a 2-credit course named Introduction to Aerospace Science;
- Changing the following courses from 4 credits to 3:
  - Aero 215
  - Aero 225
  - Aero 315
  - Aero 325
  - Aero 335

Our transition plan is to begin teaching the new versions of 200, 201, 215, 225, 315, 325, and 335 starting in Fall 2020. Students entering the Aerospace Department in Fall 2020 will graduate under the new requirements. Students currently in the program will be held

harmless, and will not be required to take Aero 350. We will accept the new courses listed above in lieu of old versions; any credits freed up will be converted to technical electives.

Independent from this change, we have also included the CARF for a new graduate course, Aero 567.

Aerospace Engineering
Sample Schedule

	Total Credit Hours	Term: 1	2	3	4	5	6	7	8
Subjects Required by all Programs (55 hours)									
Mathematics 115, 116, 215, and 216	16	4	4	4	4	-	-	-	-
ENGR 100, Introduction to Engineering	4	4	-	-	-	-	-	-	-
ENGR 101, Introduction to Computers	4	-	4	-	-	-	-	-	-
CHEM 125/126, 130 or 210, 211[1]	5	5	-	-	-	-	-	-	-
Physics 140 with Lab 141[2]	5	-	5	-	-	-	-	-	-
Physics 240 with Lab 241[2]	5	-	-	5	-	-	-	-	-
Intelectual Breadth	16	4	4	-	-	-	-	4	4
Related Technical Core Subjects (12 hours)									
MECHENG 240, Intro to Dynamics and Vibrations	4	-	-	-	4	-	-	-	-
Engineering Distribution 1[3]	4	-	-	-	-	4	-	-	-
Engineering Distribution 2[3]	4	-	-	-	-	4	-	-	-
Aerospace Science Subjects (29 hours)									
AEROSP 201, Introduction to Aerospace Engineering	3	-	-	3	-	-	-	-	-
AEROSP 215, Introduction to Solid Mechanics and Aerospace Structures	4	-	-	-	4	-	-	-	-
AEROSP 225, Introduction to Gas Dynamics	4	-	-	-	4	-	-	-	-
AEROSP 315, Aircraft and Spacecraft Structures	4	-	-	-	-	4	-	-	-
AEROSP 325, Aerodynamics	4	-	-	-	-	-	4	-	-
AEROSP 335, Aircraft and Spacecraft Propulsion	4	-	-	-	-	4	-	-	-
AEROSP 341, Aircraft Dynamics (W) or AEROSP 343, Spacecraft Dynamics (F)	3	-	-	-	-	-	3	-	-
AEROSP 470, Control of Aerospace Vehicles	3	-	-	-	-	-	-	3	-
Aerospace Engineering Subjects (16 hours)									
AEROSP 205, Intro Aerospace Engineering Systems	3	-	-	3	-	-	-	-	-
AEROSP 285, Aero Engineering Seminar	1	-	-	1	-	-	-	-	-
AEROSP 305, Aerospace Engineering Lab I	4	-	-	-	-	-	4	-	-
AEROSP 405, Aerospace Engineering Lab II	4	-	-	-	-	-	-	4	-
AEROSP 481, Aircraft Design or AEROSP 483, Space System Design	4	-	-	-	-	-	-	-	4
Electives (16 Hours)									
Technical Electives[4]	7	-	-	-	-	-	-	4	3
General Electives	9	-	-	-	-	-	5	-	4
Total	**128**	**17**	**17**	**16**	**16**	**16**	**16**	**15**	**15**

Revised: May-18

Candidates for the Bachelor of Science degree in Engineering (Aerospace Engineering) - B.S.E. (Aerospace E.) - must complete the program listed above. This sample schedule is an example of one leading to graduation in eight terms.

Notes:

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

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

[3] Engineering distribution requirement. Select two courses from: MSE 220, MSE 350, EECS 215, EECS 216, EECS 280, EECS 281

[4] Technical electives must total at least 7 credits of approved upper division courses (that is, 300 level or above). At least 3 credits must be approved mathematics or science courses, a maximum of 3 credits is allowed for directed study and a maximum of 2 credits is allowed for seminar courses. Recommended courses that satisfy the mathematics or science technical electives are described in a document that can be obtained from the Department or on the Department website.

Sample Schedule 2020-2021

Aerospace Engineering

	Total Credit Hours	Term: 1	2	3	4	5	6	7	8
Subjects Required by all Programs (55 hours)									
Mathematics 115, 116, 215, and 216	16	4	4	4	4	-	-	-	-
ENGR 100, Introduction to Engineering	4	4	-	-	-	-	-	-	-
ENGR 101, Introduction to Computers	4	-	4	-	-	-	-	-	-
CHEM 125/126, 130 or 210, 211[1]	5	5	-	-	-	-	-	-	-
Physics 140 with Lab 141[2]	5	-	5	-	-	-	-	-	-
Physics 240 with Lab 241[2]	5	-	-	5	-	-	-	-	-
Intelectual Breadth	16	3	3	2	-	-	-	4	4
Related Technical Core Subjects (12 hours)									
MECHENG 240, Intro to Dynamics and Vibrations	4	-	-	-	4	-	-	-	-
Engineering distribution 1[3]	4	-	-	-	-	4	-	-	-
Engineering distribution 2[3]	4	-	-	-	-	4	-	-	-
Aerospace Science Subjects (26 hours)									
AEROSP 201, Introduction to Aerospace Science	2	-	-	-	2	-	-	-	-
AEROSP 215, Introduction to Solid Mechanics and Aerospace Structures	3	-	-	-	3	-	-	-	-
AEROSP 225, Introduction to Gas Dynamics	3	-	-	-	3	-	-	-	-
AEROSP 315, Aircraft and Spacecraft Structures	3	-	-	-	-	3	-	-	-
AEROSP 325, Aerodynamics	3	-	-	-	-	-	3	-	-
AEROSP 335, Aircraft and Spacecraft Propulsion	3	-	-	-	-	3	-	-	-
AEROSP 341, Aircraft Dynamics (W) or AEROSP 343, Spacecraft Dynamics (F)	3	-	-	-	-	-	3	-	-
AEROSP 350, Introduction to Aerospace Computing	3	-	-	-	-	-	3	-	-
AEROSP 470, Control of Aerospace Vehicles	3	-	-	-	-	-	-	3	-
Aerospace Engineering Subjects (17 hours)									
AEROSP 200, Introduction to the Aerospace Enterprise	2	-	-	2	-	-	-	-	-
AEROSP 205, Intro. to Aerospace Engineering Systems	3	-	-	3	-	-	-	-	-
~~AEROSP 285, Aero Engineering Seminar~~	~~1~~	-	-	~~1~~		-	-	-	-
AEROSP 305, Aerospace Engineering Lab I	4	-	-	-	-	-	4	-	-
AEROSP 405, Aerospace Engineering Lab II	4	-	-	-	-	-	-	4	-
AEROSP 481, Aircraft Design (F) or AEROSP 483, Space System Design (W)	4	-	-	-	-	-	-	-	4
Electives (18 Hours)									
Technical Electives[4]	9	-	-	-	-	-	-	3	6
General Electives	9	-	-	-	-	2	3	2	2
Total	128	16	16	16	16	16	16	16	16

Candidates for the Bachelor of Science degree in Engineering (Aerospace Engineering) - B.S.E. (Aerospace E.) - must complete the program listed above. This sample schedule is an example of one leading to graduation in eight terms.

Notes:

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

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

3. Engineering distribution requirement. Select two courses from: MSE 220, MSE 350, EECS 215, EECS 216, EECS 280, EECS 281

4. Technical electives must total at least 9 credits of approved upper division courses (that is, 300 level or above). At least 3 credits must be approved mathematics or science courses, a maximum of 3 credits is allowed for directed study and a maximum of 2 credits is allowed for seminar courses. Recommended courses that satisfy the mathematics or science technical electives are described in a document that can be obtained from the Department or on the Department website.

Current CoE Dual Degree Admissions Policy

There are currently no admissions criteria or application deadlines for non-CoE students to add a CoE dual degree. Students simply get signatures from a CoE Advisor and CoE Registrar on an MDDP form (if there is an agreement between the schools) or complete the IDP process (if there is not an agreement between the schools) and then submit it to their home school. This allows students to bypass the admissions criteria that first-year, external transfer, and cross campus transfer students must meet. The proposed admissions policy below would create admissions criteria and application deadlines in alignment with those in place for cross campus transfer students to address this equity concern.

Proposed CoE Dual Degree Admissions Policy

Admissions Criteria

To be admitted to CoE as a dual degree student, students must:

- Be admissible to CoE (i.e. meet cross campus admissions criteria and be eligible to declare a major)
- Have completed one year on the Ann Arbor campus (one term if originally admitted as an external transfer student)
- Have a cumulative GPA of at least 2.5
- Be in good academic standing

Application Deadlines

- Same as CoE cross campus transfer application deadlines
    - Feb 1 for Fall admission
    - Oct 1 for Winter admission

Application Process

- Apply to CoE and be accepted as a dual degree student
- Obtain the new dual degree form (ideally this will be an online form). Univ RO dual degree working group is working on this.
- Complete form, route to both schools' advisors and registrar's for signatures, submit to home school registrar.

Dual Degree Admissions Policies at other U-M Schools/Colleges

School/College	Minimum GPA/Credit Requirement to Declare Dual Degree
LSA	1. The student must be admissible to both Schools/Colleges (i.e. meet cross campus transfer requirements) 2. A minimum of 30 cr must have been completed on the Ann Arbor campus before they apply for a joint degree 3. CUM GPA 3.0 4. Meet with an Academic Standards Board member to fill out an application.
Ross	Ross requires that BBA students have completed their first year at UM (for us this is always Fall/Winter, so two terms), be eligible to declare the major they are adding (so have completed any major prerequisites, or be admitted where applicable) and be in good academic standing.
Stamps	Stamps requires our majors to have earned 30 credits at the UM and to have a 3.0 cumulative GPA in order to declare a dual degree. They are also required to have completed all our first-year foundation courses (six studios, a Stamps non-studio course and two semesters of our lecture series). The student must meet with their academic advisor as well as our Director of Admissions.
Kinesiology	We actually require students adding Kinesiology to apply and be admitted as a cross-campus transfer and then they can declare the dual degree.

LSA Proposal to Increase Credit Requirement for CoE/LSA MDDP's

The School of Literature, Arts, and Sciences (LSA) has proposed increasing the credits for the LSA-Coe MDDP from 128 credits to 150 credits. We are asking for any additional thoughts on the proposal. Important information to consider are:

- All LSA MDDPs with other University College's require 150 credits.
- There is currently a Registrar's Office working group that is meeting throughout the year to make the MDDP process easier for students across the University and this is in discussion (Matt will present on this).
- Most of the time, students end up with 150 credits in completing the CoE-LSA MDDP program to begin with.
- Queries will be run of student's who've graduated with the CoE-LSA MDDP to get a larger intake of the impact of this proposal.

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
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:01/29/2020
Effective Term: Fall 2020

☒	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): Aerospace Engineering Subject: AEROSP Catalog: 200
☐	☐ 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) Introduction to the Aerospace Enterprise
☒	Abbreviated Title (20 char)	Abbreviated Title (20 char) Intro Aero Entrprs
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) An introduction to leadership, culture, and wide variety of technical fields that are part of the design, construction, and operations of Aeronautical and Astronautical vehicles. The course includes numerous seminars by notable practitioners.	
☒	Full Term Credit Hours Undergraduate Min: 2.00 Graduate Min: Undergraduate Max: 2.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☒	Course Credit Type Undergraduate	
☐	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: AEROSP

Catalog: 200

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

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

Add Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☒ No Consent

Drop Consent
- ☐ Department Consent
- ☐ Instructor Consent
- ☒ No Consent

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

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

Graded Component
- ☒
- ☐
- ☒
- ☐
- ☐
- ☐

Terms Typically Offered (Please select only one)
Fall, Winter or [blank]

Instructor Name: George Halow

Instructor Title: Professor of Practice

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. S. Powell Date:2**/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description	Course Description An introduction to leadership, culture, and wide variety of technical fields that are part of the design, construction, and operations of Aeronautical and Astronautical vehicles. The course includes numerous seminars by notable practitioners.
Class Length	Class Length Full term
Contact Hours (Lecture)	Contact Hours (Lecture) 1.5 hours
Contact Hours (Recitation)	Contact Hours (Recitation) 1.5 hours
Contact Hours (Lab)	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
This required new course fills a void in comprehensive Aerospace Enterprise/Industry teachings, supplementing strong engineering science education with industry and enterprise knowledge, leadership behaviors, and tools & coaching on how to manage a career within the Aerospace Enterprise.

It replaces and enhances an existing required 1-credit course (Aero 285, Aerospace Engineering Seminar) and provides substantially enhanced pedagogy and teachings relative to the Aerospace Enterprise, including different sectors, entities (industry, government, academia, and adjacencies), design and production requirements, and exemplary leadership behaviors of business and engineering ethics, teaming, communications, and sustainability.

Virtually all of the material has been piloted very successfully in Fall 2019 (128 students) and Winter 2020 (>100 students) in the existing course (Aero 285) it is replacing; course evaluation material is attached. Two significant issues warrant the change:

1) Contact hours (2.5/week) are already on the borderline of too heavy for a 1-credit class
2) While students have voiced strong support for the material, many (in course evaluations, RateMyProfessor) have cited the high workload for a 1-credit class.

3) Technical Communication continues to be an important part of the new course but it has been integrated into the syllabus, as opposed to a separate component covered by Tech Com faculty.

AEROSP 200 Syllabus

COLLEGE OF ENGINEERING
AEROSPACE ENGINEERING
UNIVERSITY OF MICHIGAN

Aerospace Engineering 285
Aerospace Engineering Seminar
Winter, 2020 1 Credit Hour

Course Objectives	Prepare students for careers in the Aerospace enterprise by developing broad knowledge of the history of flight, operating environments and elements (aeronautics and astronautics, civil and military flight, enterprise structure), career opportunities, and exemplary engineering culture of leadership and professional behaviors. Upon course completion, students should have the skills to: • Build on the history of the Aerospace enterprise in advancing the art • Navigate through the various elements of the aerospace enterprise – through basic awareness of types of air- and spacecraft & uses, OEMs, customers, the supply base, global markets and sizes • Exhibit a suite of role model personal & professional leadership behaviors (including ethics in engineering, diversity/equity/inclusion, working in teams, sustainable development) • Establish a preliminary career goal within the Aerospace enterprise, and take concrete steps to take at the University of Michigan to realize that goal	
Instructors	George Halow (Prof) gfhalow@umich.edu (734)936-1462 FXB 3009 Office Hrs: M 3:00 – 5:00pm, W 9:30 – 10:30am and by appointment	Kaelan Oldani (GSI) oldanik@umich.edu (734)936-0103 FXB 2243 Office Hrs: By appointment
Description	The course will be delivered in three (3) components: I. The Aerospace Enterprise II. Engineering Leadership, Culture, and Communication III. Careers in Aerospace The first component, **The Aerospace Enterprise**, will be an overview of civil, military, and space aviation. It will include industry overviews, governing agencies – US and international – and prevailing issues to provide for meaningful discussion. Examples will be drawn from commercial aviation, military applications, and spacecraft. The second component, **Engineering Leadership, Culture, and Communication**, will drill down into what it means to exhibit leadership and professionalism in engineering. Specific topics include engineering and business ethics, DEI, socially- and environmentally-responsible engineering, team leadership and development, and technical & business communications. The final component, **Careers in Aerospace**, will open with introspection on what each student wants to get from his or her career, walk through the various options in the Aerospace enterprise, and then provide guidance for students to plan their time at Michigan to help realize those goals. Each component will be comprised of pedagogy created through real-world experiences, and enhanced by relevant guest speakers from industry, government, and/or academia. Student assignments/deliverables, and associated grading scale, will include:	

	% of Total	Due Date(s)
• Journals (2 @ 20% each)	40%	Various (see syllabus)
• Poster	20	Various (see syllabus)
• Team Report on Readings (accident)	15	Wednesday, April 15th
• Miscellaneous Assignments/Surveys	5	Various (see syllabus)
• Engagement (attendance/participation)	20	Ongoing
TOTAL	**100%**	

Assignments

Journals

The Friday seminars cover contemporary Aerospace topics by predominantly external visitors. Students will be required to write Journals on a rotating basis (submission dates based upon the 1st letter of last name; see syllabus) for the Friday lectures, due in Canvas the following Wednesday at 11:00am. Instruction for writing an effective Journal will be given the first day of class; students have the opportunity to embellish/enhance the Journals, subject to the single-page, single-spacing within and double-spacing between paragraphs, not including figures/tables.

Objectives of the journals are to test students' ability to:

- Listen, comprehend, and pick out the important/salient points of a lecture
- Clearly, concisely, and succinctly reflect those salient points in a "what you need to know" vs. "what I know" organized, structured document

Two to three journal entries will be randomly selected to do a 4-minute in-class presentation on the day they are due.

Poster

Each student will create an electronic poster that can be displayed on a screen and is taking into account the points made during the lecture poster design. Please use PowerPoint to create the poster and upload it as a .pdf to our Canvas site. The topic of your poster should be an aircraft, a spacecraft, an important air- or spacecraft system, a satellite, the space station, or a specific aerospace personality you admire. Alternatively, you may also design a poster for a specific project you are working on this semester.

** Note both Journals and Posters are individual – not team – assignments. Each student will be required to submit two (2) Journals, and one (1) Poster, based upon their section. Sections are as follows:

Section	Last name begins with
Boeing 747	A-E
Lockheed SR-71	F-L
North American X-15	M-R
Saturn V	S-Z

Accident Reports

One (1) team report on an Aerospace accident is required. Teams have the choice of picking either an aeronautical or an astronautical example from the following lists:

Aircraft (https://www.ntsb.gov/investigations/AccidentReports/Pages/aviation.aspx)

1. N8082U United Airlines Flight 173 McDonnell Douglas DC-8-61 (Dec 29th, 1978)
2. N62AF Air Florida Flight 90, Boeing 737-200 (Jan 13th, 1982)
3. N513AU USAir Flight 427, Boeing 737-3B7 (Sep 8th, 1994)
4. N963AS Alaska Airlines Flight 261, McDonnell Douglas MD-83
5. N1819U United Airlines Flight 232, McDonnell Douglas DC-10

Spacecraft

1. Apollo 1 (204) https://history.nasa.gov/Apollo204/summary.pdf
2. Challenger Accident Report https://www.govinfo.gov/content/pkg/GPO-CRPT-99hrpt1016/pdf/GPO-CRPT-99hrpt1016.pdf
3. Columbia Accident Report http://s3.amazonaws.com/akamai.netstorage/anon.nasa-global/CAIB/CAIB_medres_full.pdf

	Reports should follow the general format and structure given in the Formal Reports Workshop (March 11th), and address: • What was the root cause of the failure? • What could have or should have been done to prevent it? • What permanent corrective actions were put in place to prevent future occurrences? • What were the predominant cultures or behaviors which created the environment for the accident, and what changes would you make? • What is your overall impression of the report – is it succinct, direct, clear, comprehensive? Does it adequately address root cause, lessons learned, and improvement actions? • Formatting – section headers, flow, footers (w/page number, creation/revision dates) Students will be randomly assigned into teams of 4-5. The teams will be graded on the overall quality of the report, plus a random (professor-enhanced) peer review evaluation of how much they contributed to the team, and how they encouraged excellence in team dynamics. **Engagement** Engagement is 20% of the total grade and includes two components: • attendance 75% • active participation 25% Each student is allowed one (1) unexcused absence before points are deducted from the attendance score. Active participation has some subjectivity, but is the norm in just about any environment
Course Culture	I will do everything in my power to ensure that every student in this course gets what they need to learn the most they can. I am committed to a class culture that welcomes and serves students of all ages, ethnicities, genders, gender identities and expressions, national origins, religious affiliations, sexual orientations, and socioeconomic backgrounds – and other visible and nonvisible differences. I will work to foster a respectful, welcoming, and inclusive environment, and will expect each student to contribute as well. Your suggestions are encouraged and appreciated.
Mental Wellness	It is common for students to experience any of a number of things that can be a barrier to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating, and lack of motivation. The department and university are committed to advancing the mental health and well-being of our students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. You can learn more about the range of confidential services available here: https://caps.umich.edu/mitalk
Rules of the Road; Key Success Factors	• Re-read posted material, and your notes, within 24 hours after class – also will significantly aid in retention • Be attentive in class and contribute to class discussions. Better to occasionally give a wrong answer than never to speak up. • No use of electronic devices in class, unless in emergency (proof required) • Time management is critical – do not wait until the night before your journal is due, nor start working on your report a couple of days before it's due. You will manage your stress and grades best if you manage and plan your workload accordingly. • Knowing when you need help is a sign of strength, not weakness; seek help early from the instructors, fellow students, or friends who have taken the class if you do not understand something. • This is the only course of its kind in the curriculum, and thus is your only opportunity to get a structured education of the history and working environment of the Aerospace enterprise. Deep learning in this course will prove to be a significant aid throughout your time at the University of Michigan, and after graduation.

COLLEGE OF ENGINEERING
AEROSPACE ENGINEERING
UNIVERSITY OF MICHIGAN

Course Syllabus

(Some presentation titles subject to change)

Date	Topic	Purpose	Materials	Assignments Due
		Course Component I – The Aerospace Enterprise		
Jan 8	Course introduction: • Objectives • Syllabus • Speaker series • Technical Communication • Rules of the road • Engineering honor code Effective Journals	Ground students in objectives, structure, requirements, rules of the road Introduce students to effective summarizing (journals)	Syllabus Halow/TC rubrics on journals	Pre-Course Career Survey (link provided in Canvas) ***due Jan 9th 11:59pm***
Jan 10	1a Aviation History– (Halow)	Provide aerospace history and background	Select video clips, and discussion	
Jan 15	Introduction to Military Aviation (Halow)	Intro to military aviation industry, products, ethics of technology application for military purposes	Halow-created slides from basic research	Journal 1a (Grp Boeing 747)
Jan 17	1b Laying Out the National Space Security Enterprise – B.T. Cesul	Military use of space, including contemporary issues like space debris, space control, Space Command v. Space Force, even just an introduction to how the US Nat'l Security Space Enterprise is structured	Cesul-provided	
Jan 22	Introduction to Spacecraft (Halow)	Intro to space industry, products, size, companies, reg agencies, and commercialization of space	Halow-created slides from basic research, plus video	Journal 1b (Grp Lockheed SR-71)
Jan 24	1c Space Technology, Exploration, and Commercialization – Raenaurd Turpin, Boeing Space Systems	Space systems presentation	Turpin-generated	Review at least one aircraft and one spacecraft accident report (links provided)
Jan 29	Introduction to Aircraft (Halow)	Intro to civil aviation industry, companies, products	Halow-created slides from basic research, plus video	Journal 1c (Grp NA X-15) Choice of Poster topic submitted to instructors for approval
Jan 31	1d Commercial Aviation – Technologies, Value Stream, and Major Supplier Contributions – Juan deBedout, Collins	Civil aviation and general technology, opportunities in major supplier companies	deBedout-provided	*Optional: questions due for panel discussion (not graded)*
Feb 5	Tech Comm – Posters Workshop (Eric Kumpf)	Introduction to writing effective posters	Kumpf-provided	Journal 1d (Grp Saturn V)

Date	Topic	Purpose	Materials	Assignments Due
Course Component II – Engineering Leadership, Culture, and Communication				
Feb 7	2a Panel Discussion – Culture and Careers in Aerospace – members of the Aerospace Industrial Advisory Board (IAB) and others	• Provide students career options, and exemplary culture & behaviors, from industry, government, and academia perspectives • Introduce Aero 285 components 2 and 3	• Each panelist would give a 5 min intro/overview based on experience • Halow pose questions from pre-submitted list • Additionally, questions will be taken from the audience	
Feb 12	Ethics and Integrity in Business – George Halow	Expose students to multiple scenarios of ethical transgression	Powerpoint with four (4) cases – 10 minutes per case	Journal 2a (Grp Boeing 747)
Feb 14	2b Impact of Engineering Ethics – Boeing 737 Max (Halow)	Introduce ethics by showing what the potential ramifications of ethical breaches can be	• 60 Minutes Australia video • Open class discussion/ observations	
Feb 19	Ethics and Leadership – George Halow	• Provide students with tools to navigate through ethical dilemmas • Provide perspectives on the impact of ethics on leadership and teams	Powerpoint with pedagogy and leadership elements	Journal 2b (Grp Lockheed SR-71)
Feb 21	2c Environmental & Social Sustainability, and Leadership in Corporate Citizenship – John Viera, Executive in Residence, Erb Institute	• Intro to Sustainability – environmental and social responsibility • What engineers can do to have a positive and lasting impact on society	Viera-developed material	
Feb 26	Class cancelled			
Feb 28	No class – early dismissal for spring break	Early dismissal: spring break		
Mar 11	Formal Reports Workshop (Halow)	Review structure for Formal Reports, and Accident Report best practices		Poster a (Grp Boeing 747)
Mar 13	2d (choice) Leading Highly Effective Teams – Lindy Greer (Michigan Ross)	Introduce pedagogy for creating and managing effective teams	Greer-developed material	
Mar 18	Perceptions, Expectations, Prejudice in the Work Environment – Karen Albrecht	Deeper understanding of DEI, and how personal prejudices play a role in behaviors and decisions		Journal 2d (Grp Saturn V) Individual write-ups (responses) for each student's accident report question
Course Component III – Careers in Aerospace				
Mar 20	Expanding Your Flight Envelope: How to Discover & Launch Your Dream Career – Ben Marchionna, SkySpecs		Marchionna-developed	Completion of Myers-Briggs Survey (*March 22nd; link provided in Canvas*)
Mar 25	Building Your Career – Critical Dimensions – George Halow	Assessment of MBTI and how it can help identify the right career path	Halow-developed	Poster b (Grp Lockheed SR-71)
Mar 27	Connecting People, Powering Freedom, and Growing Economies: A Career Designing And	Outline of a career which weaves through technical & leadership roles aviation. Includes engine testing videos,	Duke-developed	

Date	Topic	Purpose	Materials	Assignments Due
	Developing Gas Turbine Engines – Jennifer Duke (Pratt & Whitney)	and detail on integrated product teams		
Apr 1	How Will You Plan Your Education at Michigan to Realize Your Goals – George Halow	• Pose basic questions for students to figure out what they want to get out of their careers • Present resources available to students	Halow-developed	Poster c (Grp NA X-15)
Apr 3	Life in the Extremes – Kathryn Clark, University of Michigan	Comparison of two very unique careers – academia and industry/NASA		Completion of Follow-Up Career Survey (*by April 5th*)
Apr 8	Poster Report-Outs			Poster d (Grp Saturn V)
Apr 10	*No Class – Good Friday*			
Apr 15	Resume Workshop (Oldani)	Intro to writing effective and impactful resumes	Oldani-generated	Accident Reports
Apr 17	Accident Report team report-outs	Reinforce learnings, practice public speaking	Randomly-chosen teams to present	

	Day	Time	Location
	Wednesday Class	3:00 – 4:00pm	EECS 1500
	Friday Lecture	1:30 – 3:00pm	Beyster 1670

Student Teaching Evaluations

Quantitative scores from the instructor report for Aero 285 (fall, 2019), piloting most of the material to be added for Aero 200 (which is proposed to replace Aero 285).

University of Michigan
Fall 2019 Instructor Report With Comments
AEROSP 285-001: Aero Eng Sem
George Halow

46 out of 128 students responded to this evaluation.

Responses to the University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
This course advanced my understanding of the subject matter.(Q1631)	31	12	1	1	0	0	4.8	4.5	4.4
My interest in the subject has increased because of this course.(Q1632)	31	10	0	1	0	1	4.8	4.2	4.1
I knew what was expected of me in this course.(Q1633)	27	14	3	0	0	0	4.7	4.4	4.3
Overall, this was an excellent course.(Q1)	38	4	1	1	0	0	4.9	4.2	4.1
I had a strong desire to take this course.(Q4)	21	10	12	1	0	0	4.4	4.0	4.0
As compared with other courses of equal credit, the workload for this course was...(SA=Much Lighter to SD=Much Heavier) (Q891)	4	6	21	11	0	2	3.0	3.0	2.6

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
Overall, George Halow was an excellent teacher.(Q2)	43	1	0	0	0	0	5.0	4.6	4.4
George Halow seemed well prepared for class meetings.(Q230)	44	0	0	0	0	0	5.0	4.8	4.6
George Halow explained material clearly.(Q199)	43	1	0	0	0	0	5.0	4.6	4.4
George Halow treated students with respect.(Q217)	44	0	0	0	0	0	5.0	4.8	4.7

Responses to additional questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median
I developed a greater understanding of my ethical responsibilities. (Q24)	32	11	0	0	0	0	4.8	4.0
I developed a greater understanding of my responsibilities as a professional. (Q25)	36	8	0	0	0	0	4.9	4.2
This course improved my ability to communicate technical information, designs, and analyses. (Q28)	27	10	5	2	0	0	4.7	4.2
I developed a greater understanding of the impact of engineering on society. (Q29)	32	11	0	1	0	0	4.8	4.1
I developed a greater understanding of the impact of engineering on the environment. (Q30)	27	14	2	1	0	0	4.7	4.4
I now have a greater understanding of the contemporary issues in this field. (Q33)	31	11	1	1	0	0	4.8	4.5

Sampling of comments from the instructor report for Aero 285 (fall, 2019). Note they are for the version of Aero 285 piloting the "new" material to be incorporated in Aero 200. Basic comments show very positive response to the new material, but it is already bordering on too heavy for a 1-credit class before any further enhancements.

Comments
This course was like no other in the Aero department. Even though it was quite a bit of work for a 1–credit class, it was all worth it in the end. Professor Halow's engagement in the course is what kept me looking forward to the lectures, and he was very accommodating in our questions and concerns for the class. The guest speakers brought in provided me with a much better understanding of what it's like to be in different sectors of the aerospace enterprise, and has increased my interest in areas I thought I'd never be involved in. Overall, I would definitely take this class again! Thanks for a great semester!
Having access to a professor like George Halow was an incredible opportunity that allowed me the chance to explore the possibilities for my future. Even though he is a first year faculty member, his dedication to his student's learning and future was remarkable. I would recommend this course, despite the heavy workload for a single course, just to have Halow has a professor.
This course was an eye–opener on how the Aerospace industry is structured and how WE navigate around and handle obstacles and ethical dilemmas. I personally enjoyed case studies and the radiant enthusiasm Prof. Halow has to offer. More, the lunch sessions were super helpful to get personalized comments and appreciate each speaker's unique background stories and experiences.
Professor Halow was an astounding teacher. I heard many negative things about this seminar coming into it, but Halow has completely made it better. Genuinely, it changed my perspective and made me feel more excited/confident to explore my aerospace field.
George was an excellent professor. Before taking this course, I did not really see the point to it. However, I think that George made it really worthwhile as a course that introduces students to a little bit about what engineering is in the real world. The seminars helped to reinforce this and helped to show what opportunities there are after graduation. Try to hang onto George for a while, don't let Ross scoop him up.
should be a 2 credit course
George Halow is an extremely charismatic guy and a great teacher. Aerospace 285 opened my eyes to the possible career paths an aerospace undergrad degree can offer you and made me genuinely excited to be pursuing my degree.
Prof. Halow is the best! Such a good resource, and seems like he has dramatically improved this class.

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
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:01/29/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☐	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 201	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 201
☐	☐ 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) Introduction to Aerospace Engineering	Course Title (full title) Introduction to Aerospace Science
☐	Abbreviated Title (20 char) Intro Aero	Abbreviated Title (20 char) Intro Aero Science
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) An introduction to aerospace engineering science. Flight vehicles in the atmosphere and in space. Introduction to propulsion, aerodynamics, and aircraft performance. Introduction to satellites, rockets, and orbital mechanics.	
☒	Full Term Credit Hours Undergraduate Min: 2.00 Graduate Min: Undergraduate Max: 2.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate	
☐	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: AEROSP

Catalog: 201

☐

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) ENG 100/101, PHYS 140/141, MATH 116 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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: Ken Powell

Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. M. Powell Date: **2/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description Introduction to Aerospace Engineering. Flight vehicles in the atmosphere and in space. Flight technologies, including structures, materials, propulsion, aerodynamics, vehicle dynamics, flight control, flight information systems and systems integration. An overview of aeronautics. Steady aircraft flight and performance. An overview of astronautics.	Course Description An introduction to aerospace engineering science. Flight vehicles in the atmosphere and in space. Introduction to propulsion, aerodynamics, and aircraft performance. Introduction to satellites, rockets, and orbital mechanics.
Class Length Full term	Class Length Full term
Contact Hours (Lecture) 3.0 hours	Contact Hours (Lecture) 2.0 hours
Contact Hours (Recitation) 0.0	Contact Hours (Recitation) 0.0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Introduces fundamental Aerospace science, establishing a baseline for students in higher-level courses.

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
The number of credits is changed from three (3) credits to two (2), to provide a credit hour for the expansion of Aero 200 (formerly Aero 285). Content has been reduced to fit appropriately as a 2-credit course, by leveraging synergies/eliminating redundancies with other courses.

Course Outcomes

a. Introduction
    a. Describe the basic parts of aircraft and spacecraft
    b. Understand terms and definitions commonly used in the analysis and design of aircraft and spacecraft. Apply dimensional analysis to identify non-dimensional quantities and to check consistency of equations and formulas.
b. Programming and Algorithms
    a. Write programs using iterations, conditional statements, vectors, and matrices.
    b. Use vector mathematics to formulate and solve problems with Matlab.
    c. Generate computer plots of one and two-dimensional data, using curves, surfaces, and contours.
    d. Implement and understand the theory behind common numerical algorithms, including interpolation, curve fitting, integration.
c. Aerodynamics and Aircraft Propulsion
    a. Apply hydrostatics to analyze layers in the standard atmosphere model.
    b. Define force and moment coefficients on airfoils and wings.
    c. Use lift, drag, and moment formulas to analyze aircraft performance.
    d. Explain properties of jet engines.
    e. Apply thrust and power formulas to solve problems involving air-breathing propulsion.
d. Aircraft Kinematics and Performance
    a. Define position, velocity, acceleration, and force vectors.
    b. Explain the common coordinate systems used in aerospace engineering, including inertial, body-fixed, and wind-aligned.
    c. Transform vectors between coordinate systems using rotation matrices.
    d. Determine range and endurance of aircraft.
    e. Analyze takeoff and landing portions of flight, taking into account constraints such as stall and maximum thrust or power.
    f. Explain basic flight maneuvers, including relevant control surfaces, equations of motion, and analytical or numerical solutions.
    g. Analytically and numerically plan efficient aircraft flight routes.
e. Space and Spacecraft Performance
    a. Explain gravity, orbits, and the space environment of our solar system.
    b. Use numerical time marching to simulate orbits and solve multiple-body problems.
    c. Explain characteristics and evaluate properties of circular, elliptical, parabolic, and hyperbolic orbits.
    d. Explain rocket propulsion, including fundamental differences with air-breathing propulsion

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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:01/29/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☐	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 215	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 215
☐	☐ 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) Introduction to Solid Mechanics and Aerospace Structures	Course Title (full title) Introduction to Solid Mechanics and Aerospace Structures
☐	Abbreviated Title (20 char) Intro Aero Struct	Abbreviated Title (20 chars) Intro Aero Struct
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) An introduction to the fundamental phenomena of solid and structural mechanics in aerospace systems. Includes analysis and numerical methods of solution that are used for design of aerospace structures.	
☒	Full Term Credit Hours Undergraduate Min: 3.00 Graduate Min: Undergraduate Max: 3.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate	
☐	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: AEROSP
Catalog: 215

☐

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

Grading
☐ Not for Credit
☐ Not for Degree Credit
☒ Degree Credit Only

Add Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

Drop Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☒	Enforced Prerequisite (254 char) Math 216 (co), Aero 201 (co) 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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: John Shaw

Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. M. Powell Date:2**/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description An introduction to the fundamental phenomena of solid and structural mechanics in Aerospace systems. Includes analysis and numerical methods of solutions used for design of thin-walled Aerospace structures. Emphasis is placed on understanding behavior particular to thin-walled structures.	Course Description An introduction to the fundamental phenomena of solid and structural mechanics in Aerospace systems. Includes analysis and numerical methods of solutions used for design of thin-walled Aerospace structures. Emphasis is placed on understanding behavior particular to thin-walled structures.
Class Length Full term	Class Length Full term
Contact Hours (Lecture) 4.0	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Required first course in solid mechanics and structures, followed by Aero 315.

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
The number of credits is changed from four (4) credits to three (3), as part of a rebalancing of the curriculum.

The syllabus is attached. Material has been removed from the 4-credit version to fit in the allotted time.

1. Introduction

Physical units

Review of statics

Free body diagrams

2. Mechanics of Deformable Bodies

Statically determinate vs. indeterminate structures

Displacements and deformation

Combining equilibrium and geometric considerations

Force-displacement relations

3. Axial Deformation of Bars

Normal stress-strain

Force-elongation for variable cross-section bars

Equilibrium differential equation

Boundary conditions

Temperature effects

Composite bars

4. Torsion of Circular Bars

Kinematics for torsion of circular bars

Shear stress-strain

Torque-twist relation for variable cross-section bars

Equilibrium differential equation

Boundary conditions

5. Stress Analysis

Definition of traction vector & 3D stress components

Definition of 3D strain components

3D Stress and Strain transformation in Matlab using transformation matrices

Plane stress, Mohr’s circle

3D Principal stresses/directions (eigenvalue problem)

6. Strain Analysis

Definition of 3D strain components

Plane strain, Mohr's circle

3D Principal strains/directions

7. Engineering Beam Theory

Shear force-bending moment diagrams and relations

Jump conditions for point loads & moments

Kinematics of Bernoulli-Euler beams

Normal stresses in beams

Shear stresses in beams

Equilibrium differential equation (2nd & 4th order)

Bending deflections

Superposition

Boundary conditions & matching conditions

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:01/29/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☐	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 225	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 225
☐	☐ 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) Introduction to Gas Dynamics	Course Title (full title) Introduction to Gas Dynamics
☐	Abbreviated Title (20 char) Intro Gas Dynamics	Abbreviated Title (20 chars) Intro Gas Dynamics
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) This course covers fundamental concepts in thermodynamics and fluid dynamics. Topics include molecular and continuum concepts for fluids, first and second laws of thermodynamics, conservation laws for moving fluids, one-dimensional compressible flows, shocks and expansion waves, and flows in nozzles.	
☒	Full Term Credit Hours Undergraduate Min: 3.00 Graduate Min: Undergraduate Max: 3.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate	
☐	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: AEROSP
Catalog: 225

☐

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

Grading
☐ Not for Credit
☐ Not for Degree Credit
☒ Degree Credit Only

Add Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

Drop Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

	CURRENT LISTING	REQUESTED LISTING
☐	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☒	Enforced Prerequisite (254 char) Math 215, Chem 125/130, Phys 140/141 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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: Ken Powell
Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. H. Powell Date:2**/14/20**

Dept Chair(s):
Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description This course covers fundamental concepts in thermodynamics and fluid dynamics. Topics include molecular and continuum concepts for fluids, first and second laws of thermodynamics, conservation laws for moving fluids, one-dimensional compressible flows, shocks and expansion waves, flows in nozzles, and two- and three-dimensional compressible flows.	Course Description This course covers fundamental concepts in thermodynamics and fluid dynamics. Topics include molecular and continuum concepts for fluids, first and second laws of thermodynamics, conservation laws for moving fluids, one-dimensional compressible flows, shocks and expansion waves, and flows in nozzles.
Class Length Full term	Class Length Full term
Contact Hours (Lecture) 4.0	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Required first course in thermodynamics and gas dynamics.

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
The number of credits is changed from four (4) credits to three (3), as part of a rebalancing of the curriculum.

The syllabus is attached. Material has been removed from the 4-credit version to fit in the allotted time.

Course Outcomes

I. Gas properties

1. Recall the distinguishing factors of solids, liquids, gases and plasmas
2. Use the perfect gas equation of state
3. Recall the specific heats for monatomic, diatomic and polyatomic gases
4. Be able to determine when the continuum hypothesis is valid

II. Thermodynamics

1. Define systems, control volumes, states, processes and cycles
2. Define heat and work
3. Calculate the work due to isothermal, isobaric and isochoric processes
4. Use the First Law to relate energy changes to work and heat
5. Explain the meaning of energy and enthalpy
6. Use the Second Law to relate heat and temperature to entropy change
7. Explain the meaning of entropy
8. Determine whether processes are reversible or irreversible
9. Calculate the entropy change between two states defined by any two independent properties
10. Construct p − v and T − s diagrams for various processes

III. Conservation laws

1. Define control volumes, control surfaces and flux
2. Apply conservation of mass for steady one-dimensional flows
3. Describe the forces that can act on a fluid element
4. Apply conservation of momentum for steady one-dimensional steady flows
5. Apply conservation of energy for steady one-dimensional flows

IV. Adiabatic, isentropic flow

1. Calculate the acoustic speed and Mach number
2. Work with basic isentropic relations
3. Define and calculate static and stagnation quantities
4. Explain how a Pitot probe works

V. Shock and expansion waves

1. Derive the normal shock jump relations from a control-volume analysis
2. Apply the jump relations to calculate downstream quantities from upstream quantities for a normal shock
3. Apply the jump relations to calculate downstream quantities from upstream quantities for an oblique shock
4. Calculate the angle between leading and trailing waves in an expansion fan
5. Calculate the downstream values from the values upstream of an expansion and the turning angle

VI. One-Dimensional flow

1. Plot the Rayleigh line for a flow, and explain its significance
2. Calculate the change in flow properties due to heating/cooling, using graphical, tabular and code techniques

3. Explain thermal choking
4. Describe quantitatively the changes in flow properties due to heating or cooling a sub- sonic or supersonic flow
5. Describe qualitatively how subsonic and supersonic flows behave in converging and diverging sections
6. Calculate the variation of flow properties for isentropic with area change by tabular, graphic and computational methods
7. Explain choking due to area restriction
8. Calculate the maximum mass flow for a rocket nozzle

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
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:01/21/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☒	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 285	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
☒	Course Title (full title) Aerospace Engineering Seminar	Course Title (full title)
☒	Abbreviated Title (20 char) Aero Eng Sem	Abbreviated Title (20 char)
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) Seminars by noted speakers, designed to acquaint undergraduates with contemporary technologies and broader issues in the global aerospace enterprise. Technical communications based upon the seminars	
☒	Full Term Credit Hours Undergraduate Min: 1.00 Graduate Min: Undergraduate Max: 1.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☒	Course Credit Type Undergraduate	
☐	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: Aero 285 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) AEROSP 201 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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: N/A

Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. S. Powell Date:2**/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description Seminars by noted speakers, designed to acquaint undergraduates with contemporary technologies and broader issues in the global aerospace enterprise. Technical communications based upon the seminars.	Course Description
Class Length Full term	Class Length
Contact Hours (Lecture) 1.0	Contact Hours (Lecture)
Contact Hours (Recitation) 0.0	Contact Hours (Recitation)
Contact Hours (Lab) 0	Contact Hours (Lab)

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
This course is replaced by AEROSP 200 (separate CARF provided) and is thus deleted.

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
500 S. State Street
Ann Arbor, MI 48109-1382
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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:01/29/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 315	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 315
☐	☐ 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) Aircraft and Spacecraft Structures	Course Title (full title) Aircraft and Spacecraft Structures
☐	Abbreviated Title (20 char) Air/Space Structures	Abbreviated Title (20 chars) Air/Space Structures
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) An introduction to the fundamental phenomena of solid and structural mechanics in aerospace systems. Includes analysis and numerical methods of solution that are used for design of aerospace structures.	
☒	Full Term Credit Hours Undergraduate Min: 3.00 Graduate Min: Undergraduate Max: 3.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate	
☐	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: AEROSP
Catalog: 315

☐ 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) Aerosp 215, Math 216, ME 240 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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: Carlos Cesnik
Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. M. Powell Date:2/**14/20**

Dept Chair(s):
Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description An introduction to the fundamental phenomena of solid and structural mechanics in aerospace systems. Includes analysis and numerical methods of solution that are used for design of aerospace structures.	Course Description An introduction to the fundamental phenomena of solid and structural mechanics in aerospace systems. Includes analysis and numerical methods of solution that are used for design of aerospace structures.
Class Length Full term	Class Length Full term
Contact Hours (Lecture) 4.0	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Required first course in solid mechanics and structures, followed by Aero 315.

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
The number of credits is changed from four (4) credits to three (3), as part of a rebalancing of the curriculum.

The syllabus is attached. Material has been removed from the 4-credit version to fit in the allotted time.

Detailed Syllabus

1) Introduction
   a) Typical aircraft and spacecraft constructions
   b) Structural elements: bar, shear panel, beam
   c) Internal vs. external forces
   d) Free-body diagrams
2) Overview of the 3D Linear Elasticity (see “Elasticity Handout”)
   a) Elements of a Boundary-value Problem
   b) Analysis of Stress
   c) Analysis of Strain
   d) Material behavior
   e) St. Venant’s Principle
3) Torsion and bending of aircraft structures
   a) Introduction
   b) Pure torsion of thin-walled (single-cell) closed section tubes
   c) Pure torsion of multicell thin-walled closed cross sections
   d) Bi-directional bending and extension of beams
   e) Combined bending and shear in thin-walled sections—pure flexural load (no torsion)
   f) Shear center
   g) Closed thin-walled cross sections under combined bending, shear and torsion
   h) Multicell closed sections
4) Energy Approach
   a) Introduction to energy approach
   b) Elastic Strain Energy: Internal strain energy of typical 1D components:
   c) Work done by the applied forces in typical 1D components:
   d) Principle of Minimum Potential Energy (PMPE)
   e) Rayleigh-Ritz method of solution (approximate solution method)
5) Structural Stability: Buckling
   a) Introduction
   b) Types of buckling
   c) Bifurcation Buckling by Energy Methods
   d) Using Rayleigh-Ritz method to find approximate solution
6) Structural Dynamics
   a) Continuous Systems

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
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:01/29/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	**REQUESTED LISTING**
☐	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 325	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 325
☐	☐ 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) Aerodynamics	Course Title (full title) Aerodynamics
☐	Abbreviated Title (20 char) Aerodynamics	Abbreviated Title (20 chars) Aerodynamics
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) Fundamental concepts in aerodynamics. Students learn how airfoils produce lift and how the pressure distribution about an airfoil can be calculated. Introduces the boundary-layer concept, how boundary layers lead to drag and what makes them prone to instability and turbulence or separation.	
☒	Full Term Credit Hours Undergraduate Min: 3.00 Graduate Min: Undergraduate Max: 3.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate	
☐	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: AEROSP
Catalog: 325

☐

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

Grading
☐ Not for Credit
☐ Not for Degree Credit
☒ Degree Credit Only

Add Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

Drop Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

	CURRENT LISTING	REQUESTED LISTING
☒	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☒	Enforced Prerequisite (254 char) Math 216, Aerosp 225	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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: Ken Powell

Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. M. Powell Date:2**/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description Fundamental concepts in aerodynamics. Students learn how airfoils produce lift and how the pressure distribution about an airfoil can be calculated. Introduces the boundary-layer concept, how boundary layers lead to drag and what makes them prone to instability and turbulence or separation. Effects of the wing planform shape on lift and drag. Introduction to airfoil design, high-lift devices and high-speed aerodynamics.	Course Description Fundamental concepts in aerodynamics. Students learn how airfoils produce lift and how the pressure distribution about an airfoil can be calculated. Introduces the boundary-layer concept, how boundary layers lead to drag and what makes them prone to instability and turbulence or separation. Effects of the wing planform shape on lift and drag.
Class Length Full term	Class Length Full term
Contact Hours (Lecture) 4.0	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Required first course in aerodynamics

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
The number of credits is changed from four (4) credits to three (3), as part of a rebalancing of the curriculum.

The syllabus is attached. Material has been removed from the 4-credit version to fit in the allotted time.

Desired Course Outcomes

I. Introduction

1. Analyze validity of vector expressions.
2. Apply Gauss's and Stokes' theorems in two and three dimensions
3. Transform differential and integral expressions to cylindrical coordinates.
4. Recall basic thermodynamics relations.

II. Kinematics

1. Define the material derivative and explain Eulerian and Lagrangian reference frames.
2. Explain differences between pathlines, streamlines, streaklines, and timelines.
3. Apply conservation of mass in integral and differential form.
4. Analyze incompressible, irrotational flow using a streamfunction and velocity potential.
5. Calculate vorticity and rate-of-strain tensors for a given velocity field.
6. Relate angular velocity, shear strain, and normal strain to the rotation and deformation of a fluid element.
7. Explain the relationship between vorticity and circulation.

III. Dynamics

1. Apply conservation of momentum in integral and differential form.
2. Set up and solve 2D problems involving the incompressible Navier-Stokes equations.
3. Use Bernoulli's equation to relate pressure, velocity, and altitude.
4. Explain the generation of lift on an airfoil using flow turning and streamline curvature.

IV. Potential flow

1. Analyze incompressible, irrotational flows using the complex potential.
2. Superimpose elementary complex potentials and apply the method of images.
3. Explain the relationship between circulation and lift via the Kutta-Joukowski theorem.
4. Define the coefficient of pressure and calculate it for elementary potential flows.

V. Thin-airfoil theory

1. Be familiar with the basic terminology of airfoils theory.
2. Explain the Kutta condition.
3. Sketch and explain a typical pressure distribution on an airfoil, with emphasis on the leading-edge region and the effects of camber and thickness.
4. Explain the difference between the center of pressure and the aerodynamic center.
5. Analyze the performance of an airfoil using the equations of thin airfoil theory.
6. Understand the assumptions and limitations of thin airfoil theory.
7. Explain the basic elements of the vortex panel method.

VI. Boundary layers

1. Explain the conditions under which a boundary layer is present, with reference to viscosity, the Reynolds number, and boundary conditions.
2. Define the wall shear stress and the skin friction coefficient.
3. Explain the assumptions of the boundary layer equations.
4. Apply the Blasius solution to calculate properties of a laminar boundary layer.
5. Explain the concept of a similarity solution in the context of boundary layers.

6. Calculate the skin friction drag on a flat plate in 2D and 3D, accounting for the possibility of laminar to turbulent transition.
7. Describe laminar boundary layer separation and the factors that contribute to it.
8. Explain the onset of turbulence in a boundary layer (i.e. transition) and the qualitative effects of turbulence on boundary layer evolution including the impact on velocity profile, skin friction coefficient, boundary layer thickness, and separation.

VII. Finite-wing theory

1. Apply the Biot-Savart law to compute the velocity induced by a vortex filament.
2. Define wing aspect ratio, taper ratio, span, twist, and sectional camber.
3. Explain the basic elements of Prandtl's lifting line theory.
4. Describe downwash and how it relates to induced drag.
5. Explain the point-collocation method for solving Prandtl's lifting line equation.
6. Apply Prandtl's lifting line equation to solve for the forces on a given wing geometry.
7. Use Prandtl's lifting line equation to design wings that meet specific requirements, such as minimum induced drag.
8. Understand the properties of an elliptic lift distribution.
9. Define the lift curve slope and factors that affect it.
10. Explain the benefits of ground effect and formation flight.

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:01/29/2020
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☒	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 335	Dept (Home): Aerospace Engineering Subject: AEROSP Catalog: 335
☐	☐ 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) Aircraft and Spacecraft Propulsion	Course Title (full title) Aircraft and Spacecraft Propulsion
☐	Abbreviated Title (20 char) Air/Space Propulsion	Abbreviated Title (20 chars) Air/Space Propulsion
☐	Course Description (Please limit to 50 words and attach separate sheet if necessary) Airbreathing propulsion, rocket propulsion and an introduction to modern advanced propulsion concepts. Includes thermodynamic cycles as related to propulsion and the chemistry and thermodynamics of combustion. Students analyze turbojets, turbofans and other air-breathing propulsion systems. Introduces liquid- and solid-propellant rockets and advanced propulsion concepts such as Hall thrusters and pulsed plasma thrusters. Students also learn about the environmental impact of propulsion systems and work in teams to design a jet engine.	
☒	Full Term Credit Hours Undergraduate Min: 3.00 Graduate Min: Undergraduate Max: 3.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☐	Course Credit Type Undergraduate	
☐	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: AEROSP
Catalog: 335

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

Grading
☐ Not for Credit
☐ Not for Degree Credit
☒ Degree Credit Only

Add Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

Drop Consent
☐ Department Consent
☐ Instructor Consent
☒ No Consent

	CURRENT LISTING	**REQUESTED LISTING**
☒	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
☒	Enforced Prerequisite (254 char) Math 216, Aerosp 225	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☐ Course Components
☒ Lecture
☐ Seminar
☐ Recitation
☐ Lab
☐ Discussion
☐ Independent Study

Graded Component
☒
☐
☐
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☐

Terms Typically Offered (Please select only one)
Fall, Winter or [blank]

Instructor Name: Tim Smith

Instructor Title: Lecturer

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. S. Powell Date:2**/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description Airbreathing propulsion, rocket propulsion and an introduction to modern advanced propulsion concepts. Includes thermodynamic cycles as related to propulsion and the chemistry and thermodynamics of combustion. Students analyze turbojets, turbofans and other air-breathing propulsion systems. Introduces liquid- and solid-propellant rockets and advanced propulsion concepts such as Hall thrusters and pulsed plasma thrusters. Students also learn about the environmental impact of propulsion systems and work in teams to design a jet engine.	Course Description Airbreathing propulsion, rocket propulsion and an introduction to modern advanced propulsion concepts. Includes thermodynamic cycles as related to propulsion and the chemistry and thermodynamics of combustion. Students analyze turbojets, turbofans and other air-breathing propulsion systems. Introduces liquid- and solid-propellant rockets and advanced propulsion concepts such as Hall thrusters and pulsed plasma thrusters. Students also learn about the environmental impact of propulsion systems and work in teams to design a jet engine.
Class Length Full term	Class Length Full term
Contact Hours (Lecture) 4.0	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Required first course in propulsion

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
The number of credits is changed from four (4) credits to three (3), as part of a rebalancing of the curriculum.

The syllabus is attached. Material has been removed from the 4-credit version to fit in the allotted time.

- Introduction
  - Overview of propulsion
  - Thermodynamic systems & the first law
  - Entropy & the second law, gas mixtures
  - Thrust & efficiency
- Thermodynamic cycles
  - Otto cycle engines
  - Supercharging & Diesel cycle engines
  - Ideal Brayton cycle engines
  - Modified Brayton cycle & pulse engines
- Jet engines
  - Intro to combustion
  - Adiabatic flame temperature & combustion waves
  - Ramjets & supersonic inlets
  - Intro to turbomachinery
  - Axial compressors
  - Compressor performance
  - Combustors & nozzles
  - Axial turbines
  - Component matching
- Rockets
  - Introduction to rockets
  - Rocket performance & the rocket equation
  - Multistaging & propellant delivery systems
- Heat transfer
  - Conductive heat transfer
  - Convective heat transfer
  - Radiative heat transfer
- Advanced propulsion systems
  - Liquid-propellant turbomachinery
  - Nuclear thermal rockets
  - Intro to electric propulsion
  - Electrothermal rockets
  - Ion engines & cathodes
  - Hall thrusters
  - Electric propulsion research at UM

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
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:01/29/2020
Effective Term: Fall 2020

☒	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): Aerospace Engineering Subject: AEROSP Catalog: 350
☐	☐ 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) Fundamentals of Aerospace Computing
☒	Abbreviated Title (20 char)	Abbreviated Title (20 chars) Fund Aero Computing
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) Fundamentals of computer science, computational science, and embedded systems, with applications from aerospace engineering. Topics include: pointers; data structures; algorithms; computational complexity; signal decomposition; numerical linear algebra; numerical integration; and modeling, design, analysis and verification of sensors, actuators, and embedded processors.	
☒	Full Term Credit Hours Undergraduate Min: 3.00 Graduate Min: Undergraduate Max: 3.00 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☒	Course Credit Type Undergraduate	
☐	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: AEROSP
Catalog: 350

☒

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) Math 216, ENG 101
☐	Enforced Prerequisite (254 char)	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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: Jean-Baptiste Jeannin

Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. S. Powell Date:2**/14/20**

Dept Chair(s):

Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description	Course Description Fundamentals of computer science, computational science, and embedded systems, with applications from aerospace engineering. Topics include: pointers; data structures; algorithms; computational complexity; signal decomposition; numerical linear algebra; numerical integration; and modeling, design, analysis and verification of sensors, actuators, and embedded processors.
Class Length Full term	Class Length Full term
Contact Hours (Lecture)	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Required junior-level course in aerospace computing. Builds on material students learn in ENG 101, and prepares them for elective courses in computational science (Aerosp 423) and/or embedded systems (Aerosp 552).

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
This course is the culmination of two years of work to add a computing thread to our required curriculum. While some of our students pursue a minor in computer science, a review of our curriculum made knowledge of computer science fundamentals, computing for simulation, and embedded systems our highest priority curricular goal. Having all our students build on what they learned in ENG 101 (or equivalent first-year computing course) with this class will allow us to teach follow-on computing courses better, since all students in those classes will have a better foundation in computer science fundamentals, and some introductory material in computing for simulation and embedded systems. A number of our faculty are very well situated to teach this class, as their research is in software verification and validation, computational fluid or structural dynamics, or embedded systems.

Responses to the University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
This course advanced my understanding of the subject matter.	2	1	0	0	0	0	4.8	4.5	4.6
My interest in the subject has increased because of this course.	1	2	0	0	0	0	4.3	4.1	4.3
I knew what was expected of me in this course.	0	1	0	0	0	2	4.0	4.4	4.5
Overall, this was an excellent course.	2	1	0	0	0	0	4.8	4.2	4.3
I had a strong desire to take this course.	0	3	0	0	0	0	4.0	4.0	4.2
As compared with other courses of equal credit, the workload for this course was... (SA=Much Lighter to SD=Much Heavier)	0	0	0	1	0	2	2.0	3.0	2.9

Responses to the University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
Overall, Jean-Baptiste Jeannin was an excellent teacher.	2	1	0	0	0	0	4.8	4.5	4.6
Jean-Baptiste Jeannin seemed well prepared for class meetings.	2	1	0	0	0	0	4.8	4.8	4.8
Jean-Baptiste Jeannin explained material clearly.	2	1	0	0	0	0	4.8	4.6	4.6
Jean-Baptiste Jeannin treated students with respect.	3	0	0	0	0	0	5.0	4.8	4.8

The medians are calculated from Fall 2018 data. University-wide medians are based on all UM classes in which an item was used. The school/college medians in this report are based on classes that are upper division with enrollment of 1 to 15 in College of Engineering.

Written Comments

Comment on the quality of instruction in this course. (Q900)

Comments
Overall I enjoyed my time in this course. I came to Michigan to learn and struggle, and this class fulfilled both roles. I learned a lot but I thought the class was quite challenging as I am a 3rd semester student with very limited experience with all 3 of the major topics covered. Because of this I struggled with a lot of the assignments and I thought that the workload was pretty high. But as a whole I really enjoyed the course and learned a great deal from my time in it.

University of Michigan
Fall 2019 Instructor Report With Comments
AEROSP 495-001: Spec Top Aero Eng
Jean-Baptiste Jeannin

13 out of 27 students responded to this evaluation.

Responses to the University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	7	6	0	0	0	0	4.6	4.5	4.4
My interest in the subject has increased because of this course. (Q1632)	4	5	3	1	0	0	4.0	4.2	4.1
I knew what was expected of me in this course.(Q1633)	3	5	4	1	0	0	3.8	4.4	4.3
Overall, this was an excellent course.(Q1)	2	8	2	1	0	0	3.9	4.2	4.2
I had a strong desire to take this course.(Q4)	7	6	0	0	0	0	4.6	4.0	4.1
As compared with other courses of equal credit, the workload for this course was...(SA=Much Lighter to SD=Much Heavier) (Q891)	0	0	6	7	0	0	2.4	3.0	2.8

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
Overall, Jean-Baptiste Jeannin was an excellent teacher. (Q2)	8	3	1	1	0	0	4.7	4.6	4.5
Jean-Baptiste Jeannin seemed well prepared for class meetings.(Q230)	9	1	2	1	0	0	4.8	4.8	4.7
Jean-Baptiste Jeannin explained material clearly.(Q199)	8	3	2	0	0	0	4.7	4.6	4.6
Jean-Baptiste Jeannin treated students with respect. (Q217)	11	2	0	0	0	0	4.9	4.8	4.8

Responses to additional questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median
I increased my ability to apply math and science knowledge to engineering problems. (Q15)	5	3	5	0	0	0	4.0	4.3
I increased my ability to formulate, and solve engineering problems. (Q23)	4	5	3	0	0	0	4.1	4.3
I increased my ability to apply engineering tools and methods. (Q35)	6	4	3	0	0	0	4.4	4.3

The medians are calculated from Fall 2019 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.

AERO 495: Fundamentals of Aerospace Computing
Fall 2019

PART I: Fundamentals of Computer Science (taught by Prof. Jean-Baptiste Jeannin)

Week 1: Logic, Programming Review (C)

Week 2: Programming with Pointers

Week 3: Data structures, Arrays, Lists

Week 4: Computational Complexity, Time and Memory Analysis

Week 5: Algorithms: Search, Sort, Recursion

Week 6: Trees, Binary Search Trees

PART II: Fundamentals of Computational Science (taught by Prof. Karthik Duraisamy)

Week 7: Interpolation, Fourier series, Signal decomposition

Week 8: Linear Algebra, Linear systems & Notions of complexity

Week 9: Numerical integration of ordinary differential equations

Week 10: Stability, order of accuracy, implicit methods for ODEs

PART III: Introduction to Embedded Systems (taught by Prof. Jean-Baptiste Jeannin)

Week 11: Modeling: Continuous Dynamics, Discrete Dynamics, Hybrid Systems

Week 12: Design: Sensors and Actuators, Input and Output

Week 13: Design: Embedded Processors, Memory Architectures

Week 14: Analysis and Verification: Invariants, Temporal Logic, Refinement

Course Approval Request Form

Office of the Registrar, University of Michigan

LS&A Suite 5000
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:01/29/2020
Effective Term: Fall 2020

☒	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): Aerospace Engineering Subject: AEROSP Catalog: 567		
☐	☐ 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) Inference, Estimation, and Learning		
☒	Abbreviated Title (20 char)			Abbreviated Title (20 chars) Infer/Est/Learning		
☒	Course Description (Please limit to 50 words and attach separate sheet if necessary) Theory and algorithms for synthesizing models and data for general applications across science and engineering. Topics include algorithms for maximum likelihood estimation, Bayesian inference, and regression for static inference problems and for estimation in dynamical systems. Theoretical foundations of the algorithms and projects that focus on implementation.					
☒	Full Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: 3.00 Graduate Max: 3.00		Half Term Credit Hours Undergraduate Min: Undergraduate Max:	Graduate Min: Graduate Max:	
☒	Course Credit Type Graduate					
☐	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: AEROSP
Catalog: 567

☒ 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) Permission of instructor
☐	Enforced Prerequisite (254 char)	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 (Please select only one)
Fall, Winter or [blank]

Instructor Name: Alex Gorodetsky
Instructor Title: Professor

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Linda Weiss Email: lweiss@umich.edu Phone: -734-7643310

Curriculum Committee: K. M. Powell Date:2**/14/20**

Dept Chair(s):
Home Department: Aerospace Engineering Date: 2/14/20

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Cross-Listed Department: Date:

Current:	Requested:
Course Description	Course Description Theory and algorithms for synthesizing models and data for general applications across science and engineering. Topics include algorithms for maximum likelihood estimation, Bayesian inference, and regression for static inference problems and for estimation in dynamical systems. Theoretical foundations of the algorithms and projects that focus on implementation.
Class Length Full term	Class Length Full term
Contact Hours (Lecture)	Contact Hours (Lecture) 3.0
Contact Hours (Recitation) 0	Contact Hours (Recitation) 0
Contact Hours (Lab) 0	Contact Hours (Lab) 0

Additional Info

Submitted by
Home department

Describe how this course fits with degree requirements
Graduate course

ABET department program outcomes for undergraduate courses
TBD

Special resources or facilities required for this course
None

Supporting Statement
This class covers probability in a rigorous way: probability may only be covered/used in 1 or 2 classes, but it forms the fundamental basis of stochastic analysis, inference, and learning methodology. The class is a unique blend of advanced estimation techniques (all types of filtering and parameter estimation), and methodologies for using data to improve models (be it physical or otherwise). These skills are essential with the growing emphasis on incorporating data in engineering. The course provides a fundamental methodology approach to inference and learning, rather than a focus on tools. The course culminates in individual projects (which, for doctoral candidates, are typically centered on the students' research)

AE740: Statistical Inference, Estimation, and Learning

Lectures: Tuesdays and Thursdays 1:30 PM – 3:00 PM
Lecture Room: 1008 FXB
Instructor: Alex Gorodetsky
Instructor Office: 3053 FXB
Office Hours: 10-11AM Tuesday/Thursday

Course Description

This course covers theory and algorithms for synthesizing models and data for general applications across science and engineering. Topics will include algorithms for maximum likelihood estimation, Bayesian inference, and regression for static inference problems and for estimation in dynamical systems. The first part of this course will focus on parameter inference and include recent advances in Monte Carlo sampling, importance sampling, Markov chain Monte Carlo (MCMC), and variational inference. The second part of the course will cover state estimation and include particle filters and variants of Kalman filters such as the extended, ensemble, unscented, and Gauss-Hermite filters. Theoretical foundations of the algorithms will be described and practical experience will be gained through projects that focus on implementation. PhD students will be encouraged to work on inference and estimation problems relevant to their ongoing research.

Topics Covered

The following topics will be discussed:

1. Introduction:
   - Probability, random variables, Gaussians
   - Concentration of measure inequalities (Markov, Chebyshev, ...)
   - Central Limit Theorem, Law of Large numbers
2. Sampling methods
   - Monte Carlo methods
   - Variance reduction methods: importance sampling, multilevel Monte Carlo, control variates
3. Inference and learning methodologies
   - Bayesian, frequentist, maximum entropy
   - Maximum likelihood estimation and regularization
   - Applications to linear-Gaussian and infinite dimensional models
   - Markov Chain Monte Carlo
   - Variational Inference methods and introduction to information theory concepts
4. Dynamical systems estimation
   - Particle filtering
   - Kalman filtering and smoothing (Extended and Ensemble Kalman filters)
   - Gaussian filters (Unscented, Cubature, Gauss-Hermite, etc.)
   - Joint parameter-state estimation

Learning Objectives

Following this course, students should be able to

1. Understand the methodology of modern techniques for fusing data and models together, and
2. Implement and design inference algorithms and identify their strengths and weakness.

Measurable Outcomes

Students successfully completing this subject will be able to:

1. Apply Monte Carlo methods and explain their convergence
2. Describe and apply standard approaches for variance reduction
3. Describe the Bayesian approach to inference and its relationship to regularization
4. Understand and assess the roles of the prior distribution in Bayesian computation
5. Applying Markov chain Monte Carlo for parameter inference both linear and nonlinear models
6. Understand the data assimilation problem as a problem of Bayesian inference
7. Explain and implement (Extended, Ensemble, Unscented) Kalman filter and particle filter algorithms
8. Design new algorithms for Gaussian filtering by leveraging ideas from numerical integration

Assignments and grading

Grading for this class will be primarily based on four large project-style assignments that are weighted equally. These projects will roughly be on the following topics

1. Monte Carlo simulation and variance reduction.
2. Bayesian inference with MCMC and regularization approaches.
3. State estimation and filtering.
4. Student's choice.

Proposals for the final project must be approved by the instructor; a list of papers and ideas can be provided upon request. While the project must investigate methodology, PhD students are encouraged to apply methods to problems within their own research. An oral presentation to the class will be required (depending on enrollment).

In addition to these projects students will be required to *scribe* at least one lecture. Two scribes will be assigned per lecture, so the total number of lectures a single student scribes will depend on enrollment. A template (in latex) will be provided. Scribing will be due **one week** after the lecture. Furthermore, a number of small homework assignments may be given throughout the term.

Table 1: Grade distribution

Component	Percentage
Projects	90
Scribing	10

Example projects from the past

In this course, I highly encourage applying the learned algorithms to problems that are of specific interest to the student because they are quite general and broadly applicable to problems throughout science and engineering. Sample projects done by students in the past have been

1. Learning provably safe paths through obstacles
2. Analyzing (social) network structures
3. Adaptive estimation and control for aircraft dynamics
4. Bayesian inference in neural networks
5. Particle filters for robot localization
6. and more....

Prerequisites

This class will build upon the fundamentals of linear algebra, probability theory, and statistics. The course will consist both of theoretical (proofs) and applied components. Basic programming skills are essential, and any language can be used to complete the assignments.

References and resources

There is no single textbook for this subject. Lectures will draw from a variety of sources, including journal papers; specific references will be provided with the notes for each lecture. Below are some resources that you may find to be of general utility. Some of the books below have free copies available online, those that do not have free copies available have been placed on reserve at the library (Duderstadt).

1. Probability Theory and Inference
   - E T Jaynes, *Probability Theory: The Logic of Science* , Cambridge University Press, 2003 (Full book is available here).
   - D. Koller and N. Friedman, *Probabilistic Graphical Models: Principles and Techniques*, MIT Press, 2009.
   - D. J. C. MacKay, *Information Theory, Inference and Learning Algorithms*, Cambridge University Press, 2003, (Full book is available here).
   - J. S. Rosenthal, *A First Look at Rigorous Probability Theory*, World Scientific, 2006.
2. Methods and Algorithms
   - C. Robert, and G. Casella, *Monte Carlo Statistical Methods*, Springer, 2004. (E-book available from UM library online)
   - T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Springer, 2009, (Updated PDF of the book is free at the link).
   - D. Sivia and J. Skilling, *Data Analysis: A Bayesian Tutorial*, Oxford University Press, 2006. (E-book available from UM library online)
   - C. E. Rasmussen and C. Williams, *Gaussian Processes for Machine Learning*, MIT Press 2006 (Full book is available here).
   - A. Owen, *Monte Carlo theory, methods and examples*, 2013. Online book available here.
3. Estimation in Dynamical Systems
   - K. Law, A. Stuart, and K. Zygalakis, *Data Assimilation: A Mathematical Introduction*, Springer, 2015, (A few free chapters here, E-book available form UM library online).
   - S. Särkkä, *Bayesian Filtering and Smoothing*, Cambrdige University Press, 2013, (Full book available here).

Responses to the University-wide questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
This course advanced my understanding of the subject matter. (Q1631)	16	4	0	0	1	0	4.8	4.5	4.6
My interest in the subject has increased because of this course. (Q1632)	18	2	0	0	1	0	4.9	4.2	4.5
I knew what was expected of me in this course.(Q1633)	13	6	1	1	0	0	4.7	4.4	4.5
Overall, this was an excellent course.(Q1)	17	3	0	0	1	0	4.9	4.2	4.5
I had a strong desire to take this course.(Q4)	16	4	0	0	1	0	4.8	4.0	4.5
As compared with other courses of equal credit, the workload for this course was...(SA=Much Lighter to SD=Much Heavier) (Q891)	3	0	4	7	7	0	2.0	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
Overall, Alex Gorodetsky was an excellent teacher. (Q2)	19	1	0	0	1	0	4.9	4.6	4.6
Alex Gorodetsky seemed well prepared for class meetings.(Q230)	20	0	0	0	1	0	5.0	4.8	4.8
Alex Gorodetsky explained material clearly.(Q199)	17	2	1	0	1	0	4.9	4.6	4.6
Alex Gorodetsky treated students with respect.(Q217)	19	1	0	0	1	0	4.9	4.8	4.8

Responses to additional questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median
I increased my ability to apply math and science knowledge to engineering problems. (Q15)	17	3	0	0	1	0	4.9	4.3
I increased my ability to formulate, and solve engineering problems. (Q23)	18	2	0	1	0	0	4.9	4.3
I increased my ability to apply engineering tools and methods. (Q35)	18	2	1	0	0	0	4.9	4.3

1. Learning provably safe paths through obstacles
2. Analyzing (social) network structures
3. Adaptive estimation and control for aircraft dynamics
4. Bayesian inference in neural networks
5. Particle filters for robot localization
6. and more....

Prerequisites

This class will build upon the fundamentals of linear algebra, probability theory, and statistics. The course will consist both of theoretical (proofs) and applied components. Basic programming skills are essential, and any language can be used to complete the assignments.

References and resources

There is no single textbook for this subject. Lectures will draw from a variety of sources, including journal papers; specific references will be provided with the notes for each lecture. Below are some resources that you may find to be of general utility. Some of the books below have free copies available online, those that do not have free copies available have been placed on reserve at the library (Duderstadt).

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   - J. S. Rosenthal, *A First Look at Rigorous Probability Theory*, World Scientific, 2006.
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   - C. Robert, and G. Casella, *Monte Carlo Statistical Methods*, Springer, 2004. (E-book available from UM library online)
   - T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Springer, 2009, (Updated PDF of the book is free at the link).
   - D. Sivia and J. Skilling, *Data Analysis: A Bayesian Tutorial*, Oxford University Press, 2006. (E-book available from UM library online)
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   - A. Owen, *Monte Carlo theory, methods and examples*, 2013. Online book available here.
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   - K. Law, A. Stuart, and K. Zygalakis, *Data Assimilation: A Mathematical Introduction*, Springer, 2015, (A few free chapters here, E-book available form UM library online).
   - S. Särkkä, *Bayesian Filtering and Smoothing*, Cambrdige University Press, 2013, (Full book available here).

Responses to the University-wide questions about the course:

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My interest in the subject has increased because of this course. (Q1632)	18	2	0	0	1	0	4.9	4.2	4.5
I knew what was expected of me in this course.(Q1633)	13	6	1	1	0	0	4.7	4.4	4.5
Overall, this was an excellent course.(Q1)	17	3	0	0	1	0	4.9	4.2	4.5
I had a strong desire to take this course.(Q4)	16	4	0	0	1	0	4.8	4.0	4.5
As compared with other courses of equal credit, the workload for this course was...(SA=Much Lighter to SD=Much Heavier) (Q891)	3	0	4	7	7	0	2.0	3.0	3.0

Responses to University-wide questions about the instructor:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median	School/College Median
Overall, Alex Gorodetsky was an excellent teacher. (Q2)	19	1	0	0	1	0	4.9	4.6	4.6
Alex Gorodetsky seemed well prepared for class meetings.(Q230)	20	0	0	0	1	0	5.0	4.8	4.8
Alex Gorodetsky explained material clearly.(Q199)	17	2	1	0	1	0	4.9	4.6	4.6
Alex Gorodetsky treated students with respect.(Q217)	19	1	0	0	1	0	4.9	4.8	4.8

Responses to additional questions about the course:

	SA	A	N	D	SD	N/A	Your Median	University-Wide Median
I increased my ability to apply math and science knowledge to engineering problems. (Q15)	17	3	0	0	1	0	4.9	4.3
I increased my ability to formulate, and solve engineering problems. (Q23)	18	2	0	1	0	0	4.9	4.3
I increased my ability to apply engineering tools and methods. (Q35)	18	2	1	0	0	0	4.9	4.3

Course Approval Request Form

Office of the Registrar, University of Michigan

1210 ISA 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: 2020-02-12
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☐	Dept (Home): Mechanical Engineering Subject: MECHENG Catalog: 516	Dept (Home): Mechanical Engineering Subject: MECHENG Catalog: 516
☐	☐ 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) Mechanics of Thin Films and Layered Materials	Course Title (full title) Fracture and Adhesion of Interfaces and Layered Materials
☐	Abbreviated Title (20 char) Films-Layered Matls	Abbreviated Title (20 char) Films-Layered Matls
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) Stresses and deformations in layered materials and laminated composites; cohesive-zone models of fracture; energy-release rates and delamination; fracture mechanics of layered materials; physics of adhesion, spalling; interfacial fracture mechanics; mixed-mode fracture; buckling-driven delamination; cracking of thin films and coatings; adhesion and fracture tests; measurement of cohesive fracture parameters	
☑	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, Non-Rackham Graduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Mechanical Engineering Catalog: 516

☑

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) ME 311 or graduate standing	Advisory Prerequisite (254 char) ME 311 or graduate standing
☐	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: Michael Thouless Cognizant Faculty Member Title:

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

Contact Person: Email: Phone:

Curriculum Committee Member: Jwo Pan Print: Jwo Pan Date: 2/12/20

Curriculum Committee Chair: Print: Date:

Home Department Chair: Donald Siegel Print: Donald Siegel Date: 2/11/20

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 Stresses and deformations in layered materials; energy-released rates and delamination; fracture mechanics of layered materials; spalling; interfacial fracture mechanics; mixed-mode fracture; buckling-driven delamination; cracking of thin films; effects of plasticity on fracture; stress-relaxation mechanisms in multi-layered materials; adhesion and fracture tests.	Course Description Stresses and deformations in layered materials and laminated composites; cohesive-zone models of fracture; energy-release rates and delamination; fracture mechanics of layered materials; physics of adhesion, spalling; interfacial fracture mechanics; mixed-mode fracture; buckling-driven delamination; cracking of thin films and coatings; adhesion and fracture tests; measurement of cohesive fracture parameters
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:

ABET departmental program outcomes for undergraduate courses:
Not ABET accredited

Special resources of facilities required for this course:

Supporting statement:
There is no other fracture class in CoE, and this class has always been heavily focussed on fracture and adhesion as applied to thin films and layered materials. In recent years, I have put a larger emphasis on cohesive-zone models to fracture, which have really only come into their own since I first started the class 25 years ago.

Since this serves as a (if not the) primary graduate fracture class in CoE, I would like the title to reflect more accurately this role. which is a close approximation to the title of a book I am writing. This course is primarily in interfacial fracture mechanics, but it uses the important class of layered materials (such as thin films, coatings and laminated composites) as a vehicle to discuss this. The increased discussion of cohesive-zone models of fracture has meant that concepts such as plasticity and stress relaxation have had to be dropped in the interests of space.

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: 2020-02-14
Effective Term: Fall 2020

☑	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): Chemical Engineering Subject: CHE Catalog: 296
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☑	Course Title (full title)	Course Title (full title) Special Topics in Chemical Engineering
☑	Abbreviated Title (20 char)	Abbreviated Title (20 char) Spec ChE Topics
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) Selected topics pertinent to lower-level chemical engineering students.	
☑	Full Term Credit Hours Undergraduate Min: 1 Graduate Min: Undergraduate Max: 4 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student	
☑	Repeatability ☑ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☑ Can be taken more than once in the same term

Subject:	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) None.
☑	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) None. 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: Fei Wen	Cognizant Faculty Member Title: Assoc. Chair UG Ed.

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

Contact Person: Barbara Mintz Email: bgmintz@umich.edu Phone: 734-647-9876

Curriculum Committee Member:	S. Alburak	Print: Saadet Albayrak-Guralp	Date: 2/18/20
Curriculum Committee Chair:		Print:	Date:
Home Department Chair:	Sharon C. Glotzer	Print: Sharon Glotzer	Date: 2/18/20
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 Selected topics pertinent to lower-level chemical engineering students.
Class Length	Class Length Full term
Contact hours (lecture):	Contact hours (lecture):
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

ABET departmental program outcomes for undergraduate courses:
Not ABET accredited

Special resources of facilities required for this course:

Supporting statement:
New special topics course with no prerequisites, which will be geared to freshman and sophomores engineering students.

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: 2020-02-10
Effective Term: Fall 2020

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

	CURRENT LISTING	REQUESTED LISTING
☐	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 320	Dept (Home): Nuclear Engin & Radiolog Sci Subject: NERS Catalog: 320
☐	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number	☐ Course is Cross-Listed with Other Departments Department / Subject / Catalog Number
☑	Course Title (full title) Problems in Nuclear Engineering and Radiological Sciences	Course Title (full title) Applied Mathematics for Engineering Physics
☑	Abbreviated Title (20 char) Problems in NERS	Abbreviated Title (20 char) Applied Mathematics
☑	Course Description (Please limit to 50 words and attach separate sheet if necessary) This course provides an overview of applied linear algebra, systems of ordinary differential equations, basic numerical methods, vector calculus with curvilinear coordinates, partial differential equations, and fundamentals of probability applied to applications including fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.	
☑	Full Term Credit Hours Undergraduate Min: 4 Graduate Min: Undergraduate Max: 4 Graduate Max:	Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:
☑	Course Credit Type Undergraduate Student	
☐	Repeatability ☐ Course is Repeatable for Credit Maximum number of repeatable credits:	☐ Course is Y graded ☐ Can be taken more than once in the same term

Subject: Nuclear Engin & Radiolog Sci Catalog: 320

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

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

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

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

	CURRENT LISTING	REQUESTED LISTING
☑	Advisory Prerequisite (254 char) Concurrent enrollment in NERS 311	Advisory Prerequisite (254 char) Math 216 or equivalent
☐	Enforced Prerequisite (254 char) Minimum grade requirement:	Enforced Prerequisite (254 char) Minimum grade requirement:
☐	Credit Exclusions	Credit Exclusions

☑ Course Components / Graded Component

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

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

Cognizant Faculty Member Name: Brian Kiedrowski Cognizant Faculty Member Title: Assistant 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

Curriculum Committee Member:		Print:	Date:
Curriculum Committee Chair:	Won Sik Yang	Print: Won Sik Yang	Date: 2/17/2020
Home Department Chair:		Print: TODD R ALLEN	Date: 14 FEB 2020
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 This course introduces students to several basic problems in nuclear engineering and radiological sciences, together with mathematical and numerical methods for solving the problems. The course is meant to prepare students for more advanced senior-level NERS courses.	Course Description This course provides an overview of applied linear algebra, systems of ordinary differential equations, basic numerical methods, vector calculus with curvilinear coordinates, partial differential equations, and fundamentals of probability applied to applications including fluid mechanics, heat transfer, electromagnetism, quantum mechanics, medical physics, radiological engineering, nuclear reactor physics, radiation transport, and reliability analysis.
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:
Core Course

ABET departmental program outcomes for undergraduate courses:
7

Special resources of facilities required for this course:

Supporting statement
Given the current content of 320, it's time to update the course description/title topics are now included.—e.g., linear algebra, ODEs, Vector calculus, PDEs and probability