The University of Michigan
College of Engineering
Curriculum Committee

Agenda
January 22, 2013
1:30-3:00 p.m.

Room 265 Chrysler Center

1. Course Approval Forms
2. Infrastructure Systems Concentration—MS Degree Program In Civil Engineering—Jerry Lynch
3. Proposed BSAE Program Change: New Required Course – Aero 205

COURSE APPROVAL FORMS

EECS 280 Modification—Changing Prereq from: Math 115 and prior programming Experience ***to: EECS 182 or EECS 183 or ENGN 101 or ENGN 151 or permission of instructor***
Re-submitting from 01-08-2013 meeting

EECS 388 New Course

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Form Number 2375
Date 12/20/2012
Effective Term Winter 2013
Course Offer Freq ☒ Indefinitely ☐ One term only

Action Requested
○ New Course
⊙ Modification of Existing Course
○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

A. CURRENT LISTING

Home Department | Course Number

☐ Cross Listed Course Information

☐ Course Title

TITLE ABBREVIATION — Time Sched (Max = 19 Spaces): ; Transcript (Max = 20 Spaces):

☐ Course Description

PROGRAM OUTCOMES: ☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k

Degree Requirements: ○ Degree Requirement ○ Core Course ○ Free Elective ○ Tech Elective ○ Other

X Prereq: Math 115 and prior programming experience
⊙ Enforced
○ Advised

☐ Credit Restrictions

☐ Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ R
Credit Hours Min ___ Max ___
Contact Hrs/Wk ___
Number of Wks ___

B. REQUESTED LISTING

Home Department: EECS Elec Engin & Computer Sci
Course Number: 280

Cross Listed Course Information

Course Title: Programming and Introductory Data Structures

TITLE ABBREVIATION
Time Sched (Max = 19 Spaces): Prog & Data Struc
Transcript (Max = 20 Spaces): Prog Data Str

Course Description for Official Publication (Max = 50 words)

Techniques and algorithm development and effective programming, top-down analysis, structured programming, testing, and program correctness. Program language syntax and static and runtime semantics. Scope, procedure instantiation, recursion, abstract data types, and parameter passing methods. Structured data types, pointers, linked data structures, stacks, queues, arrays, records, and trees.

PROGRAM OUTCOMES: ☒ a ☐ b ☒ c ☐ d ☒ e ☐ f ☒ g ☐ h ☐ i ☐ j ☒ k

Degree Requirements: ⊙ Degree Requirement ○ Core Course ○ Free Elective ○ Tech Elective ○ Other

Prereq: EECS 182 or EECS 183 or ENGN 101 or ENGN 151 or permission of instructor
⊙ Enforced
○ Advised

Credit Restrictions

Level of Credit: ☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ I
Credit Hours Min 4 Max 4
Contact Hrs/Wk 4
Number of Wks 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeatable? ○ Yes ⊙ No
Max Hours? ___ Max Times? ___
Can it be repeated in the same term? ○ Yes ○ No

☐ **Class Type(s)**: ☒ Lec ☐ Sem ☒ Dis ☐ Other ___ ☐ Rec ☐ Lab ☐ Ind

Grading: ☒ A-E ☐ CR/NC ☐ P/F ☐ S/U

Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Graded Section: ☒ Lec ☐ Sem ☐ Dis ☐ Other ___ ☐ Rec ☐ Lab ☐ Ind

Course Is Y Graded ☐

Cognizant Faculty Member:	Title
Brian Noble	Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval Info	Approved by Name	Approved Date
☐ Curriculum Comm.		
☐ Faculty		
☐ Cross listed Unit 1		
☐ Cross listed Unit 2		

Submitted By: ☒ Home Dept. ☐ Cross-listed Dept.

	Department Chair Name	Chair Signature
Home Dept.	EECS Marios Papaefthymiou	
Cross-listed Dept(s).		

Form Number

2375

SUPPORTING STATEMENT

This changes the prerequisite requirement to more accurately reflect the kind of background students will need and the actual progression they now follow. The old prerequisite of Math 115 is a historical artifact. At present, virtually all students take either ENGN 101 or 151 (if they are in Engineering) or EECS 183 (if they are in the CS-LSA concentration) or EECS 182 (if they are in the Informatics concentration in LSA). The alternative requirement "previous programming experience" is not enforceable and has caused some difficulty for EECS 280 instructors when unprepared students attempt the course. The change here to "permission of instructor" will allow us to verify that students have written substantial programs.

Are any special resources or facilities required for this course? ☐ Yes ☒ No

Detail the Special requirements

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Form Number: 2327
Date: 11/29/2012
Effective Term: Winter 2013
Course Offer Freq: ☒ Indefinitely ☐ One term only

Action Requested
- (•) New Course
- ( ) Modification of Existing Course
- ( ) Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

A. CURRENT LISTING

Home Department:
Course Number:
Cross Listed Course Information:
Course Title:

TITLE ABBREVIATION	
Time Sched Max = 19 Spaces	
Transcript Max = 20 Spaces	

Course Description:

PROGRAM OUTCOMES: ☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k

Degree Requirements: O Degree Requirement O Core Course O Free Elective O Tech Elective O Other

Prereq
O Enforced
O Advised

Credit Restrictions

Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ R

Credit Hours Min Max
Contact Hrs/Wk
Number of Wks

B. REQUESTED LISTING

Home Department: EECS Elec Engin & Computer Sci
Course Number: 388
Cross Listed Course Information:
Course Title: Introduction to Computer Security

TITLE ABBREVIATION	
Time Sched Max = 19 Spaces	Intro Comp Security
Transcript Max = 20 Spaces	Intro Comp Security

Course Description for Official Publication (Max = 50 words)

This course introduces the principles and practices of computer security as applied to software, host systems, and networks. It covers the foundations of building, using, and managing secure systems. Topics include standard cryptographic functions and protocols, threats and defenses for real-world systems, incident response, and computer forensics. There will be homework exercises, programming projects, and a final exam.

PROGRAM OUTCOMES: ☒ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☒ h ☐ i ☐ j ☒ k

Degree Requirements: O Degree Requirement O Core Course O Free Elective (•) Tech Elective O Other

Prereq: EECS 281
(•) Enforced
O Advised

Credit Restrictions

Level of Credit: ☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ I

Credit Hours Min 4 Max 4
Contact Hrs/Wk 4
Number of Wks 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeatable? ( ) Yes (•) No Max Hours? ____ Max Times? ____
Can it be repeated in the same term? ( ) Yes ( ) No

Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☒ Dis ☐ Ind ☐ Other ___

Grading: ☒ A-E ☐ CR/NC ☐ P/F ☐ S/U

Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Graded Section: ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ___

Course Is Y Graded ☐

Cognizant Faculty Member:	Title
J. Alex Halderman	Asst. Prof

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Submitted By: ☐ Home Dept. ☐ Cross-listed Dept.

Approval Info	Approved by Name	Approved Date
☐ Curriculum Comm.		
☐ Faculty		
☐ Cross listed Unit 1		
☐ Cross listed Unit 2		

	Department Chair Name	Chair Signature
Home Dept.	EECS Marios Papaefthymiou	[signature]
Cross-listed Dept(s).		

Form Number

2327

SUPPORTING STATEMENT

In spite of computer security's essential role in modern systems, the University of Michigan does not offer a permanent undergraduate course on the subject. This proposal seeks to establish a cutting edge undergraduate security course as an integral part of the university's computer science curriculum.

This new course will build upon an experimental introductory course that Halderman has occasionally offered since his arrival at the university in 2009. This ad hoc course has been very popular—attracting approximately 60 students in its most recent offering—and has served as a test bed for a range of pedagogical approaches.

The major goal on the new course will be to instill the security mindset, including understanding how attackers think and operate, modeling threats and allocating defensive resources, applying up-to-date defensive technologies to mitigate threats, and verifying that those mitigations adequately address the identified threats. In addition to basic principles, the course will have a practical slant, teaching skills students need to develop secure systems as engineers, deploy and maintain secure systems as system administrators, and use systems securely as end users

The new course will target undergraduates in their third or fourth year and be accessible to students prior to other upper-level courses such as networking and operating systems. Although this makes teaching the material more challenging (since the instructor can assume less background knowledge), it has the major benefit of reaching students during a formative period in their computer science education and preparing them to identify threats and recognize insecure practices as they go on to study other advanced topics. It also teaches security principles in time for students who want to pursue a security focus to take additional coursework. The university already offers an advanced graduate-level security course suitable for preparing security specialists, which will dovetail with the new undergraduate course.

The course will be based on two lectures a week and a discussion section focused on course projects. Projects will include components where students play the role of an attacker and attempt to compromise mock systems, and then switch to the role of a defender and repair the vulnerabilities by applying defensive techniques. Other projects will involve forensic investigation of attacks and incident recovery. Educational objectives will be measured through a final exam, approximately six homework problem sets, project scores, and participation in class discussions.

A syllabus/schedule, and student evaluation data (from experimental runs of the course) are attached.

Are any special resources or facilities required for this course? ☐ Yes ☒ No

Detail the Special requirements

University of Michigan
Office of the Registrar - Evaluations
ro.umich.edu/evals/

Fall 2009 Final

10 students responded out of the total enrolled 34

Instructor Report

2009-12-04 - 2009-12-15 Report ID: MSR04732

Instructor: Halderman,J Alex

EECS 398 001

		Responses from your Students**							Other Users of This Item* University Wide			Other Users of This Item* School/College		
		5 SA	4 A	3 N	2 D	1 SD	NA	Your Median	75% Above	50% Above	25% Above	75% Above	50% Above	25% Above
1	Overall, this was an excellent course.	3	3	4	0	0	0	3.83	3.83	4.17	4.58	3.80	4.17	4.50
2	Overall, the instructor was an excellent teacher.	6	2	2	0	0	0	4.67	4.00	4.50	4.80	3.88	4.26	4.75
3	I learned a great deal from this course.	5	4	1	0	0	0	4.50	3.95	4.25	4.64	3.97	4.30	4.63
4	I had a strong desire to take this course.	7	2	0	1	0	0	4.79	3.56	4.00	4.50	3.67	4.13	4.54
61	Prerequisites provided adequate preparation for this course.	2	2	3	2	1	0	3.17	4.00	4.25	4.50			
140	I deepened my interest in the subject matter of this course.	4	4	2	0	0	0	4.25	3.75	4.13	4.50			
201	The instructor gave clear explanations.	9	1	0	0	0	0	4.94	4.00	4.34	4.72			
203	The instructor stressed important points in lectures/discussions.	6	4	0	0	0	0	4.67	4.10	4.46	4.75			
207	The instructor appeared to have a thorough knowledge of the subject.	8	2	0	0	0	0	4.88	4.33	4.75	4.90			
216	The instructor acknowledged all questions insofar as possible.	7	3	0	0	0	0	4.79	4.19	4.50	4.80			
218	The instructor encouraged constructive criticism.	3	4	3	0	0	0	4.00	4.00	4.33	4.70			
228	The instructor followed an outline closely.	4	5	0	1	0	0	4.30	4.00	4.40	4.79			
229	The instructor used class time well.	7	2	1	0	0	0	4.79	4.00	4.33	4.69			
230	The instructor seemed well prepared for each class.	8	1	1	0	0	0	4.88	4.20	4.60	4.83			
232	Work requirements and grading system were clear from the beginning.	1	4	1	3	1	0	3.50	4.00	4.25	4.58			
239	The amount of work required was appropriate for the credit received.	3	2	3	0	1	1	3.75	3.85	4.13	4.40			
240	The amount of material covered in the course was reasonable.	4	5	0	1	0	0	4.30	3.95	4.17	4.50			
318	Writing assignments seemed carefully chosen.	2	2	3	2	0	1	3.33	3.88	4.13	4.50			
331	The laboratory was a valuable part of this course.	2	2	0	1	0	5	4.25	3.95	4.25	4.67			
332	Laboratory assignments seemed carefully chosen.	1	1	2	1	0	5	3.25	3.75	4.00	4.50			
336	Laboratory assignments required a reasonable amount of time and effort.	1	1	1	2	0	5	3.00	3.79	4.00	4.42			
337	Laboratory assignments were relevant to what was presented in class.	2	2	1	0	0	5	4.25	4.00	4.30	4.67			
340	The textbook made a valuable contribution to the course.	0	0	0	0	0	10	n/a	3.50	4.00	4.38			
356	Examinations covered the important aspects of the course.	0	3	5	1	0	1	3.20	4.00	4.19	4.50			
365	Grades were assigned fairly and impartially.	0	7	1	0	1	1	3.86	3.92	4.17	4.50			
366	The grading system was clearly explained.	0	4	3	1	1	1	3.33	3.92	4.25	4.57			

* The quartiles are calculated from Fall 2009 data. The university-wide quartiles are based on all UM classes in which an item was used. The school/college quartiles in this report are based on upper division classes with an enrollment of 16 to 74 students in College of Engineering.

** SA - Strongly Agree, A - Agree, N - Neutral, D - Disagree, SD - Strongly Disagree, NA - Not Applicable.

University of Michigan
Office of the Registrar - Evaluations
ro.umich.edu/evals/

Fall 2010 Final

10 students responded out of the total enrolled 28

Instructor Report

2010-12-03 - 2010-12-14 Report ID: MSR04732

Instructor: Halderman,J Alex

EECS 398 001

		Responses from your Students**							Other Users of This Item* University Wide			School/College		
		5 SA	4 A	3 N	2 D	1 SD	NA	Your Median	75% Above	50% Above	25% Above	75% Above	50% Above	25% Above
1	Overall, this was an excellent course.	5	4	0	1	0	0	4.50	3.83	4.19	4.60	3.91	4.17	4.50
2	Overall, the instructor was an excellent teacher.	4	3	3	0	0	0	4.17	4.00	4.50	4.80	4.04	4.38	4.71
3	I learned a great deal from this course.	7	2	1	0	0	0	4.79	3.94	4.28	4.67	4.00	4.28	4.59
4	I had a strong desire to take this course.	7	2	1	0	0	0	4.79	3.50	4.06	4.50	3.56	4.00	4.50
61	Prerequisites provided adequate preparation for this course.	3	3	3	1	0	0	3.83	4.00	4.23	4.45			
140	I deepened my interest in the subject matter of this course.	6	3	0	1	0	0	4.67	3.75	4.13	4.50			
201	The instructor gave clear explanations.	5	5	0	0	0	0	4.50	4.00	4.38	4.73			
203	The instructor stressed important points in lectures/discussions.	5	4	1	0	0	0	4.50	4.10	4.50	4.77			
207	The instructor appeared to have a thorough knowledge of the subject.	10	0	0	0	0	0	5.00	4.40	4.75	4.91			
216	The instructor acknowledged all questions insofar as possible.	6	4	0	0	0	0	4.67	4.20	4.56	4.79			
218	The instructor encouraged constructive criticism.	6	3	0	0	0	1	4.75	4.07	4.50	4.75			
228	The instructor followed an outline closely.	3	2	1	4	0	0	3.50	4.13	4.56	4.79			
229	The instructor used class time well.	2	3	3	1	0	0	3.67	4.00	4.38	4.70			
230	The instructor seemed well prepared for each class.	1	2	4	2	1	0	3.00	4.25	4.63	4.83			
232	Work requirements and grading system were clear from the beginning.	1	5	2	2	0	0	3.70	4.00	4.29	4.60			
239	The amount of work required was appropriate for the credit received.	2	6	0	0	2	0	4.00	3.89	4.13	4.50			
240	The amount of material covered in the course was reasonable.	4	5	1	0	0	0	4.30	4.00	4.20	4.50			
318	Writing assignments seemed carefully chosen.	2	4	3	0	0	1	3.88	3.88	4.15	4.50			
340	The textbook made a valuable contribution to the course.	0	0	0	0	0	10	n/a	3.50	4.00	4.34			
356	Examinations covered the important aspects of the course.	0	1	2	1	1	5	2.75	4.00	4.25	4.60			
365	Grades were assigned fairly and impartially.	1	3	3	0	0	3	3.67	4.00	4.24	4.56			
366	The grading system was clearly explained.	1	2	3	4	0	0	2.83	4.00	4.29	4.64			

* The quartiles are calculated from Fall 2010 data. The university-wide quartiles are based on all UM classes in which an item was used. The school/college quartiles in this report are based on upper division classes with an enrollment of 16 to 74 students in College of Engineering.

** SA - Strongly Agree, A - Agree, N - Neutral, D - Disagree, SD - Strongly Disagree, NA - Not Applicable.

University of Michigan
Office of the Registrar - Evaluations
ro.umich.edu/evals/

Fall 2011 Final

11 students responded out of the total enrolled 52

Instructor Report

2011-12-02 - 2011-12-14 Report ID: MSR04732

Instructor: Halderman,J Alex

EECS 398 001

		Responses from your Students**							Other Users of This Item* University Wide			Other Users of This Item* School/College		
		5 SA	4 A	3 N	2 D	1 SD	NA	Your Median	75% Above	50% Above	25% Above	75% Above	50% Above	25% Above
1	Overall, this was an excellent course.	10	1	0	0	0	0	4.95	3.90	4.25	4.70	3.93	4.21	4.56
2	Overall, the instructor was an excellent teacher.	9	2	0	0	0	0	4.89	4.11	4.59	4.85	4.05	4.40	4.77
3	I learned a great deal from this course.	10	1	0	0	0	0	4.95	4.00	4.33	4.69	4.00	4.33	4.63
4	I had a strong desire to take this course.	9	2	0	0	0	0	4.89	3.60	4.08	4.58	3.75	4.10	4.50
61	Prerequisites provided adequate preparation for this course.	8	1	1	0	0	0	4.88	4.08	4.29	4.61			
140	I deepened my interest in the subject matter of this course.	10	1	0	0	0	0	4.95	3.80	4.17	4.50			
201	The instructor gave clear explanations.	8	2	1	0	0	0	4.81	4.05	4.50	4.75			
203	The instructor stressed important points in lectures/discussions.	9	2	0	0	0	0	4.89	4.11	4.50	4.75			
207	The instructor appeared to have a thorough knowledge of the subject.	11	0	0	0	0	0	5.00	4.50	4.80	4.92			
216	The instructor acknowledged all questions insofar as possible.	11	0	0	0	0	0	5.00	4.27	4.58	4.80			
218	The instructor encouraged constructive criticism.	8	2	1	0	0	0	4.81	4.17	4.50	4.78			
228	The instructor followed an outline closely.	2	2	4	2	1	0	3.13	4.08	4.50	4.81			
229	The instructor used class time well.	2	6	3	0	0	0	3.92	4.09	4.50	4.75			
230	The instructor seemed well prepared for each class.	3	6	2	0	0	0	4.08	4.30	4.67	4.86			
232	Work requirements and grading system were clear from the beginning.	5	3	2	1	0	0	4.33	4.00	4.33	4.67			
239	The amount of work required was appropriate for the credit received.	7	4	0	0	0	0	4.71	3.94	4.19	4.50			
240	The amount of material covered in the course was reasonable.	9	2	0	0	0	0	4.89	4.00	4.25	4.50			
318	Writing assignments seemed carefully chosen.	5	3	2	0	0	1	4.50	3.83	4.13	4.50			
331	The laboratory was a valuable part of this course.	5	0	1	0	0	5	4.90	3.83	4.25	4.67			
332	Laboratory assignments seemed carefully chosen.	4	2	0	0	0	5	4.75	3.83	4.04	4.50			
336	Laboratory assignments required a reasonable amount of time and effort.	5	1	0	0	0	5	4.90	3.80	4.07	4.30			
337	Laboratory assignments were relevant to what was presented in class.	4	1	1	0	0	5	4.75	4.11	4.33	4.61			
340	The textbook made a valuable contribution to the course.	1	0	0	0	0	10	5.00	3.43	4.00	4.33			
356	Examinations covered the important aspects of the course.	3	2	2	0	0	4	4.25	4.07	4.31	4.64			
365	Grades were assigned fairly and impartially.	5	6	0	0	0	0	4.42	4.00	4.25	4.60			
366	The grading system was clearly explained.	5	3	3	0	0	0	4.33	4.00	4.33	4.64			

* The quartiles are calculated from Fall 2011 data. The university-wide quartiles are based on all UM classes in which an item was used. The school/college quartiles in this report are based on upper division classes with an enrollment of 16 to 74 students in College of Engineering.

** SA - Strongly Agree, A - Agree, N - Neutral, D - Disagree, SD - Strongly Disagree, NA - Not Applicable.

Intro to Computer Security

EECS 398
Fall 2010

Overview Schedule Homework Projects ITS Track

Course Schedule

The schedule is subject to change. Please check this page periodically.

Tuesday Lecture	Thursday Lecture	Friday EECS Discussion
Part 1. Security Fundamentals		
SEPT. 7 **The Security Mindset** Threat models, vulnerabilities, attacks; how to think like an attacker and a defender	SEPT. 9 **Message integrity, pseudorandom functions** Alice and Bob, crypto games, Kerckhoffs's principle, hashes and MACs	SEPT. 10 (EECS) Intro to EECS discussion sect. Introduce Homework 1 Basics of Python
Homework 1 available		
SEPT. 14 **Randomness and pseudorandomness** Generating randomness, PRGs, one-time pads	SEPT. 16 **Block ciphers** Simple ciphers, AES, block cipher modes	SEPT. 17 (EECS) Introduce Homework 2 Introduce Crypto Project
	Crypto Project available	Homework 1 due 5pm Homework 2 available
SEPT. 21 **Public-key crypto** RSA encryption, digital signatures, secret sharing	SEPT. 23 **Key exchange and key management** Diffie-Hellman key exchange, man-in-the-middle attacks	SEPT. 24 (EECS) Return Homework 1 Discuss Crypto Project

Tuesday Lecture	Thursday Lecture	Friday EECS Discussion
Part 2. Web and Network Security		
SEPT. 28 **Web architecture and HTTPS** The web security model, the SSL/TLS protocol, SSL certificates and CAs Guest: Mark Segal (deputy director, laboratory for telecommunications sciences, NSA)	SEPT. 30 **Penetration testing** Evaluating web site security through role-playing exercises; advantages and limitations; a recent example	OCT. 1 (EECS) Introduce Homework 3 Discuss Crypto Project
		Homework 2 due 5pm Homework 3 available
OCT. 5* **Web attacks** XSS, CSRF, and SQL-injection attacks	OCT. 7* **Web defenses** Filtering and escaping; limitations	OCT. 8 (EECS) Return Homework 2 Introduce Web Project
	Crypto Project due 5pm Web Project available	
OCT. 12 **Password security** Strong and weak passwords, salting, password cracking, online vs. offline guessing	OCT. 14 **Network attacks and defenses** advanced SSL attacks, dns forgery, phishing	OCT. 15 (EECS) Discuss Web Project ~~Midterm review~~
		Homework 3 due Monday 10/18 at 5pm
Midterm Week		
OCT. 19 *No lecture — study break*	OCT. 21 **Control hijacking, Part 1**	OCT. 22 (EECS) Return Crypto

	Software architecture and a simple buffer overflow	Project Return Homework 3 Introduce Homework 4 Discuss Web Project
	~~Midterm available from Wed. at Noon~~	~~Midterm due Fri. at NOON~~ Homework 4 available

Tuesday Lecture	Thursday Lecture	Friday EECS Discussion
Part 3. Host and Application Security		
OCT. 26 **Control hijacking, Part 2** Common exploitable application bugs, shellcode	OCT. 28* **Malware** Viruses and worms, spyware, key loggers, and botnets; defenses	OCT. 29 (EECS) ~~Return Midterm~~ Introduce AppSec project
	Web Project due 5pm AppSec Project available	
NOV. 2 **Election day special: Electronic Voting** Analysis, vulnerabilities, viruses, defenses, auditing, policy	NOV. 4* **Enterprise Security** Guest Lecturer: Paul Howell, (director - information & infrastructure assurance, UMich ITS)	NOV. 5 (EECS) Introduce Homework 5 Discuss AppSec Project
		Homework 4 due 5pm Homework 5 available
NOV. 9* **Security, law, and public policy** Guest Lecturer: Cindy Cohn (legal director, EFF)	NOV. 11 **Defending weak applications** Isolation, sandboxing, virtual machines	NOV. 12 (EECS) Return Web Project Return Homework 4 Discuss AppSec Project

Tuesday Lecture	Thursday Lecture	Friday EECS Discussion
Part 4. Security in Context		
NOV. 16 **DRM and trusted computing** Defending applications against hosts	NOV. 18 **Privacy** Online tracking, threats from "big data", targeted snooping, differential privacy Guest: TBA	NOV. 19 (EECS) Introduce Homework 6 Introduce Forensics Project
	AppSec Project due 5pm Forensics Project available	Homework 5 due 5pm Homework 6 available
NOV. 23 **Anonymity** Remailers, mixnets, TOR, Wikileaks, censorship resistance	NOV. 25 AND 26 *No lecture or discussions — Thanksgiving break*	
NOV. 30* *Cancelled*	DEC. 2* **Forensics** Taint and blur, data recovery, incident response	DEC. 3 (EECS) Return Homework 5 Discuss Forensics Project
		Homework 6 due 5pm
DEC. 7 **Side-channel attacks** Timing attacks, power analysis, cold-boot attacks, defenses	DEC. 9 **Security Today and Tomorrow** All questions answered.	DEC. 10 (EECS) Return Homework 6 ~~Review Forensics Project~~ Final Review
	~~Forensics Project due 5pm~~	Final available from Fri. at 5pm

Forensics project due Monday, Dec. 13 at 5pm

Exam Period	Take-home Final due Friday, Dec. 17 at 5pm

Proposed BSAE Program Change: New Required Course - Aero 205

The goal of this proposed program change is to improve the BSAE degree by offering a new system engineering course during the sophomore year to address several weaknesses in the aerospace engineering curriculum noted by the Aero Department Industrial Advisory board and other stakeholders. This new course was discussed at length and approved at the Aerospace Engineering Faculty retreat on 29 September 2012. Offering a system engineering course in the 2nd year will introduce students to analysis and design of an entire vehicle system, and the associated engineering tools and laboratory experience, as opposed to more focused core science and engineering lecture topics. This also expands our laboratory curriculum from a two course sequence to a three course sequence, adding elements of practical engineering hands-on experience in modern aerospace engineering areas such as computer aided design/manufacturing and embedded software. The lack of these elements in the aerospace engineering program has been noted by the Industrial Advisory Board, students and alumni. This proposal is an attempt to address these concerns. By introducing students to these subjects, which are not part of a traditional aerospace engineering curriculum, at the sophomore level we would like to introduce all aero students to practical engineering analysis and design topics early in their studies, and to encourage aero students with interests and skills in these important aerospace engineering disciplines to pursue additional course work or minors, like in Electrical Engineering, Computer Science or Multi-Disciplinary Design, for example.

The course program outcomes are listed in the Course Approval Form (CAF) and the attached table (page 2) lists the program outcomes in context with all other required aero courses. Aero students will be exposed to aero engineering objectives early in the curriculum which previously were covered in their senior year. We hope this change will provide student with useful insights on core courses and how the material in those courses is used in practice.

A revised schedule is attached (pages 3 - 5) where students will take Aero 205 in the sophomore year in place of the 3 credit Aerospace Engineering technical elective requirement. MSE 220 (currently in the third term) is moved to the seventh term to balance the course load. The new course is required for the junior level laboratory course AEROSP 305 and a modification CAF for AEROSP 305 is also attached (pages 29 and 30). The revised schedule is credit neutral for aero students pursuing dual degrees or minors since the new course replaces a required aero technical elective course. The change does not impact aero SGUS students who will be able to double count six credits of the seven technical elective credits. Similarly, aero students with broader interests in global engineering and similar initiatives are not impacted by the present proposed program change.

The new course is modeled after the very successful ENGR 100-700 course but has different objectives and outcomes. Aero students who have taken ENGR 100-700 or a similar design/build/test/operate ENGR 100 section will be exposed to new subjects including CAD/CAM, computational engineering tools and embedded software. Aero students who have not taken a design/build/test/operate ENGR 100 section will be introduced to these subjects as well as engineering analysis in the context of vehicle system design.

Mapping of required Aerospace Engineering courses to Program Outcomes

Program Outcomes	Aero 201	Aero 205	Aero 215	Aero 225	Aero 285	Aero 305	Aero 315	Aero 325	Aero 335	Aero 347	Aero 348	Aero 405	Aero 481	Aero 483
(a) ability to apply knowledge of mathematics, science and engineering	★	★	★	★		★	★	★	★	★	★	★	★	★
(b) ability to design and conduct experiments, analyze and interpret data		★				★						★		
(c) ability to design a system, component, or process		★							☆	☆	☆	★	★	★
(d) ability to function on teams		★				☆			☆			★	★	★
(e) ability to identify, formulate and solve engineering problems	★	★	★	★		★	★	★	★	★	★	★	★	★
(f) understanding of professional and ethical responsibility	☆				☆								★	★
(g) ability to communicate effectively		☆			☆	★			☆			★	★	★
(h) broad education necessary to understand the impact of engineering solutions in a global/societal context	☆				★				☆				☆	☆
(i) recognition of the need/ability to engage in life-long learning		★			★	☆			☆			☆	☆	☆
(j) knowledge of contemporary issues	★				★				☆	☆	☆	☆	★	★
(k) ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	☆	★	☆	☆		★	☆	☆	☆	☆	☆	☆	★	★
(l) knowledge of aerodynamics, materials, structures, propulsion, flight mechanics, orbital mechanics, software, and stability and control	★	★	★	★	☆	☆	★	★	★	★	★	☆	★	★
(m) Competence in the integration of aerospace science and engineering topics and their application in aerospace vehicle design	☆	★			☆					☆	☆	☆	★	★

★: *strong relationship (significant focus in this course)*   ☆: *modest relationship (some focus in this course)*

Proposed Sample Schedule

Credit Hours		Terms 1	2	3	4	5	6	7	8
Subjects required by all programs (55 hrs.)									
MATH 115, 116, 215, and 216	16	4	4	4	4	-	-	-	-
ENGR 100, Intro to Engr	4	4	-	-	-	-	-	-	-
ENGR 101, Intro to Computers	4	-	4	-	-	-	-	-	-
CHEM 125/126 and 130, or 210 and 211[1]	5	5	-	-	-	-	-	-	-
Physics 140 with Lab 141; Physics 240 with Lab 241[2]	10	-	5	5	-	-	-	-	-
Intellectual Breadth	16	4	4	-	-	-	-	4	4
Related Technical Core Subjects (12 hrs.)									
MECHENG 240, Intro to Dynamics …	4	-	-	-	4	-	-	-	-
MATSCIE 220, Intro to Materials	4	-	-	-	-	-	-	4	-
EECS 314, Cct Analysis and Electronics	4	-	-	-	-	4	-	-	-
Aerospace Science Subjects (29 hrs.)									
AEROSP 201, Intro to Aerospace Engineering	3	-	-	3	-	-	-	-	-
AEROSP 215, Intro to Solid Mechanics and Aerospace Structures	4	-	-	-	4	-	-	-	-
AEROSP 225, Intro 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 347, Space Flight Mechanics	3	-	-	-	-	3	-	-	-
AEROSP 348, Aircraft Dynamics and Control	3	-	-	-	-	-	3	-	-
Aerospace Engineering Subjects (16 hrs.)									
AEROSP 205 Intro Aerospace Eng Systems	3	-	-	3	-	-	-	-	-
AEROSP 285, Aero Engineering Seminar	1	-	-	1	-	-	-	-	-
AEROSP 305, Aerospace Engr Lab I	4	-	-	-	-	-	4	-	-
AEROSP 405, Aerospace Engr Lab II	4	-	-	-	-	-	-	4	-
AEROSP 481, Aircraft Design or AEROSP 483, Space System Design	4	-	-	-	-	-	-	-	4
Electives (16 hrs.)									
Technical Electives[3]	7	-	-	-	-	-	-	4	3
General Electives	9	-	-	-	-	-	5	-	4
Total	128	17	17	16	16	15	16	16	15

Proposed Notes:

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 CoE.

[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 CoE.

[3] Technical electives must total at least ~~10~~ 7 credits of approved upper division courses (that is, 300 level or above). At least 3 credits must be approved mathematics or sciences course~~, at least 3 credits must be Aerospace Engineering courses~~, a maximum of 3 credits is allowed for directed study and a maximum of 2 credits is allowed for seminar courses. See below for additional details.

Intellectual Breadth (16 credits):

See the College of Engineering Bulletin for rules in selecting Intellectual Breadth courses that satisfy this requirement. A 3-credit humanities course and a 3-credit 300-level or higher humanities or Liberal Arts course are required. Note that 100 level foreign language credit received by placement exam does not count as Intellectual Breadth.

Technical Electives (7 credits):

A ~~total~~ minimum of ~~10~~ 7 credits of technical elective courses is required. The courses must be upper division (that is 300 level or above) courses from engineering, mathematics, physical science, or other courses approved by an academic adviser, that are chosen to satisfy the following constraints:

One course of 3 or more credits must be advanced mathematics or advanced science; this could include a course in astronomy, biology, chemistry, computer science, mathematics, or physics. Recommended courses include; Math 351, Math 371, Math 404, Math 412, Math 416, Math 419, Math 425, Math 450, Math 454, Math 471, Stat 412, Physics 340, Physics 341, Physics 390, Physics 402, Physics 405, Physics 413, Physics 451. Other courses can be selected if approved by an academic adviser.

~~At least 3 credits of upper division Aerospace Engineering courses. The following courses satisfy this requirement: AE 384, AE 390, AE 416, AE 421, AE 445, AE 447, AE 450, AE 464, AE 484, AE 490, and all 500 level Aero courses. A complete list of Aerospace courses is provided here.~~

A maximum of 2 credits of seminar, such as AE 585, is allowed for technical elective credit.

A maximum of 3 credits of directed study is allowed for technical elective credit.

A maximum of 3 credits of AE 390 or AE 490, based on satisfactory completion of flight certification, can be used to satisfy the technical elective requirement.

Policy on Directed Study Credit for Formal Aircraft Pilot Training Activities

Aerospace Engineering students can earn directed study credit based on successful completion of pilot training activities according to the following procedures:

Aero 290:
One Aero 290 credit can be earned with a passing score on the FAA Private Pilot Exam, Aircraft Single-Engine Land (ASEL). This exam is typically taken as part of a ground school course that covers basic knowledge required for a private pilot license. Students requesting this credit must bring their FAA exam paperwork to the cognizant Aerospace Engineering faculty member for approval. A passing exam score will translate to a grade of "Pass" for Aero 290.

Aero 390:
Three Aero 390 credits can be earned by students who obtain FAA-issued license for private pilot, Aircraft Single-Engine Land (ASEL) or helicopters. More advanced FAA-issued ratings such as instrument, instructor, instrument instructor, and multi-engine are acceptable but cannot be used to obtain additional credit. To earn Aero 390 credit, students must bring their pilot's log book(s), a current medical certificate (Class III or above), and their pilot's license to the cognizant Aerospace engineering faculty member for approval. Credit for a pilot's license is offered to enhance the traditional Aerospace curricula with practical study. Therefore, the Aero 390 "licensed pilot" credit can only be obtained by students who have declared an Aerospace Engineering major. Students eligible for this credit must either obtain their license while a University of Michigan student or maintain currency by completing a documented annual or biennial proficiency check after enrollment as a University of Michigan student.

The cognizant faculty member for pilot training activities is currently Professor Carlos Cesnik. Inquiries should be directed to him.

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Form Number 2080

Date 01/09/2012

Effective Term Fall 2013

Course Offer Freq ☒ Indefinitely ☐ One term only

Action Requested
- (●) New Course
- ( ) Modification of Existing Course
- ( ) Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

A. CURRENT LISTING

Home Department | Course Number

Cross Listed Course Information

Course Title

TITLE ABBREVIATION — Time Sched Max = 19 Spaces; Transcript Max = 20 Spaces

Course Description

PROGRAM OUTCOMES: ☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k

Degree Requirements ( ) Degree Requirement ( ) Free Elective ( ) Other ( ) Core Course ( ) Tech Elective

Prereq
( ) Enforced
( ) Advised

Credit Restrictions

Level of Credit
☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work

Credit Hours Min ___ Max ___

Contact Hrs/Wk ___ Number of Wks ___

B. REQUESTED LISTING

Home Department: AEROSP Aerospace Engineering
Course Number: 205

Cross Listed Course Information

Course Title: Introduction to Aerospace Engineering Systems

TITLE ABBREVIATION
- Time Sched (Max = 19 Spaces): Intr Aero Eng Sys
- Transcript (Max = 20 Spaces): Intr Aero Eng Sys

Course Description for Official Publication (Max = 50 words)

A Systems Engineering Experience: Introduces engineering processes by means of design, build, test and operation of flight vehicles. Exposure to technologies including: computer aided design, manufacturing, simulation, composites, mechanisms, instrumentation, and basic electronics. Embedded software development for data acquisition and processing, control, and communications. Individual and team projects.

PROGRAM OUTCOMES: ☒ a ☒ b ☒ c ☐ d ☒ e ☐ f ☐ g ☐ h ☒ i ☐ j ☒ k

Degree Requirements (●) Degree Requirement ( ) Free Elective ( ) Other ( ) Core Course ( ) Tech Elective

Prereq: Phys 140, 141, Math 116, Engr 100, Engr 101 or equivalents
(●) Enforced
( ) Advised

Credit Restrictions: NONE

Level of Credit
☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work

Credit Hours Min 3 Max 3

Contact Hrs/Wk 5.0 Number of Wks 14

C.

Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeatable? ( ) Yes (●) No Max Hours? ___ Max Times? ___ Can it be repeated in the same term? ( ) Yes ( ) No

Class Type(s) ☒ Lec ☐ Sem ☐ Dis ☐ Other ___ ☐ Rec ☒ Lab ☐ Ind

Graded Section ☒ Lec ☐ Sem ☐ Dis ☐ Other ___ ☐ Rec ☐ Lab ☐ Ind

Grading ☒ A-E ☐ CR/NC ☐ P/F ☐ S/U

Location ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Course Is Y Graded ☐

Cognizant Faculty Member: Peter Washabaugh — Title: Associate Professor

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval Info	**Approved by Name**	**Approved Date**
☐ Curriculum Comm.	Fred Terry	
☐ Faculty		
☐ Cross listed Unit 1		
☐ Cross listed Unit 2		

Submitted By: ☐ Home Dept. ☐ Cross-listed Dept.

	Department Chair Name	**Chair Signature**
Home Dept.	Daniel Inman - Aerospace	
Cross-listed Dept(s).		

Form Number

2080

SUPPORTING STATEMENT

This course is intended to take a step toward introducing CAD, CAM, embedded systems, and other practical engineering topics into the sophomore Aerospace curriculum. The required course will provide all Aerospace Engineering students exposure to the fundamentals of design, build, test principles consistent with recommendations repeatedly made by our industrial advisory board. An atypical flight vehicle (hovercraft) is the focus of the course, enabling students to safely explore a variety of aerodynamic, propulsion, and construction options. Design tools can be elevated to accommodate students that have previous systems experience (e.g. blimps or underwater platforms from Engr100).

This course is modeled after the first-year Eng 100-700 blimp course, and is going through a similar development path. The course has been under development and prototyped in small sections since 2009 as Aero 495 (a special topics course). By and large the prototypes have been populated by 3rd and 4th year students and received excellent evaluations. Different flight vehicles or fabrication techniques were explored which led to adoption of the hovercraft as the central project. This craft needs a single composite shell as its main structural element. This is a platform that has rich dynamics in the plane of the floor. It allows both radio and autonomous control. The computational tools, manufacturing techniques, and microcontrollers in the course have similarly evolved. A number of software packages were used including SolidWorks, GibbsCam, Fluent, and Nastran. The final choice is CATIA as the central software environments with its own internal CAM package, and with STAR CCM+ and SimDesigner (a suite of Nastran simulators) to simulate fluids and solids, respectively. Using CATIA as a single graphical interface reduced the amount of time (~ 1 week) spent on housekeeping tutorials to simply run the various software packages. An Arduino microcontroller is used because of its open-source environment and ease of programming. A CNC wax-router is used to fabricate molds for the craft: This allows students to make errors in the main structure of their design, without incurring significant costs to the class. Similar to ENGR 100-700 we believe this platform and software choices can be implemented in class size of 40 - 60 students needed for a required aero course.

The offerings of Aero 495 have received excellent student evaluations (Q1 - 4.9, Q2 - 4.9, 5 students). For additional important information see attached documentation.

Are any special resources or facilities required for this course? ☒ Yes ☐ No

Detail the Special requirements

This course requires the Computer Aided Engineering Environment (CAEN), as well as manufacturing resources, CNC router, laser cutter, computes and testing facilities (e.g. those found in 2243 FXB). The course needs the computer in 1008 FXB to deliver the lectures (a CAEN computer that allows projection to a class), and the measurement and fabrication tools found in 2251 FXB and 2236E FXB. Similar to the blimp course, the FXB atrium is used as a test range. Each student will use an “embedded control” avionics kit consisting of analog sensors, camera, Gumstix, and Arduino.

Aero 205: Introduction to Aerospace Engineering Systems

COURSE #: 205	**COURSE TITLE:** Intr Aero Eng Sys
TERMS OFFERED: Fall and Winter	**PREREQUISITES:** Phys 140, 141, Math 116, Engr 100, Engr 101 or equivalents
INSTRUCTOR (S): Washabaugh	**SCIENCE/DESIGN: 1/2**
CATALOG DESCRIPTION: A Systems Engineering Experience: Introduces engineering processes by means of design, build, test and operation of flight vehicles. Exposure to technologies including: computer aided design, manufacturing, simulation, composites, mechanisms, instrumentation, and basic electronics. Embedded software development for data acquisition and processing, control, and communications. Individual and team projects.	**COURSE TOPICS:** 1. Introduction to design 2. Solid Modeling 3. Computer aided simulation 4. Computer aided fabrication 5. Microcontrollers and embedded programming 6. Signals and Sensors

COURSE OBJECTIVES* Students will be:	1. Introduced to the design of a system and a component 2. Introduced to a commercial solid-modeling program 3. Simulate the load-displacement or thermal characteristics of a solids, and an internal flow. 4. Fabricate components and systems using software and computer aided machine tools 5. Introduced to microcontroller and programming 6. Introduced to typical sensors and their signals. 7. Test their components and system
COURSE OUTCOMES* Students will demonstrate:	1. Competence in designing components and systems (Assessed by 1, 2, 3,4) 2. Competence with a computer solid modeling tool (Assessed by 1, 2) 3. Competence with a computer simulation tool (Assessed by 1, 2) 4. Competence with a computer fabrication tool (Assessed by 1, 2) 5. Competence with a microcontroller and its programming (Assessed by 1,2,4) 6. Understanding a microcontroller and its programming (Assessed by 1,2,4) 7. Understanding sensors and their signals (Assessed by 1,2,4)
ASSESSMENT TOOLS	1. Lab Tutorial 2. Lab questions 3. Oral Report 4. Exam

Notes:

CoE Course Approval Form: New course (Aero 205)

Effective term: Fall 2013
Course offered how often: Fall and Winter

Home dept/course number: Aerospace Engineering / AEROSP 205

Course title: Introduction to Aerospace Engineering Systems

Title abbreviation (19 or 20 spaces): Intr Aero Eng Sys

Course description (Max 50 words):
A Systems Engineering Experience: Introduces engineering processes by means of design, build, test and operation of flight vehicles. Exposure to technologies including: computer aided design, manufacturing, simulation, composites, mechanisms, instrumentation, and basic electronics. Embedded software development for data acquisition and processing, control, and communications. Individual and team projects.

Program Outcomes (to be checked):
(a) An ability to apply knowledge of mathematics, science, and engineering
(b) An ability to design and conduct experiments, as well as to analyze and interpret data
(c) An ability to design a system, component or process to meet desired needs
(e) An ability to identify, formulate, and solve engineering problems
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
(l) A knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, orbital mechanics, software, and stability and control
(m) Competence in the integration of aerospace science and engineering topics and their application in aerospace vehicle design
Degree requirements: **Degree requirement**
Prerequisites: Phys 140, 141, Math 116, Engr 100, Engr 101 or equivalents
Credit restrictions: None

Level of credit: Undergrad only
Credit hours: Min 3 Max 3
Contact hours/week: 5.0
Number of weeks: 14

Is this course repeatable? No

Class type: Lec and Lab
Graded section: Lec
Grading: A-E
Location: Ann Arbor
Course is Y graded: No

Cognizant Faculty Member: Peter Washabaugh, Aero

Supporting Statement:

This course is intended to take a step toward introducing CAD, CAM, embedded systems, and other practical engineering topics into the sophomore Aerospace curriculum. The required course will provide all Aerospace Engineering students exposure to the fundamentals of design, build, test principles consistent with recommendations repeatedly made by our industrial advisory board. An atypical flight vehicle (hovercraft) is the focus of the course, enabling students to safely explore a variety of aerodynamic, propulsion, and construction options. Design tools can be elevated to accommodate students that have previous systems experience (e.g. blimps or underwater platforms from Engr100).

This course is modeled after the first-year Eng 100-700 blimp course[1], and is going though a similar development path[2]. This course has been under development and prototyped in small sections since 2009 as Aero 495 (a special topics course). The prototypes have mainly been populated by 3rd and 4th year students and received excellent evaluations (Q1 - 4.9, Q2 - 4.9, 5 students). Each year a different flight vehicle or fabrication technique was explored. The course has gone through some dramatic changes. The initial course involved fabricating high-altitude balloon payloads. It suffered from the availability of nice weather, scalability to large numbers of students, and the relevance of CAD and CAM in the final project. The main innovation came with the adoption of the hovercraft as the central project. This craft needs a single composite shell as its main structural element. This is a platform that has rich dynamics in the plane of the floor. It allows both radio and autonomous control.

The computational tools, manufacturing techniques, and microcontrollers in the course have similarly evolved. For example, the original course used discrete software packages (SolidWorks, GibbsCam, Fluent, and Nastran). The most recent offering uses CATIA as the central software environments with its own internal CAM package, and with STAR CCM+ and SimDesigner(a suite of Nastran simulators) to simulate fluids and solids, respectively. Using CATIA as a single graphical interface reduced the amount of time (~ 1 week) spent on house keeping tutorials to simply run the various software packages. A CNC wax-router is used to fabricate molds for the craft; this allows students to make errors in the main structure of their design, without incurring significant costs to the class. The embedded computing architecture, initially planned to consist of an Arduino microcontroller and Gumstix Linux processor, will expose students two the two primary options for onboard control. Students will be exposed to data acquisition through the Arduino, communication through Arduino-Gumstix and Gumstix-ground (wifi) link, and feedback control through use of an onboard camera tracking simple environment features students can use to autonomously guide the hovercraft.

The syllabus and first-page of the lab tutorials are appended. There are still parts of the course that are still being developed. However, in order to facilitate progress it is important to appropriately position the course at the sophomore level.

References:

1: Peter D. Washabaugh and Leslie A. Olsen, "Initial Impact of a First-Year Design-Build-Test-Compete Course," 2011 Annual Conference and Exposition,Vancouver, Canada, # AC 2011-1287

2: Peter D. Washabaugh, Leslie A. Olsen and John Kadish, "An Experiential Introduction to Aerospace Engineering," 45th AIAA Aerospace Sciences Meeting, 8-11 Jan 2007, #AIAA 2007-296

Any special resources? Yes.

This course requires the Computer Aided Engineering Environment (CAEN), as well as manufacturing resources, CNC router, laser cutter, computes and testing facilities (e.g. those found in 2243 FXB). The course needs the computer in 1008 FXB to deliver the lectures (a CAEN computer that allows projection to a class), and the measurement and fabrication tools found in 2251 FXB and 2236E FXB. Similar to the blimp course, the FXB atrium is used as a test range. Each student will use an "embedded control" avionics kit consisting of analog sensors, camera, Gumstix, and Arduino. This avionics kit can be operated on a benchtop and later mounted on the hovercraft to support autonomous operation.

Sample Syllabus (Winter 2012 – Ae 495 Prototype)

Introduction to Aerospace Engineering Systems

Course Description:

This is a Systems Engineering Experience: This course introduces students to practical aerospace system engineering processes by the means of design, build, test and operation of a flight vehicle. It is intended as a preparatory class for the capstone design courses. Students will be exposed to a variety of technologies. These include computer aided design (CAD), simulation, computer aided manufacturing (CAM), computer numerically controlled (CNC) machining, simulation (Fluids and Solids), composites, mechanisms, laboratory instrumentation, basic analog and digital electronics, microcontrollers, and sensors. These lab activities culminate in a team design-build-test-compete project of a dual-mode radio controlled and autonomous hovercraft.

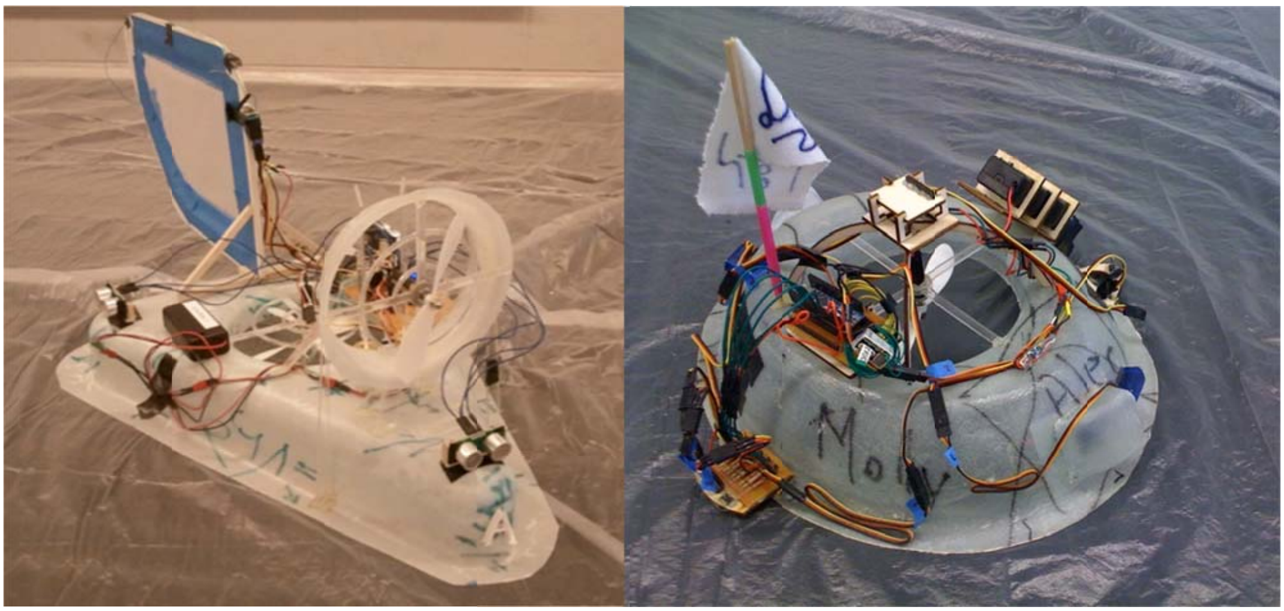

Figure 1: Autonomous Ground-Effect-Vehicles incorporating a custom designed composite shell, propulsion mechanism, avionics and control system.

This course is suitable for students that have completed Eng 101 or 151, Eng 100, and Math 116. Completion or simultaneous enrollment in Phys 240, and Phys 241, or their equivalents would be useful. A background in mechanics (e.g. ME 211, AE 215, or CEE 212), dynamics (e.g. ME 240) or more advanced mathematics (e.g. Math 215), or electronics (e.g. EECS 215) would be helpful, but is not necessary.

Extra class events: There will be two Saturday competitions where students display their flight vehicles. Each is held from 2-5pm. Both events will be held in 1109 FXB and the FXB Atrium. Allstudent registering for this class are requiredto participate in these activities.

Instructional Staff:

Instructors: Peter Washabaugh
Office: 3028 FXB
Phone: 763-1328
e-mail: pete@umich.edu
Office Hours:
M 8-10 2251FXB
F 3-42243 FXB

General Purpose of Course:
There are several goals to this course. They include:

(1) Experience a realistic Design-Build-Test-Compete product cycle on an entire vehicle
(2) Learn strategies and methods to deal with open-ended problems
(3) Use and integrate knowledge from previous courses through a design process
(4) Become acquainted with computer based tools for design and manufacture
(5) Experience teamwork in problem solving.

Coverage of an entire flight vehicle:
The goal of the course is to cover all aspects of a flight vehicle. This will include introduction to fluid and solid mechanics, propulsion and control. We will implement what is introduced. For instance this means that our simulation of fluid mechanics will include pressure and velocity measurements of how our craft performs. Similarly, we will construct and simulate our craft. Our controller will be implemented using a microcontroller. This will force us to worry about electrical hardware, sensors, actuators, and programming.

Hours and Rooms:

Section 001	Lecture	T	10:30-12:00	1008 FXB
Section 002	Lab/Dis	T	1:00-4:00	2243 FXB (10 max)
Section 003	Lab/Dis	Th	1:00-4:00	2243 FXB (10 max)

Grading:
Grades will be based on the individual assignments, the team two projects, as well as participation in class. Timely submission of all work and participation will be a substantial factor in the grade. In general late assignments are not accepted. A tentative distribution:

Individual and Tutorial Assignments	50%
Designing and Teaming Exercises (e.g. prelim. projects)	10%
Final Project (Preliminary reports, presentations)	30%
Midterm Exam	0%
Final Exam	10%

Absolute Scale (100-85% A, 85- 70% B, 70- 55% C, 55-40%D)

Quiz/Exams:

Final Exam: Wed, April 25th, 2012, 10:30am(Sharp) -12:30

Documentation
There will be handouts, e-mail and web-tools: (https://ctools.umich.edu)
All the assignments (the tutorials, preparatory assignments, homework, and reports) will be made available electronically. The recommended texts are available in the laboratory.

Primary:

Theory and Design of Air Cushion Craft, L. Yun and A. Bliault
Arnold, London, 2000, ISBN 0 340 67650 7

Reference:

Introduction to Flight, J.D.Anderson, Jr. McGraw-Hill, New York, 1978, ISBN 0-07-001637-2. (Common introductory text in Aerospace Engineering.)

Engineering Materials 1: An Introduction to their Properties and Applications, M.F. Ashby and D. R.H. Jones, Pergamon Press, 1980, ISBN 0-08-026138-8.

Roark's Formulas for Stress and Strain 6th edition, Warren C. Young,
McGraw-Hill, 1989, ISBN 0-07-072541-1

Engineering Mathematics with Mathematica, J. S. Robertson, McGraw-Hill, 1995, ISBN 0-07-053171-4.

Machinery's Handbook, 28th Edition, Erik Oberg et. al., Industrial Press, 2008, ISBN 9-78-083112800-5.

Advanced Reference Material (Very useful texts but at a more advanced level)

Similarity and Dimensional Methods in Mechanics, L. I. Sedov, Academic Press, New York and London, 1959.

Theory of Wing Sections, Including a Summary of Airfoil Data, I.H. Abbott and A.E. Von Doenhoff, Dover Publications, 1959,
ISBN 0-486-60586-8.

Experimental Methods for Engineers, J.P.Holman, 7th ed, McGraw Hill, 2001, ISBN 0073660558.

Building Scientific Apparatus, J.H.Moore, C.C. Davis, and M.A. Coplan, Addison Wesley, 1983, ISBN 0-201-05532-5.

Space Mission Analysis and Design 3rd ed J.R. Wertz and W.J. Larson, Microcosm Press, Torrance CA. 1999, ISBN 1-881883-10-8.

Fundamentals of Aircraft Design, L. M. Nicolai, METS Inc., San Jose, CA, 1975 (Revised 1984).

Computer Aided Design (CAD) and Simulation software:
The main software package used will be the Caita. This is because the ultimate target for this class is 2nd year students and Catia has the largest user base in the airframe industry. Other mechanics packages such as MSC/Nastran, and STAR CCM+ will also be introduced to simulate solids and fluids, respectively. You will definitely use word processing and other presentation software. Other analysis software (e.g. Mathematica, Matlab, etc.) can also be used as needed

Rules:

1. University of Michigan College of Engineering Honor Code.
2. Verbal discussion of the individual assignments are allowed, however, sharing of completed problems or copying is not allowed.
3 Assignments, presentation and reports will be strictly due when stated. No credit will be provided for late assignments, however I'll still annotate any assignment.
4 I expect a professional behavior in the course. That is, some professionally looking presentations and reports.

Remarks on Course Format and Procedures:
There will be two complementary and parallel activities during the first ten weeks of this course. The first is a set of tutorials on the use of computer aided design, engineering and manufacturing (CADEM) software. This will involve the CNC fabrication of a part. There will also be some type of digital electronics labs involving microcontrollers. Each individual will hand in a homework with completed exercises and other assignments approximately 10 times during the term .These assignments will document your progress through the material in the tutorials. This work will be done by individuals primarily outside of formally scheduled classes.

The second set of activities will be done during the regularly scheduled class period as well as at times to be arranged by individual teams. These activities will involve teaming exercises, some sample projects, case studies and finally culminating in a team design project. Each team will have a project that is independent of all other teams. Several project related presentations will be submitted by each team, including: slides from oral presentations. Oral progress reports will be presented by each team three times during the term.

Wk #	Date	*Lecture, Labs and Discussion Activities* *(italics indicate optional activities)*	Loc.	Assignments & Due Dates
1	1/10 Tu	*Lec: Course Intro; Intro to Solid Modeling andComputer Aided Manufacturing* • *Course Overview* • *CAD Demo* • *Microcontroller Demo* • *Fly Sample Hovercraft*	1008 FXB	Read: C-Tools Lab Document Assgn: Lab 1
	Lab Time	*Lab: CAD and CAM* • *Intro to Solid Modeling: CATIA* • *Intro to Computer Aided Manufacturing* • *Mold manufacturing – interactive demonstration* • *(Optional) Power-tool check-out*	2243 FXB	Due: Lab 1 Preparation
2	1/17 Tu	Lec: Composite Manufacturing, Embedded Programming, and Radio Components • *Material Properties and Selection* • *Programming overview* • *Analog and signals (Multimeter and Scope)*	1008 FXB	Due: Lab 1 Read: C-Tools Lab Document Assgn: Lab 2
	Lab Time	Lab: Composites and Microcontrollers • Mold finishing and composite lay-up - interactive demonstration • Microcontroller programming overview • Digital Input (Switch, PWM-receiver) • Digital Output (LED, PWM-servo, Motor) • Radio components (Transmitter, Receiver)	2243 FXB	Due: Lab 2 Preparation
3	1/24 Tu	*Lec: Introduction to Fluid Simulation, Propulsion systems, and Mechanisms; Hovercraft Teaming* • *Conservation equations (Mass, Mom., Energy)* • *Bounding calculations (Hovercraft Lift Perf.)* • *Budgets: (mass, time-response)*	1008 FXB	Due: Lab 2 Read: C-Tools Lab Document Assgn: Lab 3 Assgn: RC Hovercraft Competition + Presentation
	Lab Time	*Lab: Fluid, Propulsion and Mechanisms* • *Intro to fluid simulation: STAR-CCM+* • *Laser-cutter - Interactive demonstration* • *Compressor map: Hovercraft lift performance* • Mechanisms (Bearing, Bushing, Shaft, Gear) • Hovercraft Teaming	2243 FXB	Due: Lab 3 Preparation
4	1/31 Tu	*Lec: RC Hovercraft Teaming* • *Risk reduction and budgets* • *Design: incremental vs open*	1008 FXB	Due: Lab 3 Read: C-Tools Lab Document Assgn: Lab 4
	Lab Time	Lab: RC Hovercraft Teaming • Hovercraft teaming • Draft presentation • Hovercraft demonstration flight	2243 Atrm FXB	Due: Lab 4 Preparation Due: Lab 4 (At the end of lab)
	2/4 Sat	RC Hovercraft Competition(2pm – 5pm) • Presentation • Radio Controlled Race	1109 Atrm FXB	Due: RC Hovercraft Presentation and Competition

5	2/7 Tu	Lec: RC Hovercraft Lessons Learned; Sensors and Interfacing • Analog Input and output • Serial Ports (I2C) and logic Analyzers • Wireless Interface • Displacement, Orientation and Inertia Sensors • Sensor characterization and calibration	1008 FXB	Read: C-Tools Lab Document Assgn: Lab 5
	Lab Time	Lab: Basic Sensors • Displacement (infrared and acoustic) • Orientation (compass) • Inertial (linear accelerations and angular rate)	2243 FXB	Due: Lab 5 Preparation
6	2/14 Tu	Lec: Dynamics of an air-slide and closed –loop control; Autonomous Hovercraft Teaming • Linear Dynamics (2nd order system) • Closed-loop control (PD controller) • Implementation Limits	1008 FXB	Due: Lab 5 Read: C-Tools Lab Document Assgn: Lab 6
	Lab Time	Lab: Control of an air-slide; Hovercraft Teaming • Characterization of an air-slide craft • Stabilization of an air-slide craft • Autonomous Hovercraft Teaming	2243 FXB	Due: Lab 6 preparation
7	2/21 Tu	Lec: Advanced Sensors *(in development)* • Compass variability • Position sensor (Not GPS)	1008 FXB	Due: Lab 6 Read: C-Tools Lab Document Assgn: Lab 7
	Lab Time	Lab: Advanced Sensors *(in development)* • Compass map • Position sensor • Autonomous Hovercraft Teaming	2243 FXB	Due: Lab 7 preparation
8	2/28 Tu	Winter Recess — *NO LECTURE CLASS*	------	
	Lab Time	Winter Recess — *NO FORMAL LAB CLASS* *Optional/Open Lab: Hovercraft Fabrication and Testing 8:00 am – 5:00 pm*	2243 FXB	
9	3/6 Tu	Lec: Structures Calculations and Finite Elements • Structures: Beam theory overview and examples • Displacements, strain, stress, and loads • Finite Elements overview	1008 FXB	Due: Lab 7 Read: C-Tools Lab Document Assgn: Lab 9
	Lab Time	Lab: Simulation and Measurement of a Structure • Simulation • Fabrication (Laser Cutter) • Measurement (Shadowgraph, Photoelasticity) • Autonomous Hovercraft Teaming	2243 FXB	Due: Lab 9 Preparation
10	3/13 Tu	Lec: Structural Design • Sample Processes • Objectives, Constraints, and Trades	1008 FXB	Due: Lab 9. Read: C-Tools Lab Document Assgn: Lab 10
	Lab Time	Lab: Design of a cantilever structure • Three design iterations • Fabrication (Laser Cutter) • Measurement (Shadowgraph) • Autonomous Hovercraft Teaming	2243 FXB	Due: Lab 10 Preparation
11	3/20 Tu	Lec: Advanced Simulation *(in development)* • Natural frequencies	1008 FXB	Due: Lab 10 Read: C-Tools Lab Document

		• Buckling		Assgn: Lab 11
	Lab Time	Lab: Advanced Simulation *(in development)* • Natural frequencies • Buckling • Autonomous Hovercraft Teaming	2251 FXB	Due: Lab 11 Preparation Due: Lab 11 (End of lab)
	3/23 Fri	*Optional/Open Lab: Hovercraft Fabrication and Testing 8:00 am – 8:00 pm*	2243 FXB	
12	3/27 Tu	Lec: Autonomous Hovercraft Teaming • Class Presentations • Competition logistics and Teaming	1008 FXB	Due: Class-wide presentation of Autonomous Hovercraft (System Overview)
	Lab Time	Lab: Autonomous Hovercraft Teaming • Flight Demonstration • Autonomous Hovercraft Teaming	2243 FXB	Due: Autonomous Hovercraft Demonstration
	3/30 Fri	*Optional/Open Lab: Hovercraft Fabrication and Testing 8:00 am – 8:00 pm*	1008 FXB	
13	4/13 Tu	Lec: Hovercraft Fabrication and Teaming • Competition logistics • Hovercraft teaming	1008 FXB	
	Lab Time	Lab: Hovercraft Fabrication and Teaming • Additional flight demonstration • Autonomous hovercraft teaming	2243 FXB	
	4/6 Fri	*Optional/Open Lab: Hovercraft Fabrication and Testing 8:00 am – 8:00 pm*	1008 FXB	
	4/7 Sat	Final Oral Presentations and Autonomous Hovercraft Competition (2am – 5pm) • Presentation • Radio Controlled, augmented with sensors race • Autonomous race	1109 Atrm FXB	Due: Team Oral Presentation and Competitions
14	2/10 Tu	Lec: Hovercraft Fabrication and Teaming • Derivative Designs • Derivative Competitions	1008 FXB	
	Lab Time	*Lab: Hovercraft Fabrication and Teaming* • Derivative Designs • Derivative Competitions • Autonomous hovercraft teaming	2243 FXB	
15	2/7 Tue	Lec: Class Summary and Lessons Learned; Future Directions and Course Evaluation	1008 FXB	Due: Autonomous Hovercraft Report Due: Lecture Course Evaluations
16	4/25 Wed	Final Exam 10:30 (Sharp) -12:30	Likely 1008 FXB	

Sample Labs (Fall 2011 – Ae 495 Prototype)

Laboratory 1

Introduction to Solid Modeling and Computer Aided Manufacturing

Aero 495

© *D.A. Ellis, P.D. Washabaugh and A.S. Washabaugh*

July 22, 2011

Version 0.3

Purpose:	This is an introduction to aspects of solid modeling. This will involve becoming familiar with a commercially available modeler. The model constructed during this exercise will be used to generate a tool path so it can be fabricated using a numerically controlled router.
Concepts:	Three-dimensional modeling of solids: Surface, extrusion, joining, solid and tool path generation; G-code.
Summary:	You will first learn how to sketch in a plane. This sketch is then used to create a three-dimensional model. The model is then subtracted from a blank model (simulating a mold), and the code to manufacture the shape is both generated and simulated.
Instrumentation:	Computer workstation with CAD and CAM software, CNC Router
Due Dates:	1) Preparatory assignment due at the start of your lab section. 2) Lab Data Preparation (at the start of lecture): Tuesday, September 13th 3) ~~Lab Report: Thursday, September 21st~~

Laboratory 2

Composite Manufacturing, and Embedded Programming

Aero 495

© P.D. Washabaugh

July 29, 2011

Version 0.1

Purpose:	The purpose here is to build upon the CAD/CAM experience and fabricate a composite shell that will form the main structure of our flight-vehicle. The next goal is to investigate out primary flight computer and embedded programming.
Concepts:	Composite manufacturing, Material Selection, Embedded computing; Input and Output Circuits.
Summary:	You will first finish a female mold and then lay-up a composite shell. You will then explore a micro-controller that will form the basis of the flight computer of our craft. You will add various input and output circuits to the micro-controller and instantiate programs that employ these circuits.
Instrumentation:	Multi-meter, Oscilloscope.
Due Dates:	~~1) Preparatory assignment due at the start of your lab section.~~ 2) Lab Data Preparation (at the start of lecture): Tuesday, September 19th 3) ~~Lab Report: Thursday, September 28st~~

Laboratory 3

Introduction to Simulation – Fluid Mechanics

Aero 495

© P.D. Washabaugh

September 6, 2011

Version 0.1

Purpose:	This is an introduction to aspects of fluid simulation and testing. This will involve becoming familiar with a commercially available simulation tool. This tool will be used to understand the internal flows of the hovercraft and to approximate its overall lift performance as a function of inlet velocity. One of the tutorial craft will then be tested. The testing will require the fabrication of struts to place the motor and propeller in the center of the inlet. This will provide the lift characteristics as a function of both input energy and flight altitude.
Concepts:	Fluid simulation; Conservation of mass, momentum and energy; Bernoulli Equation.
Summary:	You will first modify a hovercraft model to simulate the fluid flow inside the craft. The lift performance of the craft will be studied as a function of input energy. The simulation can then be verified by building a physical model and measuring its performance. Building the model will necessitate cutting struts on a laser-cutter. Test the model will require the use of a power supply and pressure sensors.
Instrumentation:	Computer workstation with CFD software, Laser cutter, Power supply, Manometers.
Due Dates:	1) Preparatory assignment due at the start of your lab section. 2) Lab Data Preparation (at the start of lecture): Tuesday, September 27th 3) ~~Lab Report: Thursday, September 21st~~

Laboratory 4

Radio Controlled Components and Mechanisms

Aero 495

© P.D. Washabaugh

September 27, 2011

Version 0.0

Purpose:	This is an introduction to the use of radio-controlled components. These include transmitters and receivers. These can be used to directly control a servo, but to control a motor we will need to process the signal from the receiver with our microcontroller. We will also have the need to transfer mechanical motion. This will be accomplished by investigating bearings and gears.
Concepts:	Radio transmitters and receivers; Mechanisms and leverage.
Summary:	You will first familiarize yourself with a radio transmitter and receiver by actuating a servo. Next you will use a microcontroller to read a signal from the receiver and use it to actuate the servo from the microcontroller. This coupling between the receiver and the microcontroller will be repeated to drive our motor. This will require modifying the receiver signal to make it suitable to drive the motor control circuitry. Finally you will build a mechanism that combines the servo and the motor. This mechanism will specify the motion of the motor. This lab will complete everything necessary to fabricate your own Radio controlled hovercraft.
Instrumentation:	Transmitter, Receiver, Laser cutter
Due Dates:	1) Preparatory assignment due at the start of your lab section. 2) Lab Data Preparation (at the start of lecture): Tuesday, October 4th 3) ~~Lab Report: Thursday, October 6th~~

~~Discussion 3~~Competition 1

RC Hovercraft Competition

Aero 495 Fall 2011

© P.D. Washabaugh

September 27, 2011

Version 0.1

Purpose: Design and build a simple flight vehicle in a team environment. This activity is preparatory to building more complicated flight vehicles.

Concepts: Team behavior, optimal design, maximum lift and minimum weight and drag.

Summary: You will be divided up into teams of 4 to 6 students and asked to compete in a RC Hovercraft competition. The purpose of the competition will be to see which team's craft can race the fastest along a course.

Instrumentation: Hovercraft fabrication material (e.g. see Labs 1 through 4).

Laboratory 6

Introduction to Simulation – Solid Mechanics

Aero 495

© P.D. Washabaugh

September 20, 2011 – Edited

Version 0.1

Purpose:	This is an introduction to aspects of solid simulation and testing. This will involve becoming familiar with another commercially available simulation tool. The simulations covered here include the prediction of stress, strain, and displacement fields. You will use this simulation to study a simple bracket. We will test this bracket and examine its behavior using experimental techniques
Concepts:	Solid mechanics - static simulation; stress, strain and displacement fields. Shadowgraphy, polarization, and photoelasticity.
Summary:	You will first use your solid modeling skills to create a model of a bracket. The deformation of this bracket, while hanging a weight, will be simulated. The modeled geometry and predicted deformation will be compared to the actual shape and deformation using a shadowgraph machine. The strain field will be visualizd using the technique of photoelasticity.
Instrumentation:	Computer workstation with FEM software. Shadowgraph and photoelasticity.
Due Dates:	1) Preparatory assignment due at the start of your lab section. 2) Lab Data Preparation (at the start of lecture): Tuesday, October 11th 3) ~~Lab Report: Thursday, October 13th~~

Laboratory 8

Introduction to Design

Aero 495

© P.D. Washabaugh

October 25, 2011

Version 0.2

Purpose:	The purpose of this assignment is to have you have you strengthen your solid modeling and simulation skills by performing a design task. In an earlier assignment, you learned how to create solid models. Later you learned how to simulate or analyze these model under various boundary conditions. Here you will design, build and test a component
Concepts:	Three-dimensional modeling and simulation of solids: Loads, stresses, strains and displacements. Laser cutting and shadowgraph metrology.
Summary:	You will exercise your design capabilities by improving a specific part. This part will be cut using a laser cutter. This part will be measured using a shadowgraph machine. You will then simulate the response of this part to a load. You will visualize both by the computer simulation and an experiment, it's deformation by means of a height gage and photoelasticity.
Instrumentation:	Computer workstation with CAD and CAM software, CNC Laser Cutter
Due Dates:	1) ~~Preparatory assignment due at the start of your lab section.~~ 2) Lab Data Preparation (at the start of lecture): Tuesday, November 1st 3) ~~Lab Report: Th, November 3rd~~

Laboratory 9

Embedded Sensor and Control

Aero 495

© P.D. Washabaugh

November 1, 2011

Version 0.2

Purpose:	This is an introduction to simple sensors and simple hovercraft. We will examine an acoustic position sensor and an accelerometer.
Concepts:	Position, acceleration sensing, and feedback control
Summary:	There are two tasks associated with this lab. They include performing rough calibrations of a position sensor and an accelerometer. These sensors will then be used to make a feedback controller to maintain a position.
Instrumentation:	Computer workstation with a micro-controller, acoustic position sensor, accelerometer, and air bearing.
Due Dates:	1) ~~Preparatory assignment due at the start of your lab section.~~ ~~2) Lab Data Preparation (at the start of lecture): Tue, Novemeber 15th~~

Change output to Pin D5 for PWM enable!

~~Discussion 3~~Competition 2

Autonomous Hovercraft Competition

Aero 495 Fall 2011

© P.D. Washabaugh

November 1 , 2011

Version 0.1

Purpose:	Design and build an autonomous flight vehicle in a team environment. This activity is to building more complicated flight vehicles. The vehicle has more stringent performance requirements.
Concepts:	Team behavior, optimal design, maximum lift and minimum weight and drag. Autonomy
Summary:	You will be divided up into teams of 4 to 6 students and asked to compete in a autonomous hovercraft competition. The purpose of the competition will be to see which team's craft can race the fastest along a course. There will be two types of competitions: One is a radio-controlled competition, and the other is an autonomous competition where the craft needs to traverse the course without user input. In addition there will be obstacles: These will include one or more height barrier and artificially induced cross-winds.
Instrumentation:	All available in the lab.

University of Michigan
Office of the Registrar - Evaluations
ro.umich.edu/evals/

Winter 2012 Final
6 students responded out of the total enrolled 16

Instructor Report

2012-04-06 - 2012-04-18 Report ID: MSR04732

Instructor: Washabaugh,Peter D
AEROSP 495 001

		Responses from your Students**							Other Users of This Item* University Wide			School/College		
		5 SA	4 A	3 N	2 D	1 SD	NA	Your Median	75% Above	50% Above	25% Above	75% Above	50% Above	25% Above
1	Overall, this was an excellent course.	5	1	0	0	0	0	4.90	3.92	4.27	4.70	3.86	4.10	4.50
2	Overall, the instructor was an excellent teacher.	5	1	0	0	0	0	4.90	4.13	4.60	4.85	4.01	4.45	4.71
3	I learned a great deal from this course.	4	2	0	0	0	0	4.75	4.00	4.33	4.70	4.00	4.19	4.57
4	I had a strong desire to take this course.	4	2	0	0	0	0	4.75	3.63	4.13	4.60	3.67	4.00	4.39
15	I increased my ability to apply math and science knowledge to engineering problems.	4	2	0	0	0	0	4.75	4.00	4.23	4.50			
23	I increased my ability to formulate, and solve engineering problems.	5	1	0	0	0	0	4.90	4.00	4.18	4.50			
32	This course increased my desire to learn more about this subject in the future.	5	1	0	0	0	0	4.90	3.88	4.13	4.56			
35	I increased my ability to apply engineering tools and methods.	4	2	0	0	0	0	4.75	4.03	4.20	4.50			
125	I developed the ability to solve real problems in this field.	5	0	1	0	0	0	4.90	3.75	4.17	4.50			
140	I deepened my interest in the subject matter of this course.	5	1	0	0	0	0	4.90	3.83	4.20	4.63			
201	The instructor gave clear explanations.	6	0	0	0	0	0	5.00	4.08	4.50	4.78			
202	The instructor made good use of examples and illustrations.	5	1	0	0	0	0	4.90	4.00	4.50	4.80			
216	The instructor acknowledged all questions insofar as possible.	6	0	0	0	0	0	5.00	4.23	4.59	4.83			
229	The instructor used class time well.	4	2	0	0	0	0	4.75	4.10	4.50	4.75			
230	The instructor seemed well prepared for each class.	3	3	0	0	0	0	4.50	4.30	4.67	4.86			
232	Work requirements and grading system were clear from the beginning.	4	2	0	0	0	0	4.75	4.00	4.33	4.67			
239	The amount of work required was appropriate for the credit received.	2	3	1	0	0	0	4.17	3.94	4.20	4.50			
370	I attended class regularly.	6	0	0	0	0	0	5.00	4.62	4.80	4.90			

* The quartiles are calculated from Winter 2012 data. The university-wide quartiles are based on all UM classes in which an item was used. The school/college quartiles in this report are based on upper division classes with an enrollment of 16 to 74 students in College of Engineering.
** SA - Strongly Agree, A - Agree, N - Neutral, D - Disagree, SD - Strongly Disagree, NA - Not Applicable.

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Form Number 2376

Date 1/11/2013

Effective Term Fall 2013

Course Offer Freq ☒ Indefinitely ☐ One term only

Action Requested
- ○ New Course
- ◉ Modification of Existing Course
- ○ Deletion of Course

Complete the following sections:
New Courses - B & C completely
Modifications - A modified information, B & C completely
Deletions - A & C completely

	A. **CURRENT LISTING**	B. **REQUESTED LISTING**
Home Department / Course Number		AEROSP Aerospace Engineering 305
☐ Cross Listed Course Information		
☐ Course Title		Aerospace Engineering Laboratory I
TITLE ABBREVIATION – Time Sched (Max = 19 Spaces)		Aero Eng Lab I
TITLE ABBREVIATION – Transcript (Max = 20 Spaces)		Aero Lab I
☐ Course Description / Course Description for Official Publication (Max = 50 words)		First course of a two-semester sequence covering fundamentals of instrumentation and measurement and their application in engineering testing and experimentation. Includes principles of analog and digital data acquisition, analysis of discrete measurement data, statistical assessment of hypotheses, design of experiments, and similarity scaling of data. Emphasized development of skills for written communication and for working effectively in a team environment.
PROGRAM OUTCOMES:	☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k	☒ a ☒ b ☐ c ☒ d ☒ e ☒ f ☐ g ☐ h ☐ i ☐ j ☐ k
Degree Requirements	○ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective	◉ Degree Requirement ○ Free Elective ○ Other ○ Core Course ○ Tech Elective
X Prereq	preceded or accompanied by EECS 206 or 215 or 314. Preceded by Aero 225 and Aero 215. ○ Enforced ◉ Advised	preceded or accompanied by EECS 215 or 314. Preceded by Aero 205, Aero 225 and Aero 215 ○ Enforced ◉ Advised
☐ Credit Restrictions		
☐ Level of Credit	☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work	☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work
Credit Hours Min / Max	___ / ___	4 / 4
Contact Hrs/Wk	___	6
Number of Wks	___	term

C. Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeatable? ○ Yes ◉ No Max Hours? ___ Max Times? ___ Can it be repeated in the same term? ○ Yes ○ No

X **Class Type(s)**: ☒ Lec ☐ Sem ☐ Dis ☐ Other __ ☐ Rec ☒ Lab ☐ Ind

Graded Section: ☒ Lec ☐ Sem ☐ Dis ☐ Other __ ☐ Rec ☐ Lab ☐ Ind

Grading: ☒ A-E ☐ CR/NC ☐ P/F ☐ S/U

Course Is Y Graded ☐

Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Cognizant Faculty Member:	Title
Timothy Smith	Lecturer IV & Asst Rsch Scientist

Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval Info	**Approved by Name**	**Approved Date**
☒ Curriculum Comm.	Fred Terry	
☐ Faculty		
☐ Cross listed Unit 1		
☐ Cross listed Unit 2		

Submitted By: ☐ Home Dept. ☐ Cross-listed Dept.

	Department Chair Name	**Chair Signature**
Home Dept.	Daniel Inman - Aerospace	
Cross-listed Dept(s).		

Form Number

2376

SUPPORTING STATEMENT

This form updates the AEROSP 305 course approval form. Changes include: to require the new AEROSP 205 as an advised prerequisite, and cognizant faculty member has been updated.

Are any special resources or facilities required for this course? ☒ Yes ☐ No

Detail the Special requirements

Aerospace laboratory and instrumentation equipment