The University of Michigan
College of Engineering
Curriculum Committee

Agenda
October 26, 2010
1:30-3:00 p.m.
ROOM 265 CHRYSLER CENTER

1. Approval of Minutes From 10-12-2010
2. Current Rules Covering the Curriculum Committee
3. Course Approval Guidelines and Procedures
4. Course Approvals
5. Update on Implementation of the Intellectual Breadth Requirement—James Holloway
6. Proposal for Declaring Majors—James Holloway
7. Proposal on General Electives—James Holloway

University of Michigan
College of Engineering
Curriculum Committee Meeting
Tuesday October 12, 2010
1:30-3:00 p.m.
GM Room 4th Floor Lurie Engineering Center
Minutes

Marina Epelman called the meeting to order at 1:40 p.m.

Members Present: M. Epelman, J. Barker, M. Collette, E. Durfee, J. Holloway, R. Hryciw, A. Hunt, D. Kieras, E. Larsen, J. Li, L. Meadows, J. Pan, R. Robertson, F. Terry, S. Vozar, F. Ward

Members Absent: L. Bernal, E. Gulari, S. Montgomery

The minutes of the last meeting, September 28, 2010 were approved

Course Approval Forms

These Courses Were Approved

BME 350	Modification—Changed Title from: Introduction to Biomedical Instrumentation Design ***to: Introduction to Biomedical Engineering Design***; Changed Description; Changed Prerequisite from: None ***to: Biomede 211, 221, 231; co-requisite BME 241 The Committee approved maintaining this course as a Tech Elective (not changing to a Core Course).***
CHE 230	Modification—Changed Title from: Material and Energy Balances ***to: Introduction to Material and Energy Balances***; Changed Prerequisite from: "Engr. 103, Chem 126, Math 116 ***to: "Engr. 100, Eng 101 {or Eng 151 amended at meeting}, Chem 130, Math 116***
CHE 341	Modification—Changed Prerequisite from: "Physics 140, P/A ChE 230 and Math 216"***to: "Preceded by Physics 140 and Math 215, Preceded or accompanied by ChE 230 and Math 216***
CHE 343	Modification—Changed Prerequisite from: ChE 230 ***to: ChE 230, ChE 330 and preceded or accompanied by ChE 342***
CHE 466	Modification—Changed Course Description
CEE 325	Modification—Changed Prerequisite from: CEE 211 and ME 235 or ChemE 230 ***to: CEE 211 and prior or concurrent enrollment in CEE 230 or MechEng 235(At meeting Prerequisite changed to Enforced.)***
CEE 520	Modification—Changed Title from: Deterministic and Stochastic Models in Hydrology ***to: Physical Processes of Land-Surface Hydrology***; Changed Description; Changed Prerequisite from: CEE 420, CEE 421 ***to: CEE 421(at meeting decided to keep Prerequisite enforced and add: or graduate standing)***
EECS 418	New Course

EECS 419 New Course
EECS 463 New Course

This Course Was Tabled
CEE 573 New Course

Chemical Engineering Mission, Goals and Educational Objectives

This information was included in the meeting packet. This was a change for the mission statement for Chemical Engineering. After some discussion, it was moved and voted on. Approved with one abstention.

Additional Discussion Topics

Marina Epelman asked for departments to look at the main course approval form and suggest changes to the form. In particular, feedback on (i) interpretation of "Core Course" designation in different programs and (ii) abilities/limitations of the wolverineaccess system in enforcing prerequisites is of interest.

James Holloway asked if there are issues regarding the form for the departments to send him a note and he will bring these back to this Committee.

In future meetings, the Committee should revisit the forms and guidelines given to departments bringing new and revised courses for consideration by the Committee.

Adjournment: Motion to adjourn was made and seconded
Motion carried (approved)

Next Meeting: October 26, 2010 1:30 PM, Room 265 Chrysler Center

VII.B.I. The Curriculum Committee. The Curriculum Committee shall consist of one Member representing each department in the College (with the exception of the Department of Electrical Engineering and Computer Science, which will have one faculty representative from each of the two divisions), one representative from InterPro, one representative from the Interdisciplinary Degree Program, two representatives from the Dean's staff, and two student representatives. The Dean will appoint the two members of the Dean's staff to serve with vote, the two representatives of the student body to serve with vote, and the representative of the Interdisciplinary Degree Program to serve with vote. The Members representing their Departments on the Committee will be selected by their respective departments and will serve with vote. The Chair shall be selected annually by the Committee from the Departmental or Program representatives on the Committee.

The Curriculum Committee shall examine all educational programs of the College, graduate and undergraduate, and all proposed changes, and encourage full discussion of the proposals by the Members before they take action. The Committee, moreover, shall initiate changes by asking Departments to reexamine their programs or specific course offerings. The degree programs shall be administered by the Departments or by Program Committees. The Curriculum Committee advises, suggests, coordinates, stimulates, and in general acts for the best interests of the College. Its recommendations regarding college-wide curriculum requirements, new degree programs, and any other curricular issues the Committee determines of comparable significance, shall be brought before the Faculty for approval. The Committee will have the authority to approve by a 2/3 vote all other curriculum-related changes without a vote of the Faculty.

The Dean's Office shall provide clerical service, maintain the necessary records for the Committee, and take the necessary action to publish the changes in the College Bulletin and to notify other units in the University.

THE UNIVERSITY OF MICHIGAN
COLLEGE OF ENGINEERING
CURRICULUM COMMITTEE
GUIDELINES AND PROCEDURES
October 24, 2006

Creating a New Course

The proposal for a new course should contain justification for the establishment of and an assessment of the course's likelihood of success.

1. It is encouraged that the proposed new course be first prototyped before complete documentation is submitted to the CoE Curriculum Committee for their action.

2. Documentation for submission of a new course will consist of:
   a. completed (CAF) Course Approval Form (including supporting statements and appropriate signatures)
   b. course outline, with details to show weekly subject matter
   c. required/recommended texts/course packs, grading and exam details.

3. Documentation that needs to accompany undergraduate CAF for required courses and technical electives at the 400 level or below:
   a. ABET documentation, Step II; Outcomes and Assessments; Program Mapping
   b. Sample Schedule as it is to appear in the Bulletin, if this is altered by the proposed course.

Existing Course

The level of documentation needed for modifying an existing course is as follows:

1. For modifications to undergraduate courses in the area of program requirements or technical electives, refer to (3) under "Creating a New Course".

2. All other modifications to an undergraduate course, only a CAF with supporting statements is needed.

3. Modifications to a graduate course, only a CAF with supporting statements is needed.

Cross Listing of a Course

The explanation of how the cross listing will meet the following four items, listed in order of importance, should be put on the CAF under "Supporting Statement."

1. The course will be taught by faculty in all cross listed departments
2. There will be cognizant faculty for the course in all cross listed departments
3. All cross listed departments actively review and assess curriculum, along with the cross listed courses consistent with departmental practice
4. Course content is relevant to all departments cross listed

Establishment of a Division (Subject)
(Based on Dennis Assanis, Automotive Engineering Program, "Rationale and Proposed Guidelines for Creating a Division in InterPro," November 29, 2000.)

The following guidelines are proposed when demonstrating a need for the creation of an academic Division:

1. "Successful incubation of the interdisciplinary academic Program under one of the existing Divisions that would serve as the academic home for an interim period of at least three years."

2. "Successful development of a number of Program-specific courses that would not have been created if the proposed Division did not exist. Offering of such courses for at least two times under experimental numbers in one of the existing Divisions with satisfactory enrollment."

3. (Successful) "achievement of appropriate metrics consistent with program goals and expectations, such as reaching a steady-state enrollment of x full-time and y part-time students, graduation of z students, etc."

4. "Establishment of a curriculum committee for that division. The form and organization of the committee should be consistent with the norm of the other divisions in the CoE."

5. "Demonstrated identity of the Program, as evidenced by external recognition of Program need and objectives."

6. "Careful assessment of the pros and cons of the creation of a prospective Division by The Program's faculty council or the Program's Curriculum Committee and approval of the proposal by at least 2/3 of the faculty council members."

7. "Approval of the proposal to create a Division by the CoE Curriculum Committee." (The CoE Curriculum Committee will evaluate the curricular aspects of the proposal.)

8. "Approval of the proposal by the CoE Faculty Assembly."

COURSE APPROVAL FORMS

For October 26, 2010 CoE CC Meeting

AOSS 473	New Course
CEE 573	New Course

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

Form Number: 2174
Date: 10/5/2010
Effective Term: Winter 2011
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	Home Department: AOSS Atmos, Oceanic & Space Sci / Course Number: 473
☐ Cross Listed Course Information	Cross Listed Course Information
☐ Course Title	Course Title: Climate Physics
TITLE ABBREVIATION — Time Sched Max = 19 Spaces	Climate Physics
TITLE ABBREVIATION — Transcript Max = 20 Spaces	Climate Physics
☐ Course Description	Course Description for Official Publication (Max = 50 words): Introduction to physical mechanisms that determine climate, including relevant atmospheric, hydrologic, cryospheric, solar/orbital, volcanic, and human processes. Discusses quantitative and descriptive techniques to understand how radiative, thermodynamic, and dynamic processes distribute energy throughout the Earth System, drive climate feedbacks, and determine the sensitivity of Earth's climate to external perturbations.
PROGRAM OUTCOMES: ☐ a ☐ b ☐ c ☐ d ☐ e ☐ f ☐ g ☐ h ☐ i ☐ j ☐ k	PROGRAM OUTCOMES: ☒ a ☐ b ☐ c ☒ d ☒ e ☐ f ☒ g ☒ h ☐ i ☒ j ☐ k
Degree Requirements: ( ) Degree Requirement ( ) Core Course ( ) Free Elective ( ) Tech Elective ( ) Other	Degree Requirements: ( ) Degree Requirement ( ) Core Course ( ) Free Elective (•) Tech Elective ( ) Other
☐ Prereq: ( ) Enforced ( ) Advised	Prereq: Senior or graduate standing in science or engineering; ( ) Enforced (•) Advised
☐ Credit Restrictions	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	☐ 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 3; 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
Course Is Y Graded ☐
Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension

Cognizant Faculty Member: Mark Flanner
Title: Asst. 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: Home Dept. Atmos, Oceanic & Space Sci
~~Chair~~ Signature:
Cross-listed Dept(s).

Form Number

2174

SUPPORTING STATEMENT

Climate change has emerged as one of the most important societal issues at present and is driving research agendas at funding agencies including NASA, the Department of Energy, the National Science Foundation, and the Environmental Protection Agency. Atmospheric CO2 concentrations will surely increase in the coming decade, and hence climate-oriented research is unlikely to dissipate in the near future. Moreover, climate research is likely to increasingly involve engineering, as the need to adaptively manage urban, agricultural, and possibly even climate systems becomes more important for societal stability, indicating a need to educate engineering students on the physical mechanisms that determine the spatial and temporal distribution of climate on Earth.

This course will apply quantitative techniques to understand how radiative, thermodynamic, and dynamic processes distribute energy throughout the Earth System, drive climate feedbacks, and determine the sensitivity of Earth's climate to external perturbations. Students will apply these concepts to learn how atmospheric, cryospheric, and hydrologic processes are coupled with climate, and explore how solar/orbital, volcanic, and human processes can perturb climate. Students will also learn about inherent modes of climate variability, including the El Niño-Southern Oscillation (ENSO) and the Madden-Julian Oscillation.

This course will serve the AOSS Climate Science and new Climate Impact Engineering undergraduate concentrations, masters/ SGUS students and Ph.D. students who have not yet been exposed to principles of climate physics. This course was instructed in Winter 2010 and included 15 enrolled students, about half of whom were graduate students and half undergraduate AOSS majors. Despite this diversity, the course was highly interactive and was reviewed favorably by the students, with median end-of-semester evaluation scores of 4.25 and 4.4, respectively, in response to evaluation questions 1 and 2. The primary text used in this course is "Global Physical Climatology" by Dennis Hartmann, the preface of which states that the book is intended for "upper-division undergraduate physical science majors and, especially in the later chapters, graduate students".

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

Detail the Special requirements

AOSS 473: Climate Physics
Winter 2011

Instructor: Mark Flanner (flanner@umich.edu)

Credits: 3

Lecture: MWF 2:30-3:30

Office Hours: Tuesday 11:00-12:00 and Wednesday 3:30-4:30 in 2527B Space Research Building (SRB), or by appointment.

Pre-requisites: Basic physics and calculus

Course website: (via ctools)

Required Text: *Global Physical Climatology* by Dennis Hartmann
(Academic Press, 1994, ISBN: 978-0-12-328530-0)
* Errata published at: http://www.atmos.washington.edu/~dennis/gpc.html

Supplemental Texts:

1) *Atmospheric Science: An Introductory Survey (2nd Edition)* by Wallace and Hobbs (Academic Press, 2006, ISBN: 978-0-12-732951-2). This book provides excellent introductory descriptions of important atmospheric processes and has clear figures, but its focus is restricted to the atmosphere.
2) *Physics of Climate* by Peixoto and Oort (Springer Press, 1992, ISBN: 978-0883187128). This book provides excellent theoretical bases of climate-relevant processes. Some of the theory is more in-depth than needed for this course, but we will draw on this text occasionally throughout the course.
3) *The Physical Science Basis of Climate Change*, report produced by the Intergovernmental Panel on Climate Change Working Group 1 (2007). This report provides summaries of relevant science (up to ~2005) and is a useful source of references to peer-reviewed literature on many different topics. ** pdfs are available for free at: http://ipcc-wg1.ucar.edu/wg1/wg1-report.html.

Course Description:

This course will explore processes that determine Earth's climate. We will apply descriptive and quantitative techniques to understand how radiative, thermodynamic, and dynamic processes distribute energy throughout the Earth System, drive climate feedbacks, and determine the sensitivity of Earth's climate to external perturbations. We will apply these concepts to explore how atmospheric, hydrologic, cryospheric, solar/orbital, land surface,

volcanic, and human processes influence past, present, and future climate. We will also study inherent modes of climate variability, including the El Niño-Southern Oscillation (ENSO).

Course Structure and Policy:

Readings: All required readings will come from Hartmann's text, or will be provided as pdfs. Supplemental readings are also listed in green on the schedule below. These readings are optional, and are provided only as references for more in-depth knowledge on particular topics, should you desire it. Readings from Peixoto and Oort are somewhat dense, and may be of more interest to graduate students.

Homework: There will be about 6 homework sets, assigned bi-weekly and posted on the course website, that will draw on problems from Hartmann's text and elsewhere. You may (and are encouraged to) form study groups to discuss homework problems and approaches, but your homework responses must be prepared individually, using your own wording and formulations. You may complete these assignments in (legible) written or typed form. Unless prior arrangements have been made with an instructor, assignments turned in late will be docked 10% per weekday.

Exams: There will be one midterm and one final exam, both administered in-class. If you have a conflict with either exam time, you must make arrangements to take the exam at an earlier date. We will apply the College of Engineering honor code and honor pledge on examinations: http://www.engin.umich.edu/students/honorcode/all/

Course Project:

The purpose of this project is to explore in greater detail an agent or mechanism that induces climate change (via natural or anthropogenic means). The project will be conducted individually and will culminate in a 4-6 page written paper and a 10-minute oral presentation to class. Topic suggestions are listed below, but your choice is not limited to these suggestions.

It is intended that you research the topic and address relevant questions primarily through literature review ("Option A", see below). *However*, you may instead choose to adopt a more rigorous numerical approach to this project, through (e.g.,) model development or data analysis ("Option B"). The definition of this option is intentionally vague because of the huge variety of processes, and hence approaches to research, involved with climate change agents and mechanisms. With this flexibility comes opportunity, but also need for a well thought-out plan so the project is manageable and useful to you. Hence, if you choose this approach, you must meet with Flanner by March 15 to discuss your proposed plan and finalize an approach that will lead to successful completion of the project.

Option A:
Prepare a 4-6 page report, **in your own words,** that addresses questions such as: How does this mechanism or agent alter climate? What feedback mechanisms are involved with the radiative

forcing caused by this agent or mechanism? What climate processes (e.g., precipitation) are most affected and how? What types of models and observations are needed to understand its importance, and what are the key uncertainties associated with our current understanding? Where in the Earth System and during which seasons is the mechanism most influential, and why? Over what timescales does the mechanism operate? If dealing with an agent, what are the sources and sinks of the agent, and what controls its lifetime of influence? Is the mechanism or agent influenced by human activity, and if so, how? During which time periods in Earth's or humans' past has this mechanism or agent likely been most influential, and what may cause its strength to change in the future? Your report is not restricted to these questions, but the focus must be on physical processes, with some deviations into chemical and biogeochemical processes as needed.

Project summary

Group size:	Individual
Written report:	4-6 pages with 1.5-line spacing, 12 point font, ~1" margins, and (optional) one or two figures **that you create**
Due date:	April XX (last day of class)
Oral presentation:	In-class, 10 minutes in length, media of your choice.
Grading:	60% weighting on written report, 40% on presentation
Selection:	Topics and presentation times will be selected in class on Monday February 21 ("Selection Monday"). Please have preferred topics in mind at the beginning of this class. Each topic can only be selected by one person, and the selection order will be determined randomly ahead of time.
Format:	Typed and submitted in paper and electronic format. If "Option B" is chosen, plots that supplement the analysis should be included, and source code supplied.

Topics

Suggestions for project topics are listed below. You are welcome to choose a different topic, but it must be approved. (Anthropogenic carbon dioxide is excluded). The mechanism or agent can be natural or anthropogenic.
*If you have written previously on this topic, the content of your report must be unique.

1) methane
2) nitrous oxide
3) stratospheric ozone
4) tropospheric ozone
5) CFC's and HCFC's (or total halocarbon effect)
6) halocarbons
7) water vapor

8) sulfate aerosols from fossil fuel use
9) sulfate aerosols from volcanoes
10) carbon dioxide from volcanoes
11) black carbon aerosols in the atmosphere
12) black carbon aerosols deposited to snow
13) mineral dust aerosols
14) organic aerosols
15) nitrate aerosols
16) aerosol-cloud indirect effects
17) contrails from airplanes
18) "waste heat" or "anthropogenic heat flux" from energy use
19) altered surface albedo from land use change
20) changes in solar irradiance
21) changes in Earth's orbit
22) asteroid or comet impacts with Earth
23) cloud feedback
24) albedo feedback
25) lapse-rate feedback
26) geoengineering with sulfate aerosols
27) geoengineering with stratocumulus seeding
28) geoengineering with iron fertilization
29) geoengineering with space mirrors

Grading: Homework: 30%, Midterm: 20%, Course Project: 20%, Final: 30%.

Grade assignment will be based on absolute performance (i.e., grading is non-competitive). We will start with the following fixed-scale, but will loosen it as needed, based on course performance:

A+	97%	A	93%	A-	90%
B+	87%	B	83%	B-	80%
C+	77%	C	73%	C-	70%
D+	67%	D	63%	D-	60%

Course Schedule (tentative, next page):

Week #	Topics (by week, timing will change)	Reading (green: optional)	Homework
1	**Introduction to climate**	Hartmann, Ch.1	
	Weather and climate, climate components	IPCC, Ch.1, FAQ 1.1 and 1.2	
	atmospheric structure	Peixoto & Oort, Ch.2.1-2.4	
		Wallace and Hobbs, Ch.2.1	
2	**Global energy balance**	Hartmann, Ch.2	
	solar flux, blackbody emission		
	poleward energy transfer		HW1 assigned
3	**Holiday, NO CLASS**		
	GEB (continued)		
	CERES observations		HW1 due
4	**Surface energy balance**	Hartmann, Ch. 4	
	SE components, heat storage, albedo,	Peixoto & Oort, Ch.10	
	diurnal and latitudinal flux variability		HW2 assigned
5	**Radiative transfer**	Hartmann, Ch.3	
	Planck, Beer, and absorption spectra	Peixoto & Oort, Ch.6	
	Clouds	Wallace and Hobbs, Ch.4	HW2 due
6	**Hydrologic cycle**	Hartmann, Ch.5	
	water balance terms, P-E distribution,	Peixoto & Oort, Ch.12	
	Cryosphere		HW3 assigned
7	**Atmospheric circulation and climate**	Hartmann, Ch.6	
	Energy terms, large-scale structure,	Wallace and Hobbs, Ch.7	
	climate zones	Peixoto & Oort, Ch.7	HW3 due
8	Course project assignment, midterm review		
	Midterm Exam		
	Atmospheric circulation and climate		
	Spring Break		
9	Midterm return, ENSO	Hartmann, Ch.7	HW4 assigned
	Ocean circulation and climate	Peixoto & Oort, Ch.8	
		Wallace and Hobbs, 10.2	
10	Ocean circulation and climate		
	Ocean circulation and climate		HW4 due
	Climate feedback and sensitivity	Hartmann, Ch.9	HW5 assigned
11	Climate feedback and sensitivity	Peixoto & Oort, Ch.2.5	
	Climate feedback and sensitivity		
	Climate feedback and sensitivity		
12	**Natural climate change, Paleoclimate**	Hartmann, Ch.11	HW5 due
	Solar influence, volcanic aerosols,	Hartmann, Ch. 8	
	orbital theory, ice ages		HW6 assigned
13	**(Radiative Forcing)**	(Hartmann, Ch.12)	
		(IPCC, Chapter 2)	
14	Course project presentations		HW6 due
	Course project presentations		
	Course project presentations		
	Final review TBD		
15	Course project presentations		**Project due**
FINAL	**Final Exam (assigned time)**		

COURSE PROFILE

Degree Program: ESSE **Date:** October 7, 2010

Prepared by: Mark Flanner, Assistant Professor

COURSE #: 473	**COURSE TITLE: CLIMATE PHYSICS**
TERMS OFFERED: Winter	**For each prerequisite below, "E" denotes Enforced and "A" denotes Advised.**
TEXTBOOKS/REQUIRED MATERIAL: Global Physical Climatology by Hartman	**PREREQUISITES: senior or graduate standing (A)**
INSTRUCTOR(S): Mark Flanner	**COGNIZANT FACULTY:**
CoE BULLETIN DESCRIPTION: **Introduction to physical mechanisms that determine climate, including relevant atmospheric, hydrologic, cryospheric, solar/orbital, volcanic, and human processes. Discusses quantitative and descriptive techniques to understand how radiative, thermodynamic, and dynamic processes distribute energy throughout the Earth Syst drive climate feedbacks, and determine the sensitivity of Earth's climate to external perturbations.**	**COURSE TOPICS:** **1. Global energy budget and energy redistribution components** **2. Radiative constituents in the atmosphere and mechanisms of influence** **2. Climate feedback mechanisms** **3. Climate sensitivity and transient climate response** **4. Inherent modes of variability (El Nino)** **6. Long timescale climate change and mechanisms**
COURSE STRUCTURE/SCHEDULE Lecture: 3 per week @ 50 minutes	

COURSE OBJECTIVES	EDUCATE STUDENTS ON GLOBAL ENERGY FLOW, PROCESSES AND STATES THAT DETERMINE EQUILIBRIUM CLIMATE, AND PHYSICAL INTERACTIONS THAT GOVERN CLIMATE SENSITIVITY. VIA THE COURSE PROJECT, STUDENTS WILL ACHIEVE IN-DEPTH UNDERSTANDING OF A CLIMATE FORCING OR FEEDBACK MECHANISM OF CHOICE.
COURSE OUTCOMES For each course outcome, links to the Program Outcomes are identified.	A. Students will apply math and physics skills to derive analytical and numerical (via Matlab) solutions for homework assignments D. Students will be encouraged to collaborate on certain homework problems and required to work in groups on in-class problems E. Students will be exposed to geo-engineering problems where they identify targets and quantify minimum actions needed to achieve the targets G. Students will make an oral presentation to class on their course project at the end of the semester H. (less focus) Options for the course project will include assessment, through physical arguments, of climate changes induced by different actions, presenting opportunity to explore impacts of engineering solutions in a global/societal context. J. Anthropogenic climate change is one of the most important contemporary issues facing global society, and will be discussed within the context of course topics listed above
ASSESSMENT TOOLS For each assessment tool, links to the course outcomes are identified.	Student evaluation will be based on homework, performance on mid-term and final exams, and the course project. Technical skills will be assessed through homework problems requiring Matlab. Some components of these assignments will require students to first formulate the problem and make reasonable assumptions to achieve a solvable problem, thus enabling assessment of ability to identify, formulate, and solve technical problems. The course project contains both written and oral components, allowing evaluation of both forms of technical communication.

Revised 11 11 04

Updated

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

Form Number: 2162
Date: 9/7/2010
Effective Term: Winter 2011
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	Home Department: CEE Civil & Environmental Engin / Course Number: 573
☐ Cross Listed Course Information	Cross Listed Course Information
Course Title	Course Title: Methods of Data Analysis
TITLE ABBREVIATION — Time Sched Max = 19 Spaces / Transcript Max = 20 Spaces	TITLE ABBREVIATION — Time Sched Max = 19 Spaces: Meth Data Analysis / Transcript Max = 20 Spaces: Meth Data Analysis
Course Description	Course Description for Official Publication (Max = 50 words): Course topics are drawn from statistical inference and time series analysis to address problems encountered in engineering and environmental sciences. Goodness of fit and hypothesis testing; sampling and experimental design; linear and non-linear regression analysis; error estimation; stationary and non-stationary processes; autocovariance and cross covariance functions; linear autoregressive processes; spectral analysis of variance.
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: CEE 270 or equivalent. ○ Enforced ◉ Advised
Credit Restrictions	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	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 3; 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: Valeriy Ivanov
Title: Assistant 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.	Nancy G. Love, Professor	
Cross-listed Dept(s).	Civil & Environmental Engin	

Form Number

2162

SUPPORTING STATEMENT

The course objective is to learn concepts and techniques that are frequently required in most environmental sciences (e.g., ecology, hydrology, geomorphology, etc.) that deal with collection of data samples in field/lab experiments as well as analysis of long-term time series. The course represents a combination of topics from statistical inference and time series analysis. The only other data-oriented course offered in the department is CEE 570 "Introduction to Geostatistics" that deals with issues of geospatial data. Currently, CEE students interested in data analysis have to take courses offered through other departments, such as Industrial Engineering and Electrical Engineering and Computer Sciences. These courses are oriented towards applications of respective disciplines and therefore do not reflect the needs of CEE students.

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

Detail the Special requirements

University of Michigan, Department of Civil and Environmental Engineering

Winter 2011

CEE 573 "Methods of Data Analysis"

Instructor-in-charge:
Valeriy Ivanov
1351 Beal Avenue, 105 EWRE
Ann Arbor, MI 48109-2125
Phone: 734-763-5068
E-mail: ivanov@umich.edu

Prerequisites: CEE 270, equivalent course, or permission of the instructor.
Basic knowledge of Matlab or R, any other programming language.

Description: Course topics are drawn from statistical inference and time series analysis to address problems encountered in environmental sciences and engineering. Goodness of fit and hypothesis testing; sampling and experimental design; linear and non-linear regression analysis; error estimation; stationary and non-stationary processes; autocovariance and cross covariance functions; linear autoregressive processes; spectral analysis of variance.

Classes:
Tue., Thr.: X.00-X.30pm; EWRE XX

Office hours: Tue, Thr: X-Xpm.

References: There is no required textbook for the course. The topics explored are derived from various materials. However, the course will closely follow:

Rice, J. (1995) Mathematical statistics and data analysis. Duxbury Press. Available in Shapiro Science: QA 276.12 .R531 1995

Jenkins, G.M., and D.G. Watts (1968, 1998). *Spectral Analysis and its Applications*, Holden-Day (1968)/Emerson-Adams Press (1998). Available in Art Architecture & Engineering; Shapiro Science; CSCAR - Rackham Building (building use only): QA280.J52

* XX books will be on reserve at: Art, Architecture & Engineering Library Course Reserves
(734) 647-5747 aael.course.reserves@umich.edu

* A list of additional textbooks that might be useful is attached.

Grades:

Class participation	5%
Problem sets (5)	45%
Mid-term exam	20%
Final exam	30%

Grading policy: The letter grade for the class is based on a 100 point system for the assignments, test, and a project. The average grade for the class is a metric of assignment difficulty.

- (-5) – Erroneous numerics
- (-10) – Erroneous derivation/methodology

- (-1,-2) – Erroneous minor qualitative questions

Late returns: 25% of the grade per day of late return.

Problem sets: Use a symbolic form in all your derivations before providing a numerical answer. Present a detailed methodology of how the answer is achieved. Provide numerical values as wherever possible. Indicate units in all figures/estimation results. Attach the source code for computations that require more than several steps. Use *metric* units only.

Schedule:

Mid-term	February
Take home final quiz	April XX
Quiz turn-in	April XX

Additional references:

Bras, R.L., and I. Rodriguez-Iturbe, Random Functions and Hydrology, Dover Books on Advanced Mathematics, 559 pp., 1994.

Priestly, M.B. (1981, 1991). Spectral Analysis and Time Series. Academic Press (1981)/ Elsevier (1991). (Available in Shapiro Science: QA280.P741)

Ramsey, F. L., and D. Schafer (The Statistical Sleuth: A Course in Methods of Data Analysis, 816, 2002.

Week/ Class	Date	Topic
1/1	01/5-7	*Introduction and Review*: random variables & probability distributions
2/2	01/10-01/14	*Statistical Inference* (SI) from data: sampling distributions, test of significance
2/3	01/10-01/14	SI: confidence intervals; goodness of fit and hypothesis testing
3/4	01/17-01/21	SI: parameter estimation: moments and likelihood inference
3/5	01/17-01/21	SI: graphical presentation of data
4/6	01/24-02/28	SI: single factor analysis of variance
4/7	01/24-02/28	SI: design and power analysis in sampling and experimental design
5/8	01/31-02/4	SI: Monte-Carlo techniques in statistical inference
5/9	01/31-02/4	SI: linear and non-linear regression analysis
6/10	02/7-2/11	SI: linear and non-linear regression analysis
6/11	02/7-2/11	SI: error estimation: bootstrapping, correlated errors, bias, conditional sampling
7/12	02/14-2/18	*Time Series Analysis* (TSA): trends in data; stationary and non-stationary processes
7/13	02/14-2/18	TSA: tests of stationarity in the mean and the variance
8/14	02/21-02/25	**Review of class material**
8/15	02/21-02/25	**Mid-term test.**
	02/26-03/6	**SPRING BREAK**
9/16	03/7-03/11	TSA: autocovariance/correlation and cross covariance/correlation functions
9/17	03/7-03/11	TSA: estimation of auto/cross covariance functions; tests of their significance
10/18	03/14-03/18	TSA: linear autoregressive processes, AR(1), and moving average processes
10/19	03/14-03/18	TSA: AR(1) and MA: model identification, calibration, and use in simulation and forecasting
11/20	03/21-03/25	Fourier analysis: series, integrals, transforms, application to time series analysis
11/21	03/21-03/25	*Spectral Analysis* (SA): spectral density functions; power spectrum
12/22	03/28-04/1	SA: spectra of white noise, linear, AR(1), and MA processes
12/23	03/28-04/1	SA: sampling properties of power spectrum
13/24	04/4-04/8	SA: smoothing of spectral estimators
13/25	04/4-04/8	SA: spectral windows and their properties
14/26	04/11-04/15	SA: examples of spectral estimation
14/27	04/11-04/15	SA: spectrum sampling
15/28	04/18-04/19	**Review of class material. Take home final quiz.**
		Quiz turn-in

October 19 2010

The following text would replace the Bulletins sections "Program Selection" and "Changing or adding a program" http://www.engin.umich.edu/bulletin/rules/courses.html#selection

Proposal: Declaration of Engineering Major

In order to give students the opportunity to explore the numerous engineering degrees offered by the College, undergraduate students entering the College as first year students (not transferring from another institution of higher education) enter the College without declaring a specific engineering major. Degree programs do not include as requirements any courses expected to be taken by a student during the first year, other than the common math and science core. Students are urged to declare a specific engineering major by the start of their 3rd term of enrollment, and cannot register for a 4th term in the College unless they have met with their advisor and developed a plan to select and be admitted to a major within a reasonable time. This plan can be developed in coordination between EAC advisors and departmental degree program advisors.

In order to initially declare a major a student must:

- Have completed at least one full term of courses from the UM Ann Arbor campus.
- Have completed or earned credit for at least one course in each of these categories:
    - Calculus
    - Calculus based physics
    - Chemistry
    - An engineering course
- Have earned grades of C or better in each completed course in these categories:
    - Calculus
    - Calculus based physics
    - Algorithmic thinking/programming courses (e.g. Eng 101)
    - Chemistry
    - Introductory engineering & technical communications (e.g. Eng 100)
- Have an overall GPA of 2.0 or better. The CoE Executive Committee can approve requests to raise this limit for special circumstances for fixed periods of time.

Students seeking to change majors within engineering can do so as long their overall cumulative gpa is 2.0 or above. However, students cannot switch majors during their first term at the UM.

Program advisors can accept students not meeting these requirements at their discretion. The Associate Dean for Undergraduate Education can approve additional requirements.

Note: There are no special rules for students with more than 55 credit hours or Junior/Senior standing.

Proposal: General Electives

General electives are intended to allow students to explore any dimension of intellectual endeavor that they elect, in both technical (including engineering) and non-technical fields. This requirement can be met by any course offered by the UM Ann Arbor, subject to the following restrictions, or by transfer credit subject to the same restrictions in spirit.

Restrictions:

Courses that require tutoring of other students enrolled in courses are limited to a maximum of 3 credits, with the exception of Physics 333 & Physics 334 which are both allowed for a maximum of 6 credits.

100 level courses in military, naval, or air science are not accepted as general electives.

Math 105 and 110 are not accepted as general electives.

Tutorial courses are not acceptable for credit of grade points but will be included on the student's official record.

All undergraduate degree programs in the College of Engineering will have at least 12 credits of general electives.