The University of Michigan College of Engineering Curriculum Committee

Agenda October 12, 2010 1:30-3:00 p.m. GM Room Fourth Floor Lurie Engineering Center

- 1. Approval of Minutes From 09-28-2010
- 2. Course Approvals
- 3. Chemical Engineering Mission, Goals and Educational Objectives

University of Michigan College of Engineering Curriculum Committee Meeting Tuesday September 28, 2010 1:30-3:00 p.m. Room 2210 LEC

Minutes

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

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

Members Absent: E. Gulari, D. Kieras, L. Meadows, S. Montgomery

Guests: Aileen Huang-Saad, Thomas Zurbuchen

<u>The minutes of the last meeting(s) (April 13, April 20 and September 14, 2010) were</u> approved <u>The minutes of the September 14, 2010 meeting were approved with the addition to</u> the "proposal for revision of the CoE Core Curriculum for Intellectual Breadth" that the proposal to revise general electives credit to a required minimum of 12 was tabled.

Course Approval Forms

These Courses Were Approved

CHE 343 Modification—Changed Prerequisite from: ChE 230 (enforced) *to*: ChE 230, ChE 330, Preceded or accompanied by ChE 342 (enforced)

CHE 596(X-listed with PHARMSCI 596 and BME 596) Modification—Changed Prereq from: Grad Standing (enforced) to: Grad Standing (advised)

- IOE 439 Deletion
- IOE 636 Deletion
- MSE 517 Requested X-Listing with MACROMOL 530
- ME 501 Modification—Changed Title from: Analytical Methods in Mechanics to: Mathematical Methods in Mechanical Engineering; Changed Description; Changed Prereq from: ME 211, ME 240, and MATH 216 to: Math 216; Math217 or equivalent recommended
- ME 552(X-listed with MFG 552) Changed Level of Credit from: Min 3 Max 3 to: Min 4 Max 4; Contact Hrs Wk from: 3 to: 6

This Course Was Tabled

BME 350Modification—Changing Title from: Introduction to BiomedicalInstrumentation Design to: Introduction to Biomedical Engineering Design;
Changing Description; Changing Prereq from: None to: Biomede 211, 221,

231; co-requisite BME 241 This course was tabled for clarification as to why it was changed to be a Core Course.

Proposal to Create a Joint Masters Degree in Entrepreneurship

This was a continuation of the discussion from the last (September 14) meeting.

Information regarding this was handed out at this meeting.

Aileen Huang-Saad and Thomas Zurbuchen from the Center for Entrepreneurship presented this proposal for a second time.

Program Overview

The Center for Entrepreneurship (CFE) and the Samuel L. Zell and Robert H. Lurie Institute for Entrepreneurial Studies (ZLI), as representatives from the College of Engineering (CoE) and the Ross School of Business, respectively, propose the establishment of a joint professional master's degree to arm students with the critical multidisciplinary knowledge necessary to create new high tech ventures as standalone entities and/or within established innovative organizations. Students will learn to create and capture value from novel technologies within the context of entrepreneurship. The joint Masters Degree in Entrepreneurship described in this proposal brings together curricula and faculty from the CoE and Ross, organizing them within a structure that leverages the strengths of both institutions.

The program objectives are as follows:

- 1. Provide graduate scientists and engineers with a comprehensive understanding of technology opportunity identification and implementation.
- 2. Educate students in the scientific design approach to product development, emphasizing the important of customer input throughout design.
- 3. Provide students with fundamental entrepreneurial business skills for venture creation.
- 4. Provide students with the opportunity to integrate the key principles of entrepreneurship and technology development and experience the added-value of this cross-disciplinary approach.

After some discussion and some requested revisions it was moved and seconded to vote to approve this Program. This was approved and the revised Program will be submitted to the Faculty on October 6, 2010.

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

Next Meeting: October 12, 2010 1:30 PM, GM Room 4th Floor Lurie Engineering Center

COURSE APPROVAL FORMS

For October 12, 2010 CoE CC Meeting

BME 350	Modification—Changing Title from: Introduction to Biomedical Instrumentation Design <i>to: Introduction to Biomedical Engineering</i>
	Design; Changing Description; Changing Prerequisite from: None to: Biomede 211, 221, 231; co-requisite BME 241
CHE 230	Modification—Changing Title from: Material and Energy Balances to:
	Introduction to Material and Energy Balances; Changing Prerequisite
	from: "Engr. 103, Chem 126, Math 116 to: "Engr. 100, Eng 101, Chem
	130, Math 116
CHE 341	Modification—Changing 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—Changing Prerequisite from: ChE 230 to: ChE 230, ChE
	330 and preceded or accompanied by ChE 342
CHE 466	Modification—Changing Course Description
CEE 325	Modification—Changing Prerequisite from: CEE 211 and ME 235 or
	ChemE 230 to: CEE 211 and prior or concurrent enrollment in CEE
	230 or MechEng 235
CEE 520	Modification-Changing Title from: Deterministic and Stochastic Models
	in Hydrology to: Physical Processes of Land-Surface Hydrology;
	Changing Description; Changing Prerequisite from: CEE 420, CEE 421
	to: CEE 421
CEE 573	New Course
EECS 418	New Course
EECS 419	New Course
EECS 463	New Course

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SUPPORTING STATEMENT

The BiomedE Department is requesting a modification to BiomedE 350: Introduction to Biomedical Instrumentation Design. The rationale for this is twofold. First, BiomedE students need additional exposure to, and explicit experience with, computational design tools in order to propose and validate feasible solutions to real world biomedical engineering problems with industrial and/or. clinical relevance...This exposure and experience will provide a strong fundamental background and foundation for the design experience in the senior year (BiomedE 450). It is believed that incorporating additional design tools into this course, and the BiomedE.curriculum in general, will also better prepare our graduates for success in the biomedical device and biotechnology industries

Second, the previous BiomedE 350 course was tailored primarily to the "bioelectrics" concentration. The proposed changes will..... broaden 350 to more closely match the needs of students in all three of our undergraduate concentrations.

.....

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

Detail the Special requirements

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The course will need to be taught in a dedicated CAEN teaching classroom (e.g., LBME 1310 or equivalent) equipped with the appropriate software (Matlab, SolidWorks, COMSOL, and Simpleware for the first iteration of this revised course in Winter 2011) so that the instructor can give students thorough software tutorials and demonstrations.

BIOMEDE 350: INTRODUCTION TO BIOMEDICAL ENGINEERING DESIGN WINTER 2011

Bulletin Description:	This course uses problem-based learning to introduce students to biomedical engineering design concepts, tools,
	and methodologies. Students will work in small groups and use virtual design and computational tools to propose and validate feasible solutions to real-world biomedical engineering problems with industrial and/or clinical relevance.

Instructor: Andrew Putnam, Ph.D. Associate Professor 2154 Lurie Biomedical Engineering Building Phone: (734) 615-1398 E-mail: <u>putnam@umich.edu</u>

GSI: TBD

Course Description:

This course, intended for 3rd-year undergraduates majoring in biomedical engineering, will expose students to key aspects of the process of designing a biomedical device or biotechnology product, and provide them with the technical fundamentals to perform design. What the students learn in this course is foundational to the design experience in the 4th-year of the curriculum (BME 450).

The primary focus of this class will be a series of problem-based learning (PBL) modules used to provide student teams with practical experience through "virtual" design of biomedical devices and technologies. Students working in small groups will pose feasible solutions to real-world biomedical problems and perform engineering analyses to substantiate their proposed solutions. These PBL vignettes will be open-ended problems with no single correct answer, but somewhat more constrained than in senior design to reflect the more introductory nature of this course.

Lectures will impart general knowledge of problem solving skills and algorithm design, present the engineering and physiology background relevant for specific PBL topics, and provide tutorials for relevant software packages commonly used in biomedical engineering. Through the PBL-based design vignettes, students will gain familiarity with CAD (e.g., SolidWorks), computational (e.g., COMSOL, Matlab), and image processing (e.g., Simpleware) software packages.

Midterm and final examinations will test individual students and their knowledge of the various modules and their solution strategies.

Required Textbooks: TBD Additional References: TBD

Prerequisites: BIOMEDE 211, 221, and 231 Corequisites: BIOMEDE 241

Tentative Lecture Topics:

- 1. Introduction to engineering problem solving and algorithms.
- 2. Design cycle: Problem identification, conceptual model, mathematical model, coding, application.
- 3. Problem formulation and algorithmic design.
- 4. PBL Module #1
 - a. Matlab tutorial
 - Background biology and physiology related to module #1
- 5. PBL Module #2
 - a. CAD tutorial (SolidWorks)
 - b. Background physiology and fluid dynamics related to module #2
- PBL Module #3
 - a. Image analysis tutorial (Simpleware)
 - Background biology and physiology related to module #3
- 7. PBL Module #4
 - a. Computational tool tutorial (COMSOL)
 - b. Background physiology and mechanics related to module #4

Course Outcomes:

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

- 1. Define and solve design-oriented problems to gain familiarity with state-of-the-art software packages that are commonly used in engineering design.
- 2. Formulate feasible design strategies based on model algorithms.
- 3. Document the problem identification and algorithmic design.
- 4. Translate algorithms into computational tools.
- 5. Use computational tools for virtual design, including development, validation, and optimization of prototypes.

Grading Criteria:	PBL Assignments (4) Midterm exam	60% (15% each) 20%
	Final exam	20%

Course Profile: Biomet	Course Profile: Biomedical Engineering Program	
COURSE #: BIOMEDE 350	50	COURSE TITLE: INTRODUCTION TO BIOMEDICAL ENGINEERING DESIGN
TERMS OFFERED: Fall and Winter	and Winter	PREREQUISITES: Junior standing COGNIZANT FACULTY: A. Putnam
TEXTBOOK/REQUIRE]	TEXTBOOK/REQUIRED MATERIAL: Course pack.	
		SCIENCE/DESIGN: 1/2
CATALOG DESCRIPTI	CATALOG DESCRIPTION: This course uses problem-based learning to introduce	COURSE TOPICS:
students to biomedical eng	students to biomedical engineering design concepts, tools, and methodologies. Students	
will work in small groups a	will work in small groups and use virtual design and computational tools to propose and	2. Design cycle: Problem identification, conceptual model, mathematical model.
validate feasible solutions	validate feasible solutions to real-world biomedical engineering problems with	
industrial and/or clinical relevance.	levance.	
		<u> </u>
		5. PBL Module #2
		b. Background physiology and fluid dynamics related to module #2
		6. PBI. Module #3
		0
		b. Background physiology and mechanics related to module #4
	To expose students to key aspects of	the process of designing a biomedical device or biotechnology product.
COUDCE	2. To provide students with the technical fundamentals to perform design.	to perform design. Its and almosithm design
OB IECTIVES*		10 IIIipati generat miowieuge of protein solving sams and argonani uesign. To across students to relevant software readense commonly used in historich and maintaring dasion and analyzas
OBJECTIVES.		To expose suments to teter and software packages continuous used in connected engineering design and analyses. To provide students with practical experience in the use of software tools through "virtual" team-based design of biomedical devices and
	technologies.	
	2	n completion of this course, students should be able to: Define and colve design originated revolutions to avia familiarity with state of the art coftware nackanee that are commonly used in anoinverting
	1. Define and some design-onemed proteins to gain to design.	אווווומוווץ איונו אמנכיטי-נוולימון אטונאמוכ אלאאני איני אמראפרא נוומן מיל ניטוווועווון שאנט אווווי
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		sted to the course theory and background.
TOOLS	 Problem-based learning modules (4 total) for studen modules) and group oral presentations. 	Problem-based learning modules (4 (olar) for student groups evaluated based on written design documentation (solutions to each of the 4 PBL) modules) and group oral presentations.

	THE UNIVERSITY OF MICHIGAN COLLEGE OF Course Approval Request College Curriculum Committee, 1420 Lurie Engineeri Action Requested New Course Modification of Existing Course Deletion of Course A. CURRENT LISTING Home Department CHE Chemical Engineering 230	Form Number ing Center Building Date 10/4/2010 :: Effective Term Winter 2011
	Course Title	Course Title
x	Material and Energy Balances	Introduction to Material and Energy Balances
	TITLE Time Sched Max = 19 Spaces Mat & Enrgy Balnces	TITLE Time Sched Max = 19 Spaces Mat & Enrgy Balnces
	ABBRE- VIATION Transcript Max = 20 Spaces MAT & ENRGY BALANCES	ABBRE- VIATION Transcript Max = 20 Spaces MAT & ENRGY BALANCES
	Course Description An introduction to material and energy balances in chemical engineering applications, including environmental and biological systems. Engineering problem-solving, the equilibrium concept, first law of thermodynamics. Introduction to chemical engineering as a profession.	Course Description for Official Publication (Max = 50 words) An introduction to material and energy balances in chemical engineering applications, including environmental and biological systems. Engineering problem-solving, the equilibrium concept, first law of thermodynamics. Introduction to chemical engineering as a profession.
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C.	Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeat	O Yes Max Max Can it be repeated O Yes table? No Hours? Times? in the same term? O No
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	Rec Lab Ind Course Is Y Graded	is not a regular graduate faculty
	Approval Info Approved by Name Approved Date Curriculum Comm.	- Department Chair Name
	Faculty Cross listed Unit 1	Home Dept. Mark Burns, Chem Engr
	Cross listed Unit 2	Cross-listed
		Dept(s)9

2170

SUPPORTING STATEMENT

Changing prerequisites and course title.

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Are any special resources or facilities required for this course?	_ Yes _ No
Detail the Special requirements	
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	THE UNIVERSITY OF MICHIGAN COLLEGE OF Course Approval Request College Curriculum Committee, 1420 Lurie Engineerin Action Requested New Course Modification of Existing Course Deletion of Course A. CURRENT LISTING Home Department CHE Chemical Engineering 341	Form Number
	Course Title Fluid Mechanics TITLE ABBRE- VIATION Time Sched Max = 19 Spaces Transcript Max = 20 Spaces FLUID MECH	Course Title Fluid Mechanics TITLE ABBRE- VIATION Transcript Max = 20 Spaces TRANSCRIPT TITLE Max = 20 Spaces TRANSCRIPT TITLE Max = 20 Spaces TRANSCRIPT TITLE TITLE TITLE TITLE ABBRE- TITLE TITLE TITLE ABBRE- TITLE TITLE ABBRE- TITLE TITLE ABBRE- TITLE TITLE ABBRE- TITLE TITLE TITLE ABBRE- TITLE TITLE TITLE TITLE ABBRE- TITLE TI
	Course Description Fluid mechanics for chemical engineers. Mass, momentum, and energy balances on finite and differential systems. Laminar and turbulent flow in pipes, equipment, and porous media. Polymer processing and boundary layers. Potential, two-phase, and non- Newtonian flow.	Course Description for Official Publication (Max = 50 words) Fluid mechanics for chemical engineers. Mass, momentum, and energy balances on finite and differential systems. Laminar and turbulent flow in pipes, equipment, and porous media. Polymer processing and boundary layers. Potential, two-phase, and non- Newtonian flow.
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	Curriculum Comm. Faculty Cross listed Unit 1	Department Chair Name Chair Signature Home Dept. Mark Burns, Chair
	Cross listed Unit 2	Cross-listed Dept(s)

2171

SUPPORTING STATEMENT

Changing prerequisites

Are any special resources or facilities required for this course?	Yes No
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Detail the Special requirements	
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		ERSITY OF MICHIGAN COLLEGE OF Course Approval Request	Form Number	2172
	College Cu Action Requested	rriculum Committee, 1420 Lurie Engineerir	ng Center Building Date	10/4/2010
	<ul> <li>New Course</li> <li>Modification of Existing Course</li> <li>Deletion of Course</li> </ul>	Complete the following sections: New Courses - B & C completely Modifications - A modified informati Deletions - A & C completely	Effective Terr	
	A. CURRENT LISTING		B. REQUESTED LISTING	One term only
Ĩ	Home Department	Course Number	Home Department	Course Number
	CHE Chemical Engineering	343	CHE Chemical Engineering	343
	Cross Listed Course Information		Cross Listed Course Information	
	Course Title		Course Title	
$\square$	Separation Processes		Separation Processes	
		oar Process	TITLE Time Sched Separ Process	
	ABBRE-	PAR PROCESS	ABBRE- VIATION Transcript Max = 20 Spaces SEPAR PROCE	SS
	Course Description		Course Description for Official Publication (N	/lax = 50 words)
	Introduction and survey of sepa properties, phase equilibria, an analysis and modeling of separ countercurrent operations. Incl biological, and environmental	d rate processes. Emphasis on ation processes. Staged and udes applications to chemical,	Introduction and survey of separations properties, phase equilibria, and rate pr analysis and modeling of separation pr countercurrent operations. Includes app biological, and environmental systems	ocesses. Emphasis on ocesses. Staged and plications to chemical,
	OUTCOMES: Db d	-		g ⊡i ⊠k h ⊡j
	DegreeImage: O Degree RequiRequirementsO Core Course	rement O Free Elective O Other O Tech Elective	Degree         Image: Organization of the sector of th	O Free Elective O Other O Tech Elective
x	Prereq ChE 230 © Enforced O Advised		Prereq ChE 230, ChE 330 and precede Enforced 342. Advised	ed or accompanied by ChE
	Credit		Credit Restrictions	
	Restrictions  Level of Credit  Undergrad only Rackham Grad Oracle Ugrad or Non-Rckhm Non-Rckhm Grad All Credit types		Level of Credit Undergrad only Ugrad or Rckhm Grad I Rackham Grad Ugrad or Non-Rckhm Grad Non-Rckhm Grad All Credit types	Credit HoursContact Hrs/WkMinMax440Wks14
	Repeatability (Indi Research, Dir.	Study, Dissertation: Is this course repeat	able? ^O Yes Max Max ^{No} Hours? Times?	Can it be repeated O Yes in the same term? O No
с.	Class Type(s)         \(\beed{Lec}\) Sem \(\Dec{Dis}\) Ind         \(\Beed{Rec}\) Lab \(\Dec{Dis}\) Ind         Graded Section         \(\Dec{Lec}\) Sem \(\Dec{Dis}\) Ind         \(\Dec{Lec}\) Lab \(\Dec{Dis}\) Ind         \(\Dec{Rec}\) Lab \(\Dec{Dis}\) Ind	Grading     Location       er	Cognizant Faculty Member: Mark Burns, ChE Joerg Lahann, ChE Mike Solomon Grad Course: Attach nomination if Cogniz is not a regular graduate faculty e Submitted By: Home D Department Chair Nam Home Dept. Mark A. Burns, Chair	Title Professor/Chair Associate Professor Professor zant Faculty ept. Cross-listed Dept. e Crait Signature
	·		Dept(s)	

2172

### SUPPORTING STATEMENT

Changing Prerequisites

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Are any special resources or facilities required for this course?	Yes No
Detail the Special requirements	

	THE UNIVERSITY OF MICHIGAN COLLEGE OF Course Approval Request	Form Number
	College Curriculum Committee, 1420 Lurie Engineerin Action Requested	ng Center Building Date 10/4/2010
	<ul> <li>New Course</li> <li>Modification of Existing Course</li> <li>Deletion of Course</li> </ul> Complete the following sections: New Courses - B & C completely Modifications - A modified information Deletions - A & C completely	ion, B & C completely Effective Term Winter 2011
	A. CURRENT LISTING	B. REQUESTED LISTING
	Home Department Course Number	Home Department Course Number
	CHE Chemical Engineering 466	CHE Chemical Engineering 466
	Cross Listed Course Information	Cross Listed Course Information
	Course Title	Course Title
$\Box$	Process Dynamics and Control	Process Dynamics and Control
	TITLE Time Sched Max = 19 Spaces Proc Dyn & Cntrl	TITLE Time Sched Max = 19 Spaces Proc Dyn & Cntrl
	ABBRE- VIATION Transcript Max = 20 Spaces PROC CNTRL	ABBRE- VIATION Transcript Max = 20 Spaces PROC CNTRL
X	Course Description	Course Description for Official Publication (Max = 50 words)
-	Introduction to process control in chemical engineering. Application of Laplace transforms and frequency domain theory to the analysis of open-loop and closed-loop process dynamics. Stability analysis and gain/phase margins. Controller modes and settings. Applications to the control of level, flow, heat exchangers, reactors, and elementary multivariable systems.	Introduction to process control in chemical engineering. Control architecture design, notation, and implementation. Mathematical modeling and analysis of open-loop and closed-loop process dynamics. Applications to the control of level, flow, heat exchangers, reactors, and elementary multivariable systems. Statistical process control concepts.
	PROGRAM 🛛 a 🖾 c 🖄 e 🗍 g 🗍 i 🖄 k OUTCOMES: 🗍 b 🗍 d 🗍 f 🗍 h 🗍 j	PROGRAM OUTCOMES: a a c a g i k b d f h j
	Degree         Image: Organization Degree Requirement         Organization Free Elective         Organization Other           Requirements         Organization Correction         Organization Correction         Organization         Organization	Degree         O Degree Requirement         O Free Elective         O Other           Requirements         O Core Course         O Tech Elective         O Other
	Prereq ChE 343 and 344	Prereq ChE 343 and 344
	Enforced     Advised	Enforced     Advised
	Credit	Credit
	Restrictions  Level of Credit  Contact	Restrictions  Level of Credit  Contact
	Ø Undergrad only       □ Ugrad or Rckhm Grad       □ R       Credit Hours       Hrs/Wk       3         □ Rackham Grad       □ Ugrad or Non-Rckhm Grad       □ Min       Max       Number         □ Non-Rckhm Grad       □ All Credit types       3       3       0 Wins       14	⊠ Undergrad only       □ Ugrad or Rckhm Grad       □ I       Credit Hours       Hrs/Wk       3         □ Rackham Grad       □ Ugrad or Non-Rckhm Grad       □ I       Min       Max       Number         □ Non-Rckhm Grad       □ All Credit types       3       3       of Wks       14
	Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeata	able? Ores Max Max Can it be repeated Ores in the same term? No
C.	Class Type(s) Grading Location	Cognizant Faculty Member: Title
	⊠ Lec □ Sem □ Dis □ Other ⊠ A-E ⊠ Ann Arbor	Barry Barkel Lecturer
	Rec     Lab     Ind     CR/NC     Biological Station       P/F     Camp Davis	Susan Montgomery Lecturuer
	Graded Section         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □         □ <th□< th="">         □         □</th□<>	Robert Ziff Professor
	□ Rec       □ Lab       □ Ind       Course Is Y Graded	Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty
	Approval Info Approved by Name Approved Date	
	Curriculum Comm.	- Department Chair Name Chair Signature
	Faculty     Cross listed Unit 1	Home Dept. Mark Burns, Chair
	Cross listed Unit 1	- All
		_ Cross-listed Dept(s).

2173

### SUPPORTING STATEMENT

Course Description changed.

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And any appendix recovered as facilities required for this source?	
Are any special resources or facilities required for this course?	☐ Yes ⊠ No
Detail the Special requirements	
Detail the opeoial requirements	

	Action Requested New Course Modification of Exis Deletion of Course A. CURRENT LIS Home Department CEE Civil & Enviro Cross Listed Course In	College Curr sting Course TING	Complete the follo New Courses - B & Modifications - A m Deletions - A & C	oroval Request 20 Lurie Engineerin owing sections: C completely codified informati	ng Center I ion, B & C B. RE Home De CEE Ci	Building complet QUESTE	D LIS	Effective Course Offe STING mental Eng	Date Term er Freq	2163 9/7/2010 Winter 20	D11
	Course Title				Course	Γitle					
	Fluid Mechanics				Fluid Me	chanics					
	TITLE Time Sched Max = 19 Spa VIATION Transcript Max = 20 Spa		I Mechanics		TITLE ABBRE- VIATION	Time So Max = 19 Transcr Max = 20	Spaces ript	Fluid Mech	anics		
	properties and static by control volume a laminar and turbule boundary layers, dra	cs; continuity nalysis; differ t flow; dimens ag, and lift; ir	to real and ideal flui r, energy, and mome rential equations of r sional analysis and s ncompressible flow i ery. Lectures and lal	ntum equations notion for similitude; n pipes; fluid	Principle propertie equation motion f	es of med es and st ns by cor or lamina le; bound uid meas	chanic tatics; ntrol vo ar and dary la	ficial Publica continuity, o olume analy turbulet floo yers, drag, ent and turb	o real an energy, vsis; diff w; dime and lift;	nd ideal flui , and mome ferential eq ensional an ; incompres	ids. Fluid entum uations of alysis and ssible flow in
	OUTCOMES:	a c a b a d a	e Xg i X f h j ement O Free Electi		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	GRAM		b 🛛 d 🗌	]f [	]h 🗆 j	⊠k tive O Other
	Requirements		O Tech Electi			ements	Co	re Course	(	O Tech Elec	
X	Enforced Advised				Enforced MechEng 235     Advised						
	Credit Restrictions				Credit Restrictions						
	Level of Cr	<b>edit</b> Ugrad or Non-Rck All Credit types Rckhm Grad w/ad	d'i Work Credit Hours	Contact Hrs/Wk <u>6</u> Number of Wks <u>14</u>	M Undergra	Level o ad only n Grad hm Grad Rokhm Grad		it rad or Non-Rckhn Credit types chm Grad w/add'l	n Grad Work	Credit Hours Min Max 4 4	Contact Hrs/Wk 6 Number of Wks 14
C.	<u>.</u>	search, Dir. Sl	tudy, Dissertation: Is t		e. 1	No Hour	rs? —	Max — Times?		Can it be rep in the same	
		]Dis DOth ]Ind		ation Ann Arbor Biological Station Camp Davis	Aline C	zant Fac otel	ulty M	ember:		Title Associ	ate Professor
		Dis Doth	er	Extension raded	13	a regular	gradua	omination if C ate faculty			1
	Approval Info	omm	roved by Name	Approved Date	Home E	De Dept. Na -listed Civ	ncy G vil & E	ent Chair . Love, Prof nvironmenta	Name essor/ al Engli	Chair :	s-listed Dept. Signature
	Cross listed U				- Cross	listed Civ	vil & El		al Engii	n	70

	Form Number
	2163
UPPORTING STATEMENT	
The prerequisites for this course are being changed from enforced to advisory, to make a second s	
he current practice. Enforced prerequisites are also causing backups at registration, as nearly every stur	dont roquiroo normicalon
to register	dent requires permission
*****	-
*****	
re any special resources or facilities required for this course? 🛛 🖸 Yes 🔯	No
Detail the Special requirements	
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_	<ul> <li>New C</li> <li>Modifi</li> <li>Deleti</li> </ul> A. CUI Home D CEE Civ	Colle	ege Curriculum ( Course New ( Modifi Deleti	Course App Committee, 142 Dete the follo Courses - B & cations - A mo ons - A & C c	dified informati	ng Center B : ion, B & C B. REC Home Dep	com 2UES partm vil &	pletely STED L ent Enviro	Ef Cours LISTING	tal Engin	a 🛛 Indef	0 011
x	Course T	itle histic and Stocha	etic Models in	Hydrology		Course T		05505	ofland	-Surface Hy	rdrology	· · · · ·
X	TITLE ABBRE- VIATION Course D	Time Sched Max = 19 Spaces Transcript Max = 20 Spaces Rescription atical description	Determ Stor	ch Models ch Models		TITLE ABBRE- VIATION Course De	Tin Max Tra Max =	ne Sched = 19 Speci anscript = 20 Spece ition for	es Phy Phy Phy Official	s Proc Hydr s Proc Hydr Publication (N	Aax = 50 word	s) ne atmosphere;
	overland flow. Flood routing through reservoirs and rivers. Unit hydrograph theory. Linear and nonlinear models for small watershed analysis. Application of time series and spectral analysis to hydrologic data. Streamflow simulation by autoregressive and moving average models.         PROGRAM       a       c       e       g       i       k				mall ectral analysis essive and	dry adiabatic and pseudoadiabatic processes. Vapor turbulent transfer. Heat fluxes and surface energy budgets. Mass transfer and energy budget methods for estimating evapotranspiration. Soil physical properties; water flow in unsaturated soils; infiltrations Snow hydrology. Runoff generation. Probabilistic approaches to describing spatial variability.         PROGRAM       a       c       e       g       i       k						fass transfer inspiration. oils; infiltration. oproaches to
	Degree Require	O Degree	Requirement	O Free Elective O Tech Electiv		OUTCO Degree Require		0 I	Degree Core Co	Requirement ourse	O Free Eler O Tech Ele	
X	Prereq Enforce Advise		421			Prereq O Enforce O Advised	d	E 421				
_	Credit					Credit Restrictions						
	Restrictions	Level of Credit donly Ugrad of Grad All Cred m Grad Rokhm Rokhm Grad	or Non-Rokhm Grad fit types Grad w/add'l Work	Credit Hours Min Max <u>3</u> 3	Contact Hrs/Wk Number of Wks14	Undergrad Rackham Non-Rckhi Ugrad or F	d only Grad m Grad Rokhm			lon-Rckhm Grad ypes ad w/add'i Work	Credit Hours Min Max <u>3 3</u>	Contact Hrs/Wk 3 Number of Wks 14
C.	Class Type(s)     Grading     Location       Image: Class Type(s)     Image: Class Type(s)			ation	No         Hours?         Times?         in the same term?         No           Cognizant Faculty Member:         Title           Valeriy Ivanov         Assistant Professor						term? 🖲 No	
	🛛 Lec		Other _		Extension				nomina duate fac	ation if Cogniz culty	ant Faculty	
	Cu Fai Cro	val Info rrriculum Comm. culty oss listed Unit 1 oss listed Unit 2	Approved by	v Name	Approved Date	Home De	ept.	Nancy Civil &	tment G. Lov Enviro	Home De Chair Name Chair Name e, Professo nmental Eng		s-listed Dept. Signature

2159

### SUPPORTING STATEMENT

The course number, CEE 520, existed previously, however, the class materials, problem sets, and tests were developed entirely by. Valeriy lyanov. The intention to change the title and description is necessary to better reflect the course content. The course develops mathematical description of key elements of the hydrological cycle, such as physical processes of water dynamics in the atmosphere, turbulent transfer of admixtures in the boundary layer, surface energy budget and heat fluxes, water flow in soils, and, runoff generation. The course objective is to provide a concise description of essential physical processes in the land-phase of the hydrological cycle and develop skills necessary for problem numerical treatment (model development). This is substantially different from what the old description assumed

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

Detail the Special requirements

	THE UNIVERSITY OF MICHIGAN COLLEGE OF Course Approval Request College Curriculum Committee, 1420 Lurie Engineeria Action Requested Complete the following sections: Modification of Existing Course New Courses - B & C completely Modification of Course Modifications - A modified information A. CURRENT LISTING	st Form Number 2102 beering Center Building Date 9/7/2010 Date 9/7/2010 Winter 2011 winter 2011 Winter 2011 Indefinitely B. REQUESTED LISTING One term only					
[]	Course Title	Course Title					
		Methods of Data Analysis					
2	TITLE Time Sched ABBRE- VIATION Transcript	TITLE Time Sched Meth Data Analysis ABBRE- Max = 19 Spaces Meth Data Analysis VIATION Transcript Meth Data Analysis					
	Max = 20 Spaces Course Description	VIATION Max = 20 Spaces Meth Data Analysis 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.					
l	OUTCOMES: b d f h j Degree O Degree Requirement O Free Elective O Other	OUTCOMES: b d f h j Degree O Degree Requirement O Free Elective Image: Other					
	Requirements O Core Course O Tech Elective Prereq	Requirements O Core Course O Tech Elective					
	O Enforced O Advised	Prereq CEE 270 or equivalent. O Enforced S Advised					
	Credit	Credit					
	Restrictions	Restrictions					
	Level of Credit Udregred only Rackham Grad Ugred or Non-Rokhm Grad Ugred or Non-Rokhm Grad Ugred or Rokhm	Level of Credit Undergrad only Rackham Grad Ugrad or Non-Rokhm Grad Ugrad or Rockhm Grad Ugrad or Rockhm Grad wladd'I Work Credit Hours Min Max 3 3 Contact Hrs/Wk 3 Number of Wks 14					
с.	Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeata	Hours? Times? in the same term? SNO					
コ	Class Type(s) Grading Location Image: Lec Sem Dis Other A-E Image: A-E Ann Arbor Rec Lab Ind CR/NC Biological Station Graded Section P/F Camp Davis Image: Lab Dis Other S/U S/U Extension	Cognizant Faculty Member: Title Valeriy Ivanov Assistant Professor					
	Lec Sem Dis Other_ Course is Y Graded Rec Lab Ind Course is Y Graded Ind	Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty					
	Approval Info Approved by Name Approved Date	Submitted By: Home Dept. Cross-listed Dept. Department Chair Name Chair Signature					
	Faculty Faculty Cross listed Unit 1 Cross listed Unit 2	Home Dept. Nancy G. Love, Professor					

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 Yes 🛛 No Are any special resources or facilities required for this course? 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: <u>ivanov@umich.edu</u>

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 <u>aael.course.reserves@umich.edu</u>

* 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	Торіс
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

	THE UNIVE	ERSITY OF MICHIGAN COLLEGE OF Course Approval Request	ENGINEERING	Form Number	2154
	College Curr	iculum Committee, 1420 Lurie Engineeri	ng Center Building		
	Action Requested	Complete the following costions		Date	4/15/2010
	 New Course Modification of Existing Course Deletion of Course 	Complete the following sections: New Courses - B & C completely Modifications - A modified informati Deletions - A & C completely		Effective Term	Winter 2011
	A. CURRENT LISTING		B. REQUESTED	Course Offer Freq	 Indefinitely One term only
8	Home Department	Course Number	Home Department	LISTING	Course Number
	nome Department		EECS Elec Engin	9 Computer Sei	418
	Cross Listed Course Information			•	410
	Cross Listed Course mornation		Cross Listed Course Ir	ntormation	
	Course Title		Course Title		
\Box			Power Electronics		
8	TITLE Time Sched		TITLE Time Sched		
	ABBRE- VIATION Transcript		ABBRE- Max = 19 Spac	Power Electronics	
	Max = 20 Spaces		Max = 20 Space	es	(= 50 words)
	Course Description		AC-DC, DC-DC sw converter topologies capacitors. Loss me	B. Power Semiconduc	verter topologies. Power tor devices, inductors, nalysis. Drive, snubber
	OUTCOMES: b d f		and the second second second second	⊠a⊠c ⊡e ⊡g ⊠b⊠d⊠f ⊡h	
	Requirements O Core Course	ement O Free Elective O Other O Tech Elective	Requirements O	Core Course O	Free Elective O Other Tech Elective
	Prereq O Enforced O Advised		Prereq (EECS 215 Enforced EECS 320) Advised		eded or accompanied by
	Credit Restrictions		Credit Restrictions		
	Level of Credit Undergrad only Ugrad or Rckhm Grad Rackham Grad Ugrad or Non-Rckhm G Non-Rckhm Grad All Credit types	□ R Credit Hours Contact Hrs/Wk Min Max Number of Wks	Level of Cro	d or Rckhm Grad Cr d or Non-Rckhm Grad N	Contact Hrs/Wk 4 Min Max Mumber of Wks
	Repeatability (Indi Research, Dir. St	udy, Dissertation: Is this course repeata	ble? O Yes Max No Hours?		Can it be repeated O Yes in the same term? O No
с.	Class Type(s) \(\beed{Lec}\) Sem \(\beed{Dis}\) Ind \(\beed{Dis}\) \(\mathbf{Rec}\) Action \(\mathbf{Graded Section\) \(\beed{Lec}\) Sem \(\beed{Dis}\) \(\mathbf{Rec}\) Lab \(\beed{Dis}\) \(\mathbf{Rec}\) Lab \(\beed{Dis}\) \(Approval Info\)	Cognizant Faculty Heath Hofmann Grad Course: Attach is not a regular grad	Member:	Title Asso. Prof.	
	Curriculum Comm.	oved by Name Approved Date			
	□ Faculty			tment Chair Name	Chair Signature
	Cross listed Unit 1		Home Dept. EEC	s khalilNajat	Man-MATAD
	Cross listed Unit 2		Cross-listed Dept(s)		
					26

21	15	4	
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SUPPORTING STATEMENT

This course covers electronic circuits related to power conversion (e.g., AC-DC conversion, DC-DC conversion). It was offered in FAO9 as a special topics class (EECS 498-08) and was highly reviewed (11/13 students responding Q1 4.89). It is being offered again now (FA10) and has 24 students at this time. Student interest and feedback about the course is very good and it serves a previously missing critical need in the EE course offerings.

Detail the Special requirements

The power and energy lab (3437 EECS) contains 8 lab stations. Pertinent lab equipment includes DC and 3-phase AC power supplies, a programmable DC electronic load, and components for AC-DC and DC-DC converter circuits.

EECS 498 Power Electronics Fall 2010

1. Prerequisites: EECS 215 and 216, or graduate standing

2. Lecture, Lab Times: Lecture: MW 3-4:30 in 3427 EECS Lab: Lab times will be assigned after receipt of student's schedules.

3. Purpose: Meeting the future's energy and environmental challenges will require the efficient conversion of electrical energy from one form to another. This course will discuss the circuits used to efficiently convert AC power to DC power, DC power from one voltage level to another, and DC power to AC power. The components used in these circuits (e.g., diodes, transistors, capacitors, inductors) will also be covered in detail. A key aspect of power electronic circuits is the control algorithms used to achieve the desired behavior (e.g., output voltage regulation), and so control theory as it applies to these circuits will be discussed. A lab will be held with the class where the students will obtain hands-on experience with power electronic circuits.

- 4. **Objectives:** Upon successful completion of this course, the student should:
 - 1. Understand how fundamental power electronic circuit topologies operate.
 - 2. Quantitatively determine the power quality impact of AC-connected power electronic circuits.
 - 3. Be able to design control algorithms for DC-DC converter circuits.
 - 4. Be familiar with the properties of power semiconductor devices (i.e., diodes, transistors, ...) as they are used in power electronic circuits.
 - 5. Understand how to calculate the efficiency of power electronic circuits.
 - 6. Be able to analyze and design magnetic inductors and transformers for power electronic circuits.
 - 7. Possess a basic understanding of the cooling of power electronic circuits
 - 8. Have hands-on experience with many power electronic circuit topologies in the laboratory.
 - 9. Have designed a power electronic circuit as part of a course project.

5. Topics

AC-DC Conversion DC-DC Conversion Fundamental converter topologies Isolated converter topologies Control of DC-DC Converters Power Semiconductor Devices Diodes Thyristors BJTs MOSFETs IGBTs Power Electronic Components Capacitors Inductors, Transformers

Auxiliary Circuitry

Gate and Base Drive Circuits "Snubber" Circuits Thermal Analysis

6. Texts:

Required:

Mohan, Undeland, and Robbins. *Power Electronics*, 3rd edition. John Wiley & Sons, Inc. New York, 2003.

Suggested:

Kassakian, Schlecht, and Verghese. *Principles of Power Electronics*. Addison-Wesley. Reading, Mass., 1991.

Krein. *Elements of Power Electronics*. Oxford University Press. New York, 1998 Erickson and Maksimovic. *Fundamentals of Power Electronics*, 2nd edition. Springer. New York, 1999.

7. Instructors:

Prof. Heath Hofmann	Office hours:
4116 EECS	Tuesdays and Wednesdays 10:30-12
(734) 647-1107	Other times by appointment
hofmann@eecs.umich.edu	
Prof. G.R. Lahiji	Office hours:
3115 EECS	Monday and Thursday 1:30-3:00
(734)763-1156	Other times by appointment
roientan@umich.edu	

8. Exams: The class will have one in-class midterm (whose time has yet to be determined) and a fina. If you have a valid reason for missing the midterm, you must notify the instructor at least two weeks in advance so that a conflict exam can be prepared. Students from all sections will take identical exams. Exams are closed-book, but each student is allowed a single 8.5" by 11" note sheet. Exams are returned during lecture sessions. Any student caught cheating on an exam will receive a grade of 0 for the exam. Additional sanctions may also be pursued, following university guidelines.

9. Homeworks: Homeworks will be assigned on Mondays, and, unless otherwise noted, will be collected during lecture on the Wednesday of the following week. Students are encouraged to discuss homework problems in groups. **However, each student must submit their own work.** Students submitting identical work will receive a grade of zero for the homework set. Problem set solutions will be posted on the CTOOLs web site. Graded homework sets will be returned in class. **Late homework will not be accepted.** However, the lowest homework score will be dropped in calculating your overall homework grade. In order to perform well on the exams, it is important that you work each problem assigned. Although your final homework grade may be unaffected if you do not turn in one of the problem sets, your exam grades, which play a much larger role in determining your final grade, will be adversely affected.

10. Labs: In addition to the lectures, a lab will be held every week where the students will obtain hands-on experience with electric machines and drives. Students will work with a partner in the labs, and submit a joint lab report. In addition to including the data obtained during the lab, lab reports must be well-written and clearly explain the concepts presented during the lab. It is **not**

acceptable to use data collected by other lab teams in your lab report; you must use your own. If there are problems with your lab data, contact the lab assistant. Measured results will be compared to expected values, with any discrepancies clearly discussed. Further information on the preparation of lab reports will be handed out during the first lab section.

Lab times will be established during the first week of classes, after student's schedules have been submitted, to determine times that will work best.

11. Project: At the end of the semester, students will complete a project involving the design, construction, testing, and demonstration of a power electronic circuit. Students will work on the project during lab times with their lab partner.

12. Grading: The following weighting factors determine your total course score:

Project	10%
Homework	20%
Lab Reports	20%
Midterm	25%
Final	25%

The class average does not determine the cutoff points for letter grades. Instead, the cutoff points reflect the technical competencies required of an electrical engineer. The following scale determines your final course grade:

A+	95%-100%
Α	90%-95%
A-	85%-90%
B+	80%-85%
В	75%-80%
B-	70%-75%
C+	65%-70%
С	60%-65%
C-	55%-60%
D+	50%-55%
D	45%-50%
D-	40%-45%
Е	<40%

At the discretion of the instructor, the minimum score needed to earn a certain letter grade may be lowered, but it will not be raised.

13. Web Page: Problems sets and other important files and announcements will be posted on the EECS 498 CTOOLS site.

14. Attendance: Although attendance will not be taken, you are expected to attend lecture. It is a student's responsibility to acquire handouts and information disseminated in class.

15. Honor Code: Students in the College of Engineering at the University of Michigan are expected to be intimately familiar with its Honor Code. Details of the Honor Code are available online at:

http://www.engin.umich.edu/students/honorcode/

	THE UNIVERSITY OF MICHIGAN COLLEGE O Course Approval Request College Curriculum Committee, 1420 Lurie Enginee Action Requested New Course Modification of Existing Course Deletion of Course A. CURRENT LISTING Home Department Cross Listed Course Information	ring Center Building Date 4/15/2010 s: Effective Term Winter 2011
	Course Title	Course Title Electric Machinery and Drives
	TITLE Time Sched Max = 19 Spaces	TITLE Time Sched Max = 19 Spaces Elec Mach and Drives
	ABBRE- VIATION Transcript Max = 20 Spaces	ABBRE- VIATION Transcript Max = 20 Spaces Elec Mach and Drives
	Course Description	Course Description for Official Publication (Max = 50 words)
		Generation of forces and torques in electromechanical devices. Power electronic drives, motion control. DC machines. AC machines, surface mount permanent magnet machines, induction machines. Applications examined include electric propulsion drives for electric/hybrid vehicles, generators for wind turbines, and high-speed motor/alternators for flywheel energy storage systems. Laboratory experience with electric drives.
	PROGRAM OUTCOMES: a c e g i k b d f h j Degree O Degree Requirement O Free Elective O Other	PROGRAM OUTCOMES: \(\alpha\) a \(\alpha\) c \(\end e\) a \(\gamma\) a \(\alpha\) b \(\alpha\) d \(\alpha\) f \(\end h\) b \(\gamma\) d \(\gamma\) \(\gam
	Requirements O Core Course O Tech Elective	Requirements O Core Course O Tech Elective
	Prereq O Enforced O Advised	 Prereq ((Phys 240 or 260) and EECS 215 and EECS 216) or graduate Enforced standing Advised
	Credit Restrictions	Credit Restrictions
ш	Level of Credit Contact	Level of Credit Contact
	□ Undergrad only □ Ugrad or Rckhm Grad □ R □ Rackham Grad □ Ugrad or Non-Rckhm Grad □ Min Max □ Non-Rckhm Grad □ All Credit types	Undergrad only Ugrad or Rckhm Grad Ugrad or Non-Rckhm Grad Ugrad or Non-Rckhm Grad All Credit types
C.	Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repea	Hours? Times? in the same term? O No
	Class Type(s) Grading Location \[\] Lec \[] Sem \[] Dis \[] Other \[] Other \[] A-E \[] Ann Arbor \[] Rec \[] Lab \[] Ind \[] Ind \[] Other \[] CR/NC \[] Biological Station Graded Section \[] S/U \[] Extension	Cognizant Faculty Member: Title Heath Hofmann Asso. Prof.
	Image: Lec indication of the set of	Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty
	Approval Info Approved by Name Approved Da	te Submitted By: ☐ Home Dept. ☐ Cross-listed Dept. — Department Chair Name Chair Signature
	Faculty Cross listed Unit 1	Home Dept. EECS Khalil Natthe When Mohr
	Cross listed Unit 1 Cross listed Unit 2	Cross-listed
		Dept(s)

2155

SUPPORTING STATEMENT

This course covers fundamental materials (i.e., electro mechanical devices, control theory, power electronics)
related to electric drives. It was offered in WN10 as a special topics class (EECS 498-07) and was highly reviewed
(14/22 students responding Q1 4.42). The class served both graduate and undergraduate students from program;
including EE, ME, Concurrent Marine Design, Energy Systems Engineering. Naval Architecture and Design, and Space.
Engineering. It addresses needs both in the EE program and has broad interest across the College.

Are any special resources or facilities required for this course? Yes No Detail the Special requirements

The power and energy lab (3437 EECS) contains 8 lab stations. Pertinent lab equipment includes a DC power supply, electric drive circuitry, microcontroller, and a motor dyne which includes DC, AC permanent magnet, and AC induction machines.

EECS 498 Electric Machinery and Drives

1. Prerequisites: EECS 215 and 216, or graduate standing

2. Lecture, Lab Times:

Lecture: MW 3-4:30 in 3427 EECS

Lab: Lab times will be assigned after receipt of student's schedules.

3. Purpose: In the struggle to address today's energy and environmental challenges, many potential solutions require electro-mechanical energy conversion. Examples include electric propulsion drives for electric and hybrid electric vehicles, generators for wind turbines, and high-speed motor/alternators for flywheel energy storage systems. Each of these systems contains: an electric machine operating either as a motor, a generator, or both; a power electronic circuit which interfaces the machine to a power supply or an electrical system; and a controller which measures electrical and mechanical quantities and uses this information to control the power electronic circuitry. In this course we will cover fundamental electromechanical, power electronic, and control theory in the context of electric drive systems. The capabilities and limitations of different types of electric machines (e.g., permanent magnet, induction) in various drive applications will be covered. MATLAB® Simulink® models will be used throughout the course to give students exposure to the dynamic behavior of these systems. A lab will be held with the class where the students will obtain hands-on experience with electric machines and drives.

- 4. Objectives: Upon successful completion of this course, the student should be able to:
 - 1. Derive expressions for forces and torques in electromechanical devices.
 - 2. Understand how power electronic converters and inverters operate.
 - 3. Possess an understanding of feedback control theory.
 - 4. Analyze and compare the performance of DC and AC machines.
 - 5. Understand the maximum power limitations as a function of rotor speed of the above machines when they are connected to electric drives.
 - 6. Design control algorithms for electric drives which achieve the regulation of torque, speed, or position in the above machines.
 - 7. Develop Simulink[®] models which dynamically simulate electric machine and drive systems and their controllers.

5. Topics

Overview of electric machines and drives Review of basic circuits and systems theory Fundamentals of electromechanical devices Flux linkage/current relationships Energy, co-energy Calculation of forces and torques Fundamentals of power electronics Switching elements Pulse-Width-Modulation Fundamentals of control theory Feedback Feedforward DC machines

AC machines

Equivalent 2-phase models of three-phase machines Surface-mount permanent magnet machines Synchronous reluctance machines Interior permanent magnet machines Induction machines

6. Required Text: none (course handouts) Suggested Texts:

T. Lipo and D. Novotny. *Vector Control and Dynamics of AC Drives.* Oxford, 1996. R. Krishnan. Electric Motor Drives: Modeling, Analysis, and Control. Prentice Hall, 2001. N. Mohan. *Electric Drives: An Integrative Approach.* MNPERE, 2001.

7. Instructor:

Prof. Heath Hofmann	Office hours:
4116 EECS	TBD
(734) 647-1107	
hofmann@eecs.umich.edu	Other times by appointment

8. Exams: The class will have one in-class midterm (whose time has yet to be determined) and a final If you have a valid reason for missing the midterm, you must notify your instructor at least two weeks in advance so that a conflict exam can be prepared. Students from all sections will take identical exams. Exams are closed-book, but each student is allowed a single 8.5" by 11" note sheet. Exams are returned during recitation/laboratory sessions. Any student caught cheating on an exam will receive a grade of 0 for the exam. Additional sanctions may also be pursued, following university guidelines.

9. Homeworks: Homeworks will be assigned on a weekly basis. Each homework will have approximately six problems. In addition to the standard analytical problems, most homework assignments will also require the student to develop and model a system using Simulink[®]. Students are encouraged to discuss homework problems in groups. **However, each student must submit their own work.** Students submitting identical work will receive a grade of zero for the homework set. Unless otherwise noted, homework sets are posted on the CTOOLs web site and are due one week later in class. Problem set solutions will be posted on the CTOOLs web site. Graded homework sets will be returned in class. **Late homework will not be accepted.** However, the lowest homework score will be dropped in calculating your overall homework grade. In order to perform well on the exams, it is important that you work each problem assigned. Although your final homework grade may be unaffected if you do not turn in one of the problem sets, your exam grades, which play a much larger role in determining your final grade, will be adversely affected.

10. Labs: In addition to the lectures, a lab will be held every other week where the students will obtain hands-on experience with electric machines and drives. Students will submit a lab report for each lab. In addition to including the data obtained during the lab, lab reports must be well-written and clearly explain the concepts presented during the lab. Measured results will be compared to expected values, with any discrepancies clearly discussed.

Lab times will be established during the first week of classes, after student's schedules have been submitted, to determine times that will work best.

11. Grading: The following weighting factors determine your total course score:

Homework	25%
Lab Reports	25%
Midterm	25%
Final	25%

The class average does not determine the cutoff points for letter grades. Instead, the cutoff points reflect the technical competencies required of an electrical engineer. The following scale determines your final course grade:

A+	95%-100%
A	90%-95%
A-	85%-90%
B+	80%-85%
В	75%-80%
B-	70%-75%
C+	65%-70%
С	60%-65%
C-	55%-60%
D+	50%-55%
D	45%-50%
D-	40%-45%
Е	<40%

At the discretion of the instructor, the minimum score needed to earn a certain letter grade may be lowered, but it will not be raised.

12. Web Page: Problems sets and other important files and announcements will be posted on the EECS 498 CTOOLS site.

13. Attendance: Although attendance will not be taken, you are expected to attend lecture. It is a student's responsibility to acquire handouts and information disseminated in class.

14. Honor Code: Students in the College of Engineering at the University of Michigan are expected to be intimately familiar with its Honor Code. Details of the Honor Code are available online at:

http://www.engin.umich.edu/students/honorcode/

	THE UNIVERSITY OF MICHIGAN COLLEGE OF Course Approval Request	ENGINEERING Form Number 2157
	College Curriculum Committee, 1420 Lurie Engineer Action Requested	ing Center Building Date 4/29/2010
	 New Course Modification of Existing Course Deletion of Course Complete the following sections New Courses - B & C completely Modifications - A modified informat Deletions - A & C completely	tion, B & C completely
	A. CURRENT LISTING	B. REQUESTED LISTING
	Home Department Course Number	Home Department Course Number
		EECS Elec Engin & Computer Sci 463
	Cross Listed Course Information	Cross Listed Course Information
	Course Title	Course Title
_	TITLE Time Sched	Power Systems Design and Operation
	TITLE Max = 19 Spaces ABBRE- VIATION Transcript	ABBRE-
	Max = 20 Spaces Course Description	VIATION Italiscript Max = 20 Spaces Power Sys Deg and Ope Course Description for Official Publication (Max = 50 words)
		Power systems overview; Fundamentals: phasors, complex power, three phases; Transformer modeling; Transmission line modeling; Power flow analysis; Power system control; Protection; Economic operation and electricity markets; Impact of renewable generation on grid operation and control.
	PROGRAM a c e g i k OUTCOMES: b d f h j	PROGRAM \(\alpha a \color c \color e \color g \color i \color k \\ \alpha b \alpha d \alpha f \color h \color j \\ OUTCOMES: \(\alpha b \alpha d \alpha f \color h \color j \\
	Degree O Degree Requirement O Free Elective O Other Requirements O Core Course O Tech Elective O Other	Degree O Degree Requirement O Free Elective O Other Requirements O Core Course Image: Tech Elective O Other
	Prereq O Enforced O Advised	Prereq ((Phys 240 or 260) and EECS 215 and EECS 216) or graduate Enforced standing Advised
	Credit Restrictions	Credit Restrictions
	Level of Credit Contact	Level of Credit Contact
	□ Undergrad only □ Ugrad or Rckhm Grad □ R □ Rackham Grad □ Ugrad or Non-Rckhm Grad □ Min Max Number □ Non-Rckhm Grad □ All Credit types of Wks	□ Undergrad only □ Ugrad or Rckhm Grad □ I □ Rackham Grad □ Ugrad or Non-Rckhm Grad □ I □ Non-Rckhm Grad □ Ugrad or Non-Rckhm Grad □ I ○ Non-Rckhm Grad ○ Ugrad or Non-Rckhm Grad □ I ○ Non-Rckhm Grad ○ Ugrad or Non-Rckhm Grad ○ Ugrad or Non-Rckhm Grad
C.	Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeat	able? No No Max Max Can it be repeated O Yes in the same term? No
	Class Type(s) Grading Location \[\] Lec Sem Dis Other \[\] A-E \[] Ann Arbor \[] Rec Lab Ind \[] CR/NC Biological Station Graded Section \[] S/U Extension	Cognizant Faculty Member: Title lan Hiskens Prof.
	⊠ 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 Approved by Name Approved Dat	Le Submitted By: ☐ Home Dept. ☐ Cross-listed Dept. — Department Chair Name Chair Signature
	Faculty Gross listed Unit 1 Cross listed Unit 2	Home Dept. EECS Khall' Majafi (MAnn MAJA)
		— Cross-listed Dept(s)

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SUPPORTING STATEMENT

This course provides an in-depth presentation of power systems. The depth, breadth, and intensity of the class is appropriate for senior undergraduate and beginning graduate students. It has been taught previously as a special topics class. In FAO9 (498-04) there were 31 students (both undergraduate and graduates) for EE. Aero, Nuclear Eng. & Radiolog Sciences, Energy Systems Engineering. Natural Res & Environment, and IOE. The O1 rating was 4.08. It addresses needs both in the EE program and has broad interest across the College.

University of Michigan Department of Electrical Engineering and Computer Science

EECS498-4 - Power System Analysis and Design Fall 2009

Course Administration and Outline

Instructor:	Professor Ian Hiskens 4437 EECS Building Phone: (734) 615-7076; Email: hiskens@umich.edu Office hours: Thursday 10:00am-noon
References:	 J.D. Glover, M.S. Sarma and T.J. Overbye, Power System Analysis and Design, 4th Edition, Thomson, 2008. A.R. Bergen and V. Vittal, Power Systems Analysis, 2nd Edition, Prentice Hall, 2000.
Web Site:	All course material will be published on CTools.
Software:	Powerworld Simulator software will be used for illustrations and homework assignments. MATLAB will also be useful.
Homework:	Around 10 problem sets will be assigned. The worst homework grade will be dropped in computing the overall course grade.A small design project will be assigned around mid-semester, due end of semester.
Exams:	A mid-term exam will be held during class on Wednesday, November 4. <i>Please report conflicts early.</i> The final exam will be held during the official end-of-semester examination week.
Grading Policy:	Homework 20%; Mid-term exam 25%; Project 15%; Final exam 40%.
Syllabus:	See over

Topics

- 1. Electric Power System Background
 - Overview of system structure: generation, transmission, and distribution
 - Utility scale systems versus industrial plant scale systems
 - Utility restructuring and "deregulation"
- 2. Fundamental Analysis Techniques
 - Review of phasors in sinusoidal steady state circuit analysis
 - RMS quantities
 - Concepts of active and reactive power
 - Three phase operation
- 3. Transformer Modelling
 - Three phase connections and per phase analysis
 - Per unit normalization
 - Use of tap changing and phase shifting transformers for control
- 4. Power Flow Analysis
 - Power flow formulation and solution techniques
 - Variable decoupling
 - Applications
- 5. Transmission Line Parameters and Modelling
 - Line geometry and physical parameters
 - Lumped circuit equivalent models
- 6. Power System Operation and Control
 - Voltage and frequency regulation
 - Generation and system control
 - Infrastructure requirements for controlling loads: thermostatically-controlled loads, plug-in electric vehicles
- 7. Grid Connection of Renewable Generation
 - Wind farm topology
 - Connection to weak grids
 - Variability inherent in renewable generation
- 8. Economic Operation and Competitive Markets
 - Traditional economic dispatch; relation to Power Pool concepts
 - Inclusion of system losses and equipment constraints
- 9. Faults and System Protection
 - Use of symmetrical components in fault calculations
 - Protection devices

Mission, goals, and educational objectives

MissionTo provide a solid and current technical foundation that prepares students for a career in chemical engineering or
related fields.GoalsTo educate and support diverse students and prepare them to be leaders in chemical engineering or related fields.#Educational
ObjectivesTo provide students with a solid foundation in chemical engineering, while preparing them for a broad range of career
opportunities. The program's primary emphasis is on chemical engineering fundamentals, while allowing students to
personalize their curriculum to prepare them for traditional chemical engineering careers and diverand
multidisciplinaryse careers in areas such as medicine, law, energy and the environment, and biotechnology. To
provide opportunities for teamwork, open ended problem solving and critical thinking.

Chemical Engineering program outcomes:

1. an ability to apply knowledge of mathematics, science, and engineering to chemical engineering problems [ABET: 3a]

- 2. an ability to design and conduct experiments, as well as to analyze and interpret data [ABET: 3b]
- 3. an ability to design a system, component, or process to meet desired needs [ABET: 3c; Program: 2]
- 4. an ability to function on multi-disciplinary teams [ABET: 3d]
- 5. an ability to identify, formulate, and solve engineering problems [ABET: 3e]
- 6. an understanding of professional and ethical responsibility [ABET: 3f]
- 7. an ability to communicate effectively orally and in writing [ABET: 3g]
- 8. the broad education necessary to understand the impact of engineering solutions in a global and societal context [ABET: 3h]
- 9. a recognition of the need for, and an ability to engage in life-long learning [ABET: 3i]
- 10. a knowledge of contemporary issues [ABET: 3j]
- 11. an ability to use the techniques, skills, and modern engineering and computing tools necessary for engineering practice [ABET: 3k; Program-2]
- 12. a thorough grounding in chemistry, <u>physics</u>, <u>biology and materials science</u>, <u>with courses</u> <u>and a working knowledge of advanced chemistry</u> such as organic, inorganic, physical, analytical, materials, biochemistry, or environmental science, selected based on the student's interest. [Program: 1]
- 13. a working knowledge, including safety and environmental aspects, of material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and stage-wise separation operations; process dynamics and control, chemical process economics, and design [Program: 2]

Program:1 and program:2 refer to old ChE criteria.

Approved by the Chemical Engineering faculty September 27, 2010 #