

**The University of Michigan
College of Engineering
Curriculum Committee**

Agenda

January 24, 2012

1:30-3:00 p.m.

Room 265 Chrysler Center

1. Approval of Minutes From 01-10-2012
2. Course Approval Forms

**University of Michigan
College of Engineering
Curriculum Committee Meeting
Tuesday January 10, 2012
1:30-3:00 p.m.
Room 265 Chrysler Center
Minutes**

Fred Terry called the meeting to order at 1:40 p.m.

Members Present: F. Terry, M. Bernitsas, Y. Bozer, E. Durfee, J. Holloway, D. Kieras, E. Larsen, L. Meadows, S. Montgomery, J. Pan, R. Robertson, S. Vozar, F Ward

Members Absent: L. Bernal, A. Gallimore, M. Moldwin, T. Olson

The minutes of the last meeting (November 22, 2012) were approved with the addition of Lorelle Meadows to the attendance list of that meeting

Course Approval Forms

This Course Was Approved:

NAME 580(X-Listed with MFG) Modification—Changed Title from: Optimization, Market Forecasts and Management of Marine Systems *to: **Optimization and Management of Marine Systems***; Changed Description; Removed Pre-req; Changed Contact hours from: 4 *to: 3*; Added “Tech Elective” under **Degree Requirements**

These Courses Were Tabled:

AOSS 474 (X-Listed with EARTH 474 New Course (the AOSS representative was unable to attend this meeting.

SI 650 Modification—Asking for Cross Listing with EECS 549 (waiting for more clarification from SI

The topics below were added at the meeting:

Approval of an Entrepreneurship Subject Code—James Holloway

Information regarding this was handed out at the meeting.

Objective:

Entrepreneurship is an interdisciplinary field that incorporates elements of engineering, design science, business, marketing, human resource management, psychology, organizational studies, and economics. The field aims to equip students with the methodologies and skill sets that will enable them to transform an idea into a successful startup venture. In addition to launching their own company, students who study entrepreneurship may go on to pursue a master of

entrepreneurship degree, or to contribute to an established innovative organization (intrapreneurship) work for governmental or university technology transfer operations, or pursue a career in a venture capital or patent law firm. Moreover, entrepreneurship is a mindset that promotes leadership, creativity, teamwork, risk management, self-awareness, and goal setting and achievement.

This proposal is for a subject code in Entrepreneurship (eship). Such a code will allow for the appropriate designation of courses related to entrepreneurship, and for students to receive recognition on their official academic transcript for coursework completed in this field.

There was some discussion regarding this, the name “eship” was questioned.

There was a call for a vote—Moved and Seconded. Approved.

Questions Prompted by Recent CS Changes Regarding Math—James Holloway

Information regarding this was handed out at the meeting.

James Holloway introduced this as a discussion item. This topic was prompted by recent Computer Science changes regarding the Math requirement. Fred Terry noted that there are two related things to think about –one is the Intellectual-Philosophical issue of what our students should have, but more specific to this Committee is the legalistic point, that the Computer Science Proposal wasn’t approached in an aggressive fashion, in hindsight, maybe CS should have been asked to do exactly what IOE did, as a precedent issue. There might be a question with a next Proposal as to how that should be approached. There was some discussion regarding this among other points.

Adjournment: Motion to adjourn was made and seconded

Motion carried (approved)

Next Meeting: January 24, 2012 Room 265 Chrysler Center

COURSE APPROVAL FORMS

AERO 588 New Course

AOSS 474 (X-Listed with EARTH 474) New Course

ENGR 190 Modification—Changing Description; Changing Level of Credit from:
Min 1 Max 4 *to: Min 1 max 6*

ENGR 290 New Course

ENGR 390 Modification—

ENGR 490 Modification—Changing Description

SI 650 Modification—Asking for Cross Listing with EECS 549

THE UNIVERSITY OF MICHIGAN -- COLLEGE OF ENGINEERING
Course Approval Request

College Curriculum Committee, 1420 Lurie Engineering Center Building

Form Number

2289

Date **1/13/2012**

Effective Term **Fall 2012**

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	
<input type="checkbox"/> Cross Listed Course Information			
Course Title		Course Title	
		Multidisciplinary Design Optimization	
TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces Transcript Max = 20 Spaces	TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces Transcript Max = 20 Spaces
			Multidis Design Opt
Course Description		Course Description for Official Publication (Max = 50 words)	
		Introduction to numerical optimization and its application to the design of aerospace systems, including: mathematical formulation of multidisciplinary design problems, overview of gradient-based and gradient-free algorithms, optimality conditions (unconstrained and constrained, Pareto optimality), sensitivity analysis, and multidisciplinary problem decomposition. No background in aerospace is required.	
PROGRAM OUTCOMES: <input type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input type="checkbox"/> g <input type="checkbox"/> i <input type="checkbox"/> k <input type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j		PROGRAM OUTCOMES: <input checked="" type="checkbox"/> a <input checked="" type="checkbox"/> c <input checked="" type="checkbox"/> e <input checked="" type="checkbox"/> g <input type="checkbox"/> i <input checked="" type="checkbox"/> k <input checked="" type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j	
Degree Requirements <input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective		Degree Requirements <input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input checked="" type="radio"/> Tech Elective	
Prereq		Prereq	
<input type="checkbox"/> Enforced <input type="checkbox"/> Advised		-Math 419 or equivalent <input type="checkbox"/> Enforced -Math 371 or equivalent <input checked="" type="checkbox"/> Advised -Graduate standing	
Credit Restrictions		Credit Restrictions	
Level of Credit <input type="checkbox"/> Undergrad only <input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> Rackham Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Rckhm Grad w/add'l Work <input type="checkbox"/> Ugrad or Rckhm Grad		Level of Credit <input type="checkbox"/> Undergrad only <input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> Rackham Grad <input checked="" type="checkbox"/> All Credit types <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Rckhm Grad w/add'l Work <input type="checkbox"/> Ugrad or Rckhm Grad	
Credit Hours		Credit Hours	
Min Max		Min Max	
Contact Hrs/Wk		Contact Hrs/Wk	
Number of Wks		Number of Wks	
Repeatability (Indi Research, Dir. Study, Dissertation): Is this course repeatable? <input type="radio"/> Yes <input checked="" type="radio"/> No			
Max Hours? Max Times? Can it be repeated in the same term? <input type="radio"/> Yes <input checked="" type="radio"/> No			
Class Type(s) <input checked="" type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other <input type="checkbox"/> Rec <input type="checkbox"/> Lab <input type="checkbox"/> Ind		Grading <input checked="" type="checkbox"/> A-E <input type="checkbox"/> CR/NC <input type="checkbox"/> P/F <input type="checkbox"/> S/U	
Location <input checked="" type="checkbox"/> Ann Arbor <input type="checkbox"/> Biological Station <input type="checkbox"/> Camp Davis <input type="checkbox"/> Extension		Cognizant Faculty Member: Joaquim R.R.A. Martins	
Graded Section <input type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other <input type="checkbox"/> Rec <input type="checkbox"/> Lab <input type="checkbox"/> Ind		Title Associate Professor	
Course Is Y Graded <input type="checkbox"/>		Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty	
Approval Info <input type="checkbox"/> Curriculum Comm.		Submitted By: <input type="checkbox"/> Home Dept. <input type="checkbox"/> Cross-listed Dept.	
Approved by Name		Department Chair Name	
Approved Date		Chair Signature	
<input type="checkbox"/> Faculty		Home Dept. Aerospace Engineering	
<input type="checkbox"/> Cross listed Unit 1		Cross-listed	
<input type="checkbox"/> Cross listed Unit 2		Dept(s)	

SUPPORTING STATEMENT

This course provides an introduction to multidisciplinary design optimization, assuming no previous knowledge of numerical optimization. The course begins with an introduction motivating MDO in the design of engineered systems and various real world examples. Then, the gradient methods are discussed in detail for both unconstrained and constrained problems. One chapter is dedicated to sensitivity analysis, which is directly applicable to computing the gradients needed in gradient-based optimization. Gradient-free methods are also covered, and the choice between these and gradient-based methods is discussed thoroughly. Finally, MDO methods for problem decomposition are taught. A detailed outline of this course is attached.

The coursework for this course consists in seven assignments, one for each of the main chapters in the course. The assignments require the programming of a subset of optimization algorithms for the solution of an aircraft design problem. The final exam consists of a 30 min oral examination.

This course is now being offered by the third year in a row at the University of Michigan. The enrolment was 30 students in 2010, 13 in 2011 and is currently 22 students. The course evaluations for questions 1 and 2 were 4.36/4.38 (2010) and 4.58/4.58 (2011).

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

Detail the Special requirements

Compiled on Thursday 12th January, 2012 at 13:29

Contents

1	Introduction	8
1.1	What is “MDO”?	8
1.2	Terminology and Problem Statement	9
1.2.1	Objective Function	10
1.2.2	Design Variables	11
1.2.3	Constraints	11
1.2.4	Optimization Problem Statement	11
1.2.5	Classification of Optimization Problems	12
1.3	Timeline of Historical Developments in Optimization	12
1.4	Practical Applications	15
1.4.1	Airfoil Design	15
1.4.2	Structural Topology Optimization	16
1.4.3	Composite Curing Cycle Optimization	19
1.4.4	Aircraft Design with Minimum Environmental Impact	19
1.4.5	Aerodynamic Design of a Natural Laminar Flow Supersonic Business Jet	23
1.4.6	Aerostructural Design of a Supersonic Business Jet	27
1.4.7	Aerostructural Shape Optimization of Wind Turbine Blades Considering Site-Specific Winds	28
1.4.8	MDO of an Airplane for the SAE Micro-Class Aero Design Competition	32
2	Single Variable Minimization	38
2.1	Motivation	38
2.2	Optimality Conditions	38
2.3	Function Minimization as Root Finding	39
2.3.1	Numerical Precision	39
2.3.2	Convergence Rate	40
2.3.3	Method of Bisection	41
2.3.4	Newton’s Method	41
2.3.5	Secant Method	43
2.3.6	Golden Section Search	43
2.3.7	Polynomial Interpolation	45
2.4	Line Search Techniques	48
2.4.1	Wolfe Conditions	48
2.4.2	Sufficient Decrease and Backtracking	49
2.4.3	Line Search Algorithm Using the Strong Wolfe Conditions	50
3	Sensitivity Analysis	55
3.1	Introduction	55
3.2	Motivation	55
3.2.1	Methods for Sensitivity Analysis	55
3.3	Finite Differences	56
3.4	The Complex-Step Derivative Approximation	58
3.4.1	Background	58
3.4.2	Basic Theory	58
3.4.3	New Functions and Operators	59

3.4.4	Can the Complex-Step Method be Improved?	60
3.4.5	Implementation Procedure	61
3.4.6	Fortran Implementation	61
3.4.7	C/C++ Implementations	61
3.5	Automatic Differentiation	65
3.5.1	How it Works	65
3.5.2	Tools for Algorithmic Differentiation	75
	Fortran	75
	C/C++:	76
3.5.3	The Connection to Algorithmic Differentiation	76
3.5.4	Algorithmic Differentiation vs. Complex Step	77
3.6	Analytic Sensitivity Analysis	77
3.6.1	Notation	77
3.6.2	Basic Equations	77
3.6.3	Direct Sensitivity Equations	79
3.6.4	Adjoint Sensitivity Equations	79
3.6.5	Direct vs. Adjoint	79
3.6.6	Example: Structural Sensitivity Analysis	81
4	Gradient-Based Optimization	92
4.1	Optimality Conditions	92
4.2	General Algorithm for Smooth Functions	95
4.3	Steepest Descent Method	96
4.4	Conjugate Gradient Method	99
4.5	Newton's Method	101
4.6	Quasi-Newton Methods	103
4.6.1	Davidon–Fletcher–Powell (DFP) Method	103
4.6.2	Broyden–Fletcher–Goldfarb–Shanno (BFGS) Method	106
4.6.3	Symmetric Rank-1 Update Method (SR1)	112
4.7	Trust Region Methods	112
5	Constrained Optimization	114
5.1	Optimality Conditions for Constrained Problems	114
5.1.1	Nonlinear Equality Constraints	114
5.1.2	Nonlinear Inequality Constraints	118
5.1.3	Constraint Qualification	123
5.2	Penalty Function Methods	124
5.2.1	Exterior Penalty Functions	124
	The Quadratic Penalty Method	125
5.2.2	Interior Penalty Methods	126
	The Logarithmic Barrier Method	126
	The Inverse Barrier Function	126
5.3	Sequential Quadratic Programming (SQP)	126
5.3.1	Quasi-Newton Approximations	128

6	Gradient-Free Optimization	132
6.1	Introduction	132
6.2	Nelder–Mead Simplex	134
6.3	DIVided RECTangles (DIRECT) Method	138
6.4	Genetic Algorithms	142
6.4.1	Coding and Decoding of Variables	146
6.4.2	Selection: Determining the Mating Pool	147
6.4.3	Mutation	148
6.4.4	Why do genetic algorithms work?	149
6.5	Particle Swarm Optimization	150
6.6	Some Examples	158
7	MDO Architectures	160
7.1	Problem Definition	174
7.2	Monolithic Architectures	175
7.2.1	Simultaneous Analysis and Design (SAND)	176
7.2.2	Individual Discipline Feasible (IDF)	178
7.2.3	Multidisciplinary Feasible (MDF)	180
7.2.4	Coupled-Sensitivity Analysis	183
7.3	Distributed Architectures	187
7.3.1	Concurrent Subspace Optimization (CSSO)	188
7.3.2	Bilevel Integrated System Synthesis (BLISS)	189
7.3.3	Collaborative Optimization (CO)	190
7.3.4	Analytical Target Cascading (ATC)	194
7.4	Architecture Classification and Benchmarking	195
A	Assignments	206
A.1	Journal Paper Review	206
A.2	Line Search	206
A.3	Sensitivity Analysis	208
A.4	Unconstrained Optimization	210
A.5	Constrained Optimization	211
A.6	Gradient-Free Optimization	212
A.7	Multidisciplinary Design Optimization	213
B	Report Guidelines	217
B.1	Overview	217
B.2	Submission Instructions	217
B.3	Figures and Tables	217
B.4	Equations:	218
B.5	Writing Style	219
B.6	L ^A T _E X Tips	219
B.6.1	Quick Tips	219
B.6.2	Squeezing White Space in L ^A T _E X	220

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

Date **10/26/2011**

Effective Term **Winter 2012**

Course Offer Freq ☒ Indefinitely
☐ One term only

A. CURRENT LISTING

B. REQUESTED LISTING

Home Department		Course Number		Home Department		Course Number	
				AOSS Atmos, Oceanic & Space Sci		474	
Cross Listed Course Information				Cross Listed Course Information			
				Earth and Environmental Sciences EARTH 474			
Course Title				Course Title			
				Ice Sheets, Glaciers and Climate Change			
TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces			TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces	Ice and Climate	
	Transcript Max = 20 Spaces				Transcript Max = 20 Spaces	Ice and Climate	
Course Description				Course Description for Official Publication (Max = 50 words)			
				The dynamics and mass balance of ice sheets and glaciers introduced along with mathematical theories describing how ice sheets and glaciers flow and current methods of observation. The course integrates lectures, assignments and discussion of journal articles.			
PROGRAM OUTCOMES:				PROGRAM OUTCOMES:			
<input type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input type="checkbox"/> g <input type="checkbox"/> i <input type="checkbox"/> k <input type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j				<input checked="" type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input checked="" type="checkbox"/> g <input checked="" type="checkbox"/> i <input checked="" type="checkbox"/> k <input checked="" type="checkbox"/> b <input checked="" type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j			
Degree Requirements				Degree Requirements			
<input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective				<input type="radio"/> Degree Requirement <input checked="" type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective			
Prereq				Prereq Math 115 and 116			
<input type="radio"/> Enforced <input type="radio"/> Advised				<input type="radio"/> Enforced <input checked="" type="radio"/> Advised			
Credit Restrictions				Credit Restrictions			
Level of Credit				Level of Credit			
<input type="checkbox"/> Undergrad only <input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> Rackham Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Rckhm Grad w/add'l Work <input type="checkbox"/> Ugrad or Rckhm Grad				<input type="checkbox"/> Undergrad only <input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> Rackham Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Rckhm Grad w/add'l Work <input type="checkbox"/> Ugrad or Rckhm Grad			
Credit Hours		Contact Hrs/Wk		Credit Hours		Contact Hrs/Wk	
Min	Max			Min	Max		
				3	3		13
		Number of Wks				Number of Wks	
						13	

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)		Grading		Location		Cognizant Faculty Member:		Title	
<input checked="" type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other	<input type="checkbox"/> Rec <input type="checkbox"/> Lab <input type="checkbox"/> Ind	<input checked="" type="checkbox"/> A-E <input type="checkbox"/> CR/NC <input type="checkbox"/> P/F <input type="checkbox"/> S/U	<input type="checkbox"/> CR/NC <input type="checkbox"/> P/F <input type="checkbox"/> S/U	<input checked="" type="checkbox"/> Ann Arbor <input type="checkbox"/> Biological Station <input type="checkbox"/> Camp Davis <input type="checkbox"/> Extension	<input type="checkbox"/> Ann Arbor <input type="checkbox"/> Biological Station <input type="checkbox"/> Camp Davis <input type="checkbox"/> Extension	Jeremy N. Bassis		Assistant Professor	
Graded Section						Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty			
<input checked="" type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other	<input type="checkbox"/> Rec <input type="checkbox"/> Lab <input type="checkbox"/> Ind								
		Course Is Y Graded <input type="checkbox"/>							
Approval Info		Approved by Name		Approved Date		Submitted By: <input checked="" type="checkbox"/> Home Dept. <input type="checkbox"/> Cross-listed Dept.			
<input type="checkbox"/> Curriculum Comm.									
<input type="checkbox"/> Faculty						Department Chair Name		Chair Signature	
<input type="checkbox"/> Cross listed Unit 1						Home Dept. Atmos, Oceanic & Space Sci			
<input type="checkbox"/> Cross listed Unit 2						Cross-listed Earth & Environmental Sci			
						Dept(s)			

SUPPORTING STATEMENT

The department of Atmospheric, Oceanic and Space Sciences offers students the opportunity to specialize in climate science as part of our Earth System Science and Engineering undergraduate degree that is offered jointly with the department of Earth and Environmental Sciences. This class is offered as a technical elective that undergraduate students enrolled in this program can take to broaden their background in climate science beyond atmospheric science to include the cryosphere and the impact the changing glaciers and ice sheets have on the climate and water resources. The course serves a similar purpose in our graduate curriculum as one of the few climate courses our department offers that exposes graduate students to an important part of climate science outside of atmospheric science. We anticipate attracting PhD graduate students from Atmospheric, Oceanic and Space Sciences (AOSS), Earth and Environmental Sciences (EES) and the School of Natural Resources and the Environment (SNRE) well as Masters of Engineering students from our Applied Climate program and undergraduates from AOSS and EES.

This course was well received as indicated by Q1 & Q2: Winter 2010 Q1= 4.67, Q2= 5; Winter 2011 Q1= 4.08, Q2= 4.2

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

Detail the Special requirements

AOSS 605: Ice sheets, glaciers and climate Syllabus, Winter 2011

Instructor: Dr. Jeremy Bassis
Office location: 2529 SRB
Office hours: TBD
Class Times: MWF 8:30-9:30AM

Primary textbook:

Principles of Glacier Mechanics, Hooke, 2nd Ed., 2005

Additional resources:

The Physics of Glaciers, Cuffey and Paterson, 4th Ed., 2010
Fundamentals of Glacier Dynamics (C.J. van der Veen, 1999)
Ice Sheets and Climate (Oerlemans and van der Veen, 1984)

Course Overview: Ice sheets and glaciers form an active component of the climate and hydrological systems that not only respond to climate, but also help shape the Earth's climate system. In this class students will be introduced to techniques used to observe and understand the dynamics and mass balance of ice sheets and glaciers. Course content includes an introduction to continuum mechanics, the equations of glacier and ice sheet deformation, boundary conditions, ice sheet and glacier mass and energy balance (both theory and observations). In addition, we shall discuss both current topics of interest to the glaciological and climate community and how these topics are relevant to efforts to better predict future sea level rise.

Prerequisites: Familiarity with linear algebra and partial differential equations. Homework assignments will involve pencil and paper exercises and some programming/data analysis with MATLAB or alternative language of preference.

Grading Rubric:	Problem sets:	40%
	Mid-term exam:	20%
	Oral presentation:	10%
	Final student report:	20%
	Participation/in class projects:	10%

Homework Assignments: We will have approximately 10 homework assignments during the semester. No late homework will be accepted without prior consent. If you are unable to turn in an assignment on time contact me before it is due.

Oral presentation(s): Each student will choose a topic not covered in class and explain this topic to the class. Students should aim for about 15-20 minute presentations. Fellow students will evaluate the presentations.

Final Project: The final project will consist of a research proposal (less than 10 pages). The topic of the research proposal is up each student, but should involve ice sheets/glaciers or the cryosphere. The proposal will involve (i) an outline of a problem of interest containing appropriate motivation and background information; (ii) a description of a research plan specifically designed to address the problem, including relevant equations; (iii) a list of expected obstacles and difficulties. The proposal will be evaluated based on its intellectual merit using NSF criteria (see <http://www.nsf.gov/pubs/1998/nsf9891/nsf9891.pdf> for a definition and examples). NB: The research proposal is aspirational -- you don't need to do the research described in the proposal, just describe the research you propose to do.

Tentative timeline for final project:

Friday, January 28th: One paragraph proposal topic due.

Friday, February 25th: Progress report

Friday, April 1st: Rough drafts due, in class peer review

Friday, April 15th: Final paper due

Participation: Participation grades will be determined by your contributions to discussions.

Mid-term exam: A single exam is tentatively scheduled during week 10 (the exact date will depend on our final class times.)

Outline

	<u>Topic</u>	<u>Reading</u>
<u>Week 1</u>	Ice sheets, glaciers and the climate system	IPCC, Chapter 4 (p. 341-342 and p. 356-367) Hook, Chapter 1
<u>Week 2</u>	Ice sheet mass balance (theory)	Hook, Chapter 3
<u>Week 3</u>	Ice sheet mass balance (observations)	Velicogna, GRL paper Pritchard, Nature paper
<u>Week 4</u>	Ice streams and surging glaciers	<i>Paper TBD</i>
<u>Week 5</u>	Flow and fracture of a crystalline material	Hook, Chapter 4
<u>Week 6</u>	The velocity field in a glacier (the shallow ice approximation)	Hook, Chapter 5
<u>Week 7</u>	Catchup	<i>Paper TBD</i>
<u>Week 8</u>	Basal sliding (theory)	Hook, Chapter 7
<u>Week 9</u>	Basal sliding (observations)	Iverson, Science Paper Weertman Paper

<u>Week 10</u>	Subglacial hydrology (theory and observations) Exam	Hook, Chapter 8 Stearns, Nature Paper
<u>Week 11</u>	Temperature in ice sheets and glaciers	Hook, Chapter 6
<u>Week 12</u>	Ice shelves, tidewater glaciers and ice ocean interaction	Scambos, Antarctic Research Paper Holland, Nature Paper
<u>Week 13</u>	Wrap-up/Presentations	

COURSE PROFILE

Degree Program: Earth System Science and Engineering
Prepared by: Jeremy N. Bassis

Date: Oct 19, 2011

COURSE #: 474	COURSE TITLE: ICE SHEETS, GLACIERS AND CLIMATE
TERMS OFFERED: Winter	For each prerequisite below, "E" denotes Enforced and "A" denotes Advised.
TEXTBOOKS/REQUIRED MATERIAL: N/A	PREREQUISITES: MATH 115 & 116 (A)
INSTRUCTOR(S): Jeremy N. Bassis	COGNIZANT FACULTY: Jeremy N. Bassis
CoE BULLETIN DESCRIPTION: The dynamics and mass balance of ice sheets and glaciers introduced along with mathematical theories describing how ice sheets and glaciers flow and current methods of observation. The course integrates lectures, assignments and discussion of journal articles.	COURSE TOPICS: <ul style="list-style-type: none"> • Introduction to the role of ice sheets in climate change, sea level rise and water resources • Introduction to continuum mechanics • Theory and observations of glacier and ice sheet deformation • Ice sheet and glacier mass and energy balance (theory and observations) • Ice-ocean interaction • Projections of future sea-level rise • Impacts of melting glaciers and decreased snowpack on water resources • Topics of current topics of interest
COURSE STRUCTURE/SCHEDULE Lecture: 2 per week @ 75 minutes per lecture	

COURSE OBJECTIVES	(1) To provide understanding of the role ice sheets and glaciers play in sea level rise, past present and future climate change and fresh water budgets and; (2) to introduce students to the observational and mathematical techniques used to observe and understand the dynamics, thermodynamics and mass balance of ice sheets and glaciers.
COURSE OUTCOMES For each course outcome, links to the Program Outcomes are identified.	<p>A. Students will apply math and science skills to derive solutions for homework assignments and complete programming exercises</p> <p>B. Students will download, analyze and interpret data and compare data to the predictions of numerical models</p> <p>D. Students will collaborate on homework problems and form in-class discussion groups with Engineering students paired with LSA students</p> <p>G. Students will prepare and present in-class oral presentations and write a proposal on a topic of their choice</p> <p>I. Students will recognize the need for life long learning by reading historic and current topic papers to see how knowledge has evolved</p> <p>J. Students will read current papers introducing them to contemporary topics in glaciology and climate change</p>
ASSESSMENT TOOLS For each assessment tool, links to the course outcomes are identified.	Student evaluations will be based on homework, in-class discussions, oral presentations and performance on the final project. Homework assignments will require a combination of the application of mathematical and physical reasoning and programming in MATLAB. Some problems will require that the students compare observations with theory to determine and determine which assumptions of the theory are violated by the data. Ability to communicate orally will be assessed through in-class oral presentations. Technical writing skills will be evaluated through the final project, which consists of identifying a problem and then identifying a method of solving the problem in the format of a research proposal.

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

Date 12/20/2011

Effective Term

Course Offer Freq

- ☒ Indefinitely
☐ One term only

A. CURRENT LISTING

B. REQUESTED LISTING

Home Department		Course Number		Home Department		Course Number	
				ENGR Engineering		190	
Cross Listed Course Information				Cross Listed Course Information			
Course Title				Course Title			
				Special Topics in Engineering			
TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces			TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces	Spec Topics in Engr	
	Transcript Max = 20 Spaces				Transcript Max = 20 Spaces		
Course Description				Course Description for Official Publication (Max = 50 words)			
Place holder course for special topics, description and credit hours at the discretion of the instructor.				Special topics of current interest selected by faculty.			
PROGRAM OUTCOMES:		<input type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input type="checkbox"/> g <input type="checkbox"/> i <input type="checkbox"/> k <input type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j		PROGRAM OUTCOMES:		<input type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input type="checkbox"/> g <input type="checkbox"/> i <input type="checkbox"/> k <input type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j	
Degree Requirements		<input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective		Degree Requirements		<input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective	
Prereq				Prereq			
<input type="radio"/> Enforced <input type="radio"/> Advised				<input type="radio"/> Enforced <input type="radio"/> Advised			
Credit Restrictions				Credit Restrictions			
Level of Credit		Credit Hours	Contact Hrs/Wk	Level of Credit		Credit Hours	Contact Hrs/Wk
<input type="checkbox"/> Undergrad only <input type="checkbox"/> Rackham Grad <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Ugrad or Rckhm Grad	<input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Rckhm Grad w/add'l Work	Min Max 1 4	Number of Wks 14	<input type="checkbox"/> Undergrad only <input type="checkbox"/> Rackham Grad <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Ugrad or Rckhm Grad	<input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Rckhm Grad w/add'l Work	Min Max 1 6	Number of Wks varie

Repeatability (Indi Research, Dir. Study, Dissertation): Is this course repeatable? ☒ Yes ☐ No Max Hours? 15 Max Times? 5 Can it be repeated in the same term? ☒ Yes ☐ No

Class Type(s)		Grading		Location		Cognizant Faculty Member:		Title	
<input checked="" type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other	<input type="checkbox"/> Rec <input type="checkbox"/> Lab <input type="checkbox"/> Ind	<input checked="" type="checkbox"/> A-E <input type="checkbox"/> CR/NC <input type="checkbox"/> P/F <input type="checkbox"/> S/U	<input type="checkbox"/> Ann Arbor <input type="checkbox"/> Biological Station <input type="checkbox"/> Camp Davis <input type="checkbox"/> Extension						
Graded Section		Course Is Y Graded <input type="checkbox"/>		Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty					
Approval Info		Approved by Name		Approved Date		Submitted By: <input checked="" type="checkbox"/> Home Dept. <input type="checkbox"/> Cross-listed Dept.		Department Chair Name	
<input type="checkbox"/> Curriculum Comm.								Chair Signature	
<input type="checkbox"/> Faculty						Home Dept. Engineering			
<input type="checkbox"/> Cross listed Unit 1						Cross-listed Dept(s).			
<input type="checkbox"/> Cross listed Unit 2									

SUPPORTING STATEMENT

We are making these changes to create a consistent set of experimental course numbers in the ENGR division

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

Detail the Special requirements

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

Date 11/2/2011

Effective Term Winter 2012

Course Offer Freq

- ☒ Indefinitely
☐ One term only

A. CURRENT LISTING

B. REQUESTED LISTING

Home Department ENGR Engineering Course Number 290

Home Department ENGR Engineering Course Number 290

Cross Listed Course Information

Cross Listed Course Information

Course Title

Course Title

Special Topics in Engineering

TITLE
ABBRE-
VIATION

Time Sched
Max = 19 Spaces
Transcript
Max = 20 Spaces

TITLE
ABBRE-
VIATION

Time Sched
Max = 19 Spaces
Transcript
Max = 20 Spaces

Spec Topics in Engr

Course Description

Course Description for Official Publication (Max = 50 words)

Special topics of current interest selected by faculty.

PROGRAM
OUTCOMES:

- ☐ a ☐ c ☐ e ☐ g ☐ i ☐ k
☐ b ☐ d ☐ f ☐ h ☐ j

PROGRAM
OUTCOMES:

- ☐ a ☐ c ☐ e ☐ g ☐ i ☐ k
☐ b ☐ d ☐ f ☐ h ☐ j

Degree
Requirements

- ☐ Degree Requirement ☐ Free Elective ☐ Other
☐ Core Course ☐ Tech Elective

Degree
Requirements

- ☐ Degree Requirement ☐ Free Elective ☐ Other
☐ Core Course ☐ Tech Elective

Prereq

- ☐ Enforced
☐ Advised

Prereq

- ☐ Enforced
☐ Advised

Credit
Restrictions

Credit
Restrictions

Level of Credit

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

Credit Hours
Min Max
1 4

Contact
Hrs/Wk
Number
of Wks

Level of Credit

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

Credit Hours
Min Max
1 6

Contact
Hrs/Wk
Number
of Wks
varie

Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeatable?

- ☒ Yes
☐ No

Max
Hours?

15

Max
Times?

5

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

Cognizant Faculty Member:

Title

Graded Section

- ☒ Lec ☐ Sem ☐ Dis ☐ Other
☐ Rec ☐ Lab ☐ Ind

Course Is Y Graded ☐

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

Approval Info

☐ Curriculum Comm.

Approved by Name

Approved Date

Submitted By:

☒ Home Dept. ☐ Cross-listed Dept.

☐ Faculty

☐ Cross listed Unit 1

☐ Cross listed Unit 2

Department Chair Name

Chair Signature

Home Dept.

Cross-listed

Dept(s).

J. Meadows

SUPPORTING STATEMENT

We are making these changes to create a consistent set of experimental course numbers in the ENGR division.

Are any special resources or facilities required for this course?

☐ Yes ☐ No

Detail the Special requirements

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

Date 11/2/2011

Effective Term Winter 2012

Course Offer Freq

- ☒ Indefinitely
☐ One term only

A. CURRENT LISTING

B. REQUESTED LISTING

Home Department ENGR Engineering Course Number 390

Home Department ENGR Engineering Course Number 390

Cross Listed Course Information

Cross Listed Course Information

Course Title
Special Topics

Course Title
Special Topics in Engineering

TITLE ABBREVIATION Time Sched Max = 19 Spaces Spec Topics in Engr
Transcript Max = 20 Spaces

TITLE ABBREVIATION Time Sched Max = 19 Spaces Spec Topics in Engr
Transcript Max = 20 Spaces

Course Description
Spec Topics in Engr

Course Description for Official Publication (Max = 50 words)
Special topics of current interest selected by faculty.

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

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

Degree Requirements ☐ Degree Requirement ☐ Free Elective ☐ Other
☐ Core Course ☐ Tech Elective

Degree Requirements ☐ Degree Requirement ☐ Free Elective ☐ Other
☐ Core Course ☐ Tech Elective

Prereq
☐ Enforced
☐ Advised

Prereq
☐ Enforced
☐ Advised

Credit Restrictions

Credit Restrictions

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

Credit Hours Min Max
Contact Hrs/Wk
Number of Wks

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

Credit Hours Min Max
Contact Hrs/Wk
Number of Wks

Repeatability (Indi Research, Dir. Study, Dissertation): Is this course repeatable? ☒ Yes ☐ No Max Hours? 15 Max Times? 5 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: Lorelle Meadows Title

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

Approval Info Approved by Name Approved Date
☐ Curriculum Comm.

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

- ☐ Faculty
☐ Cross listed Unit 1
☐ Cross listed Unit 2

Department Chair Name Chair Signature
Home Dept. *L.Meadows*
Cross-listed Dept(s).

SUPPORTING STATEMENT

We are making these changes to create a consistent set of experimental course numbers in the ENGR division

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

Detail the Special requirements

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

Date 12/19/2011

Effective Term Winter 2012

Course Offer Freq

- ☒ Indefinitely
☐ One term only


A. CURRENT LISTING

B. REQUESTED LISTING

Home Department		Course Number		Home Department		Course Number	
				ENGR Engineering		490	
Cross Listed Course Information				Cross Listed Course Information			
Course Title				Course Title			
				Special Topics in Engineering			
TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces			TITLE ABBRE- VIATION	Time Sched Max = 19 Spaces	Spec Topics in Engr	
	Transcript Max = 20 Spaces				Transcript Max = 20 Spaces		
Course Description for Official Publication (Max = 50 words)				Course Description for Official Publication (Max = 50 words)			
Individual or group study of topics of current interest selected by faculty.				Special topics of current interest selected by faculty.			
PROGRAM OUTCOMES:		<input type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input type="checkbox"/> g <input type="checkbox"/> i <input type="checkbox"/> k <input type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j		PROGRAM OUTCOMES:		<input type="checkbox"/> a <input type="checkbox"/> c <input type="checkbox"/> e <input type="checkbox"/> g <input type="checkbox"/> i <input type="checkbox"/> k <input type="checkbox"/> b <input type="checkbox"/> d <input type="checkbox"/> f <input type="checkbox"/> h <input type="checkbox"/> j	
Degree Requirements		<input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective		Degree Requirements		<input type="radio"/> Degree Requirement <input type="radio"/> Free Elective <input type="radio"/> Other <input type="radio"/> Core Course <input type="radio"/> Tech Elective	
Prereq				Prereq			
<input type="radio"/> Enforced <input type="radio"/> Advised				<input type="radio"/> Enforced <input type="radio"/> Advised			
Credit Restrictions				Credit Restrictions			
Level of Credit		Credit Hours		Level of Credit		Credit Hours	
<input type="checkbox"/> Undergrad only <input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> Rackham Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Rckhm Grad w/add'l Work <input type="checkbox"/> Ugrad or Rckhm Grad		Min Max		<input type="checkbox"/> Undergrad only <input type="checkbox"/> Ugrad or Non-Rckhm Grad <input type="checkbox"/> Rackham Grad <input type="checkbox"/> All Credit types <input type="checkbox"/> Non-Rckhm Grad <input type="checkbox"/> Rckhm Grad w/add'l Work <input type="checkbox"/> Ugrad or Rckhm Grad		Min Max	
		Contact Hrs/Wk				Contact Hrs/Wk	
		Number of Wks				Number of Wks	

Repeatability (Indi Research, Dir. Study, Dissertation): Is this course repeatable? ☒ Yes ☐ No Max Hours? 15 Max Times? 5 Can it be repeated in the same term? ☒ Yes ☐ No

C.

Class Type(s)		Grading		Location		Cognizant Faculty Member:		Title	
<input checked="" type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other		<input checked="" type="checkbox"/> A-E <input type="checkbox"/> CR/NC <input type="checkbox"/> P/F <input type="checkbox"/> S/U		<input checked="" type="checkbox"/> Ann Arbor <input type="checkbox"/> Biological Station <input type="checkbox"/> Camp Davis <input type="checkbox"/> Extension					
Graded Section									
<input checked="" type="checkbox"/> Lec <input type="checkbox"/> Sem <input type="checkbox"/> Dis <input type="checkbox"/> Other									
<input type="checkbox"/> Rec <input type="checkbox"/> Lab <input type="checkbox"/> Ind									
		Course Is Y Graded <input type="checkbox"/>							
Approval Info		Approved by Name		Approved Date		Submitted By:		<input type="checkbox"/> Home Dept. <input type="checkbox"/> Cross-listed Dept.	
<input type="checkbox"/> Curriculum Comm.									
<input type="checkbox"/> Faculty						Department Chair Name		Chair Signature	
<input type="checkbox"/> Cross listed Unit 1						Home Dept. Engineering			
<input type="checkbox"/> Cross listed Unit 2						Cross-listed Dept(s)			

We are making these changes to create a consistent set of experimental course numbers in the ENGR division.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

Detail the Special requirements



Course Approval Request Form

Office of the Registrar, University of Michigan

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



CHECK APPROPRIATE BOXES FOR ALL CHANGES

Action Requested

- ☐ New Course
☒ Modification of Existing Course
☐ Deletion of Existing Course

Date of Submission:
Effective Term: Winter 2012

<input type="checkbox"/>	Course Offered <input type="checkbox"/> Indefinitely <input type="checkbox"/> One term only	RO USE ONLY Date Received: Date Completed: Completed By:
--------------------------	---	--

CURRENT LISTING

REQUESTED LISTING

<input type="checkbox"/>	Dept (Home): Information Subject: SI Catalog: 650			Dept (Home): Subject: Catalog:		
<input checked="" type="checkbox"/>	<input type="checkbox"/> Course is Cross-Listed with Other Departments			<input checked="" type="checkbox"/> Course is Cross-Listed with Other Departments		
	Department	Subject	Catalog Number	Department CSE	Subject EECS	Catalog Number 549
<input type="checkbox"/>	Course Title (full title) Information Retrieval			Course Title (full title)		
<input type="checkbox"/>	Abbreviated Title (20 char)			Abbreviated Title (20 char)		
<input type="checkbox"/>	Course Description (Please limit to 50 words and attach separate sheet if necessary)					
<input type="checkbox"/>	Full Term Credit Hours Undergraduate Min: Graduate Min: 3.00 Undergraduate Max: Graduate Max: 3.00			Half Term Credit Hours Undergraduate Min: Graduate Min: Undergraduate Max: Graduate Max:		
<input type="checkbox"/>	Course Credit Type select one					
<input type="checkbox"/>	Repeatability <input type="checkbox"/> Course is Repeatable for Credit Maximum number of repeatable credits:			<input type="checkbox"/> Course is Y graded <input type="checkbox"/> Can be taken more than once in the same term		

Subject: SI Catalog: 650			
<input type="checkbox"/>	Grading Basis <input type="checkbox"/> Graded (A – E) <input type="checkbox"/> Credit/No Credit <input type="checkbox"/> Satisfactory/Unsatisfactory <input type="checkbox"/> Pass/Fail <input type="checkbox"/> Business Administration Grading <input type="checkbox"/> Not for Credit <input type="checkbox"/> Not for Degree Credit <input type="checkbox"/> Degree Credit Only	Add Consent <input type="checkbox"/> Department Consent <input type="checkbox"/> Instructor Consent <input type="checkbox"/> No Consent	Drop Consent <input type="checkbox"/> Department Consent <input type="checkbox"/> Instructor Consent <input type="checkbox"/> No Consent

CURRENT LISTING

REQUESTED LISTING

<input type="checkbox"/>	Advisory Prerequisite (254 char)	Advisory Prerequisite (254 char)
<input type="checkbox"/>	Enforced Prerequisite (254 char)	Enforced Prerequisite (254 char)
<input type="checkbox"/>	Minimum grade requirement:	Minimum grade requirement:
<input type="checkbox"/>	Credit Exclusions	Credit Exclusions
<input type="checkbox"/>	Course Components <input type="checkbox"/> Lecture <input type="checkbox"/> Seminar <input type="checkbox"/> Recitation <input type="checkbox"/> Lab <input type="checkbox"/> Discussion <input type="checkbox"/> Independent Study	Graded Component <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<div style="text-align: right;">Terms Typically Offered (Please select only one) [blank] or [blank]</div>		
Instructor Name: _____ Instructor Title: _____		

SIGNATURES ARE REQUIRED FROM ALL DEPARTMENTS INVOLVED

Contact Person: Marsha Antal

Email: mwhitish

Phone: 615.8247

Curriculum Committee:	Date: _____
Dept Chair(s):	
Home Department:	Date: 11/9/11
Cross-Listed Department:	Date: 11/11/11
Cross-Listed Department: _____	Date: _____
Cross-Listed Department: _____	Date: _____