The University of Michigan
College of Engineering
Curriculum Committee

Agenda
October 23, 2012
1:30-3:00 p.m.

Room 265 Chrysler Center

1. Approval of Minutes
2. BME Program Change Request
3. New Course and Curriculum Change for ECE
4. Course Approval Forms

BIOMEDICAL ENGINEERING

UNIVERSITY of MICHIGAN ■ COLLEGE of ENGINEERING

MEMORANDUM

To: CoE Curriculum Committee

From: Jan Stegemann
Associate Chair for Undergraduate Education
Department of Biomedical Engineering

Date: October 15, 2012

cc : Doug Noll
Therese Kummer
BME UEC:
Susan Bitzer
Joe Bull
Dennis Claflin
Cheri Deng
Brian Love
Rachael Schmedlen

Subject: Program Change Request – Integration of BioMedE 350 "Introduction to Biomedical Engineering Design" into the BME Core Curriculum

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This memo describes the proposed process for integrating a junior-level design class into the biomedical engineering (BME) undergraduate core curriculum. This addition is motivated by consistent and clear feedback from our students, alumni and potential employers that BME graduates would be well served by improved design skills. In particular, these constituencies have expressed a need for more experience with modern computational tools and their application to problems in biomedical engineering.

The class to be added is BioMedE 350 Introduction to Biomedical Engineering Design. This class has been updated and taught for the last two Winter terms as a technical elective. The CoE Bulletin entry explains its main purpose: "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." Currently, the computational tools used include Matlab, SolidWorks, and COMSOL, and the design problems change each year.

Based on constituent feedback the BME Undergraduate Education Committee (UEC) has proposed the following plan for integrating BioMedE 350 in to the department's Core Curriculum:

Starting in Fall 2013,

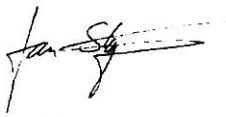
1) BioMedE 350 Intro to BME Design will become a required 3 credit course for incoming freshmen, though they will not take it until their junior year. The course is planned for each Winter term, and therefore the first cohort to be required to take the course will enroll in W16. Prior to that, BioMedE 350 will remain an elective.

2) BioMedE 418 Quantitative Cell Biology will become a 3 credit course, which will require removing 1 credit from its current version. To ensure compliance with ABET guidelines, we will remove 1 Life Science credit, so that this course will have 1 remaining Life Science credit and 2 Engineering credits (i.e. 3 credits total). The UEC has consulted with students and instructors, and removal of 1 LS credit can be accomplished by trimming overlap with other classes, in particular in the areas of cell and extracellular matrix biology. This class will be offered in Fall and Winter terms, and current students will need to ensure that they adjust to the altered credit count, if needed.

3) The Concentration Requirement for all BME undergraduate students will be reduced to 14 credits from the current 16. This curriculum change provides the needed additional 2 credits to make room for BME350 while keeping our program at 128 credits total. As with the current program, most students will therefore need to take 4 or 5 required/elective concentration courses to satisfy the Concentration Requirement.

This plan was presented to the BME Faculty at the regular faculty meeting on October 5, 2012. After thorough discussion, the BME faculty voted and were unanimously in favor (18-0) of adopting this plan for integration of BioMedE 350.

The intent of this program change is to augment an already very good design experience, and to make our senior capstone design experience even more effective. However we also hear from our stakeholders that there is a need for more design in the earlier years of our program. Addition of BioMedE 350 according to the plan outlined above will address this need, while keeping our Core Curriculum strong and focused on engineering content.



Jan Stegemann

Attachments:

Course Approval Request for changing BIOMEDE350 to a BME Core class
Course Approval Request for changing BIOMEDE418 to 3 from 4 credits
BME Undergraduate Curriculum document
Sample Schedule for BME Undergraduate Student assuming no AP credit
Sample Schedule for BME Undergraduate Student assuming AP credit in Chemistry and Math

The Biomedical Engineering Curriculum – Version F13

BiomedE Undergraduate Core Curriculum

Subjects required by all programs	Cr. Hrs
Math 115, 116, 215, 216	16
Engineering 100, Intro to Engineering	4
Engineering 101, Intro to Computing	4
Chemistry 130	3
Physics 140/141, 240/241	10
Humanities/Social Sciences	16
	53
Advanced Science and Engineering Math	
Biology 172 or 174, Intro to Biology (F,W)	4
(If using AP Bio credit (195), then Biology 173 (2) is required)	
Chemistry 210/211, Structure & Reactivity I (F, W, Sp)	5
MCDB 310, Intro Biochemistry (F,W,Sp) **or**	
BiolChem 415, Intro Biochemistry (F,W) **or**	3-4
Chem 351, Fundamentals Of Biochemistry (F,W)	
	12-13
Required Program Subjects	
BiomedE 211, Circuits & Systems for Biomedical Engineering (F)	4
BiomedE 221, Biophysical Chemistry and Thermodynamics (F)	4
BiomedE 231, Intro to Biomechanics (W)	4
BiomedE 241, Biomedical Engineering Undergraduate Laboratory (F, W)	4
MSE 250, Principles of Engineering Materials (F, W)	4
BiomedE 350, Intro to BiomedE Design (W)	3
BiomedE 418, Quantitative Cell Biology (W)	3
BiomedE 419, Quantitative Physiology (F)	4
BiomedE 450, Biomedical Engineering Design (4) (W) **or**	
BiomedE 451, Biomedical Engineering Design I (2) (F) **and**	4-5
BiomedE 452, Biomedical Design II(3) (W)	
BiomedE 458, Biomedical Instrumentation & Design (F,W)	4
	38-39
BSE Concentration Requirements and Electives*	**14**
Unrestricted Electives	**11**
Total	**128**

* Must include at least 12 credits of engineering courses

Table 3.3 BiomedE Biochemical Concentration

Concentration Requirements (7 credits)

BiomedE 331, Intro to Biofluid Mechanics (F)	4 cr. hrs.
BiomedE 321, Bioreaction Engineering & Design (W)	3

Lab Requirement (3 credits)

MCDB 429, Laboratory in Cell & Molecular Biology (W)*	3
MatScie 360, Experimental Meth in MSE Lab I (F)	3

Choose one (3-4 credits)

BiomedE 410, Biomedical Materials (F)	3
BiomedE 479, Biotransport (W)	4

Concentration Electives

BiomedE 332, Intro to Biosolid Mechanics (W)	4
BiomedE 410, Biomedical Materials (F)	3
BiomedE 474, Tissue Engineering (F)	3
BiomedE 476, Advanced Biofluid Mechanics (W)	4
BiomedE 479, Biotransport (W)	4
BiomedE 522, Biomembranes: Transport and Signaling (W)	3
BiomedE 556, Molecular & Cellular Biomechanics (F)	3
BiomedE 561, Biological Micro- & Nanotechnology (F)	3
ChE 517, Biochemical Science & Technology (W)	3
MatScie 350, Principles of Engineering Materials II (F)	4
MatScie 412, Polymer Materials (F)	3
MatScie 420, Mech Behavior of Materials (F)	3
MatScie 440, Ceramic Materials (W)	3
MatScie 512, Polymer Physics (W)	3

*MCDB 429 is not considered an Engineering course for purposes of the ABET requirement students have a minimum of 48 credit hours of Engineering in their bachelors program.

BiomedE Bioelectrical Concentration

Concentration Requirements (8 credits)

BiomedE 311, Biosystems and Signals (W) or EECS 216, Intro to Signals and Systems (F,W)	4 cr. hrs.
BiomedE 417, Electrical Biophysics (W)	4

At least one of the following (3-4 credits):

BiomedE 552, Biomedical Optics (F)	3
EECS 320, Intro to Semiconductor Devices (F,W)	4
EECS 414, Intro to MEMS (F)	4
EECS 451, Digital Signal Processing (F,W)	4

Concentration Electives:

BiomedE 331, Intro to Biofluid Mechanics (F)	4
BiomedE 552, Biomedical Optics (F)	3
EECS 283, Programming for Engineers (F, W)	4
EECS 311, Analog Electronics (W)	4
EECS 312, Digital Integrated Circuits (F, W)	4
EECS 320, Intro to Semiconductor Devices (F, W)	4
EECS 334, Principles of Optics (W)	4
EECS 401, Probabilistic Methods in Engineering (F, W)	4
EECS 414, Intro to MEMS (F)	4
EECS 423, Solid State Device Lab (F)	4
EECS 434, Photonics (F)	4
EECS 435, Fourier Optics (W odd years)	3
EECS 438, Adv. Lasers & Optics Lab (W)	4
EECS 452, DSP Lab (F, W)	4
EECS 460, Fund Control Sys (F)	3
Math 354, Fourier Analysis & its Applications ("sporadically")	3
Math/BiomedE 464, Inverse Problems (W)	3
MechEng/BiomedE 424, Engineering Acoustics (F)	3
NERS/BiomedE 481, Radiation Imaging (W)	2

BiomedE Biomechanical Concentration

Concentration Requirements (8 credits)

BiomedE 331, Intro to Biofluid Mechanics (F)	4 cr. hrs.
BiomedE 332, Intro to Biosolid Mechanics (W)	4

At least one of the following (3-4 credits)

BiomedE 456, Biomechanics (F)	3
BiomedE 476, Advanced Biofluid Mechanics (W)	4
BiomedE 479, Biotransport (W)	4
IOE 463, Work Measurement & Prediction (F)	3
IOE 491, Applied Physical Ergonomics (F)	3
IOE 333, Ergonomics (F,W)	3
IOE/BiomedE 534, Occupational Biomechanics (W)	3

Concentration Electives:

BiomedE 456, Biomechanics (F)	3
BiomedE 476, Advanced Biofluid Mechanics (W)	4
BiomedE 479, Biotransport (W)	4
IOE 333, Ergonomics (F,W)	3
IOE/BiomedE 534, Occupational Biomechanics (W)	3
IOE 436, Human Factors in Computer Systems (W)	3
IOE 438, Occupational Safety Management (W)	2
IOE 463, Work Measurement & Prediction (F)	3
IOE 491, Applied Physical Ergonomics (F,W)	3
MechEng 250, Design and Manufacturing I (F,W)	4
MechEng 406, Biomechanics for Engineers (W)	3
MechEng 360, Modeling of Dynamic Systems (F,W)	4
MoveSci 230, Musculoskeletal Anatomy (F,W) (changing W12 to 3 credit hours + separate lab for 1 credit hour)	4
MoveSci 435, Biomechanics of Human Locomotion (F every other year & will first be offered F04)	3
ANAT 403, Human Body* (F,W)	5

*ANAT (was BiomedE) 403 is not considered an Engineering course for the ABET requirement: all students have a minimum of 48 credit hours of Engineering in their bachelors program.

University of Michigan

Biomedical Engineering: Sample Schedule
for students with AP Credit in Chemistry and Math

Revised: Dec 2012

	Fall	Cr	Winter	Cr
Freshman	ENGR100: Intro to Engineering	4	ENGR101: Intro Computers & Programming [1]	4
	BIOL172: Introductory Biology	4	CHEM210: Structure & Reactivity	4
	MATH116: Calculus II	4	CHEM211: Investigations in Chemistry	1
	Hum/Soc Sci Elective I	4	MATH215: Calculus III	4
			Hum/Soc Sci Elective II	4
	Total Credits	*16*	*Total Credits*	*17*
Sophomore	PHYS140: General Physics I [1]	4	MATH216: Intro to Differential Equations	4
	PHYS141: Elementary Lab I [1]	1	PHYS240: General Physics II	1
	MCDB310: Intro to Biol Chem [2]	3	PHYS241: Elementary Lab II	4
	MATSCI250: Principles Engin Materials	4	BME231: Intro to Biomechanics	4
	Hum/Soc Sci Elective III	4	Hum/Soc Sci Elective IV	4
	Total Credits	*16*	*Total Credits*	*16*
Junior	BME211: Circuits & Systems	4	BME241: BME Undergrad Lab	4
	BME221: Biophysical Chem & Thermo	4	BME350: Intro to BME Design	3
	BME418: Quantitative Cell Biology [3]	3	Concentration Elective II	3
	Concentration Elective I	3	Unrestricted Elective I	4
	Total Credits	*14*	*Total Credits*	*14*
Senior	(BME451: BME Design I [4])	(2)	BME450: BME Design [4]	4
	BME419: Quantitative Physiology	4	(or BME452: BME Design II [4])	(3)
	BME458: BME Instrumentation & Design	4	Concentration Elective IV	4
	Concentration Elective III	4	Unrestricted Elective II	4
			Unrestricted Elective III	3
	Total Credits	*12-14*	*Total Credits*	*14-15*
Masters	MATH450: Adv Math for Engineers I	3-4	BME503: Stat Methods for BME	3
	BME500: BME Seminar	1	BME590: Directed Research II	2-3
	BME550: Ethics & Enterprise	1	(***or*** BME599: Grad Inn Design II)	(4)
	BME590: Directed Research I	2-3	MS Concentration Elective	3-4
	(***or*** BME599: Grad Inn Design I	(3)		
	MS Concentration Elective	3-4		
	Total Credits	*10-13*	*Total Credits*	*8-11*

This Sample Schedule is for students have taken AP, IB, or A-Level exams, or have transfer credit from another institution for Math and Chemistry, and have met the College of Engineering requirements for these areas.

[1] - If you have taken AP, IB, or A-Level exams, or have transfer credit from another institution for Physics or Engineering 101, you may have met the College of Engineering requirements for these areas. See your academic advisor for more information about whether your test scores or transfer credits satisfy the above requirements.

[2] - May be substituted with BIOCHEM415: Intro to Biol Chem ***or*** CHEM351: Fund of Biochem.

[3] - If using AP Credit (BIOL195) then BIOL173 is required.

[4] - Students may take the two-semester BME451/452 BME Design experience (Fall/Winter), or the one-semester (Fall) BME 450 Design class.

A list of Concentration Requirements and Electives is available on the department website and in 1111 Gerstacker.

Note: This is a sample schedule only. Students have some flexibility in designing a curriculum to meet their needs.

University of Michigan

Biomedical Engineering: Sample Schedule

Revised: Dec 2012

	Fall	Cr	Winter	Cr
Freshman	ENGR100: Intro to Engineering	4	ENGR101: Intro Computers & Programming [1]	4
	BIOL172: Introductory Biology	4	MATH116: Calculus II	4
	MATH115: Calculus I [1]	4	CHEM210: Structure & Reactivity	4
	CHEM130: General Chemistry [1]	3	CHEM211: Investigations in Chemistry	1
			Hum/Soc Sci Elective I	4
	Total Credits	*15*	*Total Credits*	*17*
Sophomore	MATH215: Calculus III	4	MATH216: Intro to Differential Equations	4
	PHYS140: General Physics I [1]	4	PHYS240: General Physics II	4
	PHYS141: Elementary Lab I [1]	1	PHYS241: Elementary Lab II	1
	MATSCI250: Principles Engin Materials	4	BME231: Intro to Biomechanics	4
	Hum/Soc Sci Elective II	4	Hum/Soc Sci Elective III	4
	Total Credits	*17*	*Total Credits*	*17*
Junior	MCDB310: Intro to Biol Chem [2]	3	BME241: BME Undergrad Lab	4
	BME211: Circuits & Systems	4	BME350: Intro to BME Design	3
	BME221: Biophysical Chem & Thermo	4	Concentration Elective I	4
	BME418: Quantitative Cell Biology [3]	3	Unrestricted Elective II	4
	Unrestricted Elective I	3		
	Total Credits	*17*	*Total Credits*	*15*
Senior	(BME451: BME Design I [4])	(2)	BME450: BME Design [4]	4
	BME419: Quantitative Physiology	4	(or BME452: BME Design II [4])	(3)
	BME458: BME Instrumentation& Design	4	Concentration Elective III	3
	Concentration Elective II	3	Concentration Elective IV	4
	Unrestricted Elective III	4	Hum/ Soc Sci Elective IV	4
	Total Credits	*15-17*	*Total Credits*	*14-15*
Masters	MATH450: Adv Math for Engineers I	3-4	BME503: Stat Methods for BME	3
	BME500: BME Seminar	1	BME590: Directed Research II	2-3
	BME550: Ethics & Enterprise	1	(***or*** BME599: Grad Inn Design II	(4)
	BME590: Directed Research I	2-3	MS Concentration Elective	3-4
	(***or*** BME599: Grad Inn Design I	(3)		
	MS Concentration Elective	3-4		
	Total Credits	*10-13*	*Total Credits*	*8-11*

[1] - If you have taken AP, IB, or A-Level exams, or have transfer credit from another institution for Math, Chemistry, Physics or Engineering 101, you may have met the College of Engineering requirements for these areas. See your academic advisor for more information about whether your test scores or transfer credits satisfy the above requirements.

[2] - May be substituted with BIOCHEM415: Intro to Biol Chem ***or*** CHEM351: Fund of Biochem.

[3] - If using AP Credit (BIOL195) then BIOL173 is required.

[4] - Students may take the two-semester BME451/452 BME Design experience (Fall/Winter), or the one-semester (Fall) BME 450 Design class.

A list of Concentration Requirements and Electives is available on the department website and in 1111 Gerstacker.

Note: This is a sample schedule only. Students have some flexibility in designing a curriculum to meet their needs.

BME 350	Modification---Changing Degree Requirements from: Tech Elective ***to: Core Course***
BME 418	Modification—Changing Level of Credit and contact hours from:4 ***to: 3***
IOE 419	New Course
NAME 525	New Course

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

Form Number: 2360
Date: 10/16/2012
Effective Term: Winter 2013
Course Offer Freq: ☒ Indefinitely ☐ One term only

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

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

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Course Number	Home Department: BIOMEDE Biomedical Engineering / Course Number: 350
☐ Cross Listed Course Information	Cross Listed Course Information
☐ Course Title	Course Title: Introduction to Biomedical Design
TITLE ABBREVIATION — Time Sched Max = 19 Spaces / Transcript Max = 20 Spaces	Time Sched Max = 19 Spaces: Intro BME Design / Transcript Max = 20 Spaces: Intro BME Design
☐ Course Description	Course Description for Official Publication (Max = 50 words): 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.
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
X 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: BiomedE 211, 221, 231; co-requisite BiomedE 241 — ○ 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 ☐ R — 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 ☐ i — Credit Hours Min 3 Max 3 — Contact Hrs/Wk 3 — Number of Wks 14

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

C.

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: Andrew Putnam — Title: Associate Professor

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

Approval Info — **Approved by Name** — **Approved Date**

☐ Curriculum Comm. ____ ____
☐ Faculty ____ ____
☐ Cross listed Unit 1 ____ ____
☐ Cross listed Unit 2 ____ ____

Submitted By: ☒ Home Dept ☐ Cross-listed Dept

	Department Chair Name	Chair Signature
Home Dept	Biomedical Engineering	Dc Fm
Cross-listed Dept(s)		

Form Number

2360

SUPPORTING STATEMENT

Feedback from our core constituencies (students, alumni, employers) has clearly indicated a need for a junior-level BME Design class. BioMedE 350 Introduction to Biomedical Engineering Design has been recently updated and has been taught as an elective course for two terms with very positive evaluations. After consultation with the faculty, the BME Undergraduate Education Committee is requesting that BioMedE 350 become a part of the Core Curriculum in BME. A plan for integrating this 3 credit course into the Core Curriculum has been developed.

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

Detail the Special requirements

The CAEN lab in LBME is reserved for this class meeting, in addition to a classroom.

BRIEF COURSE DESCRIPTION:

The service industry accounts for about 75% of the US employment and almost 60% of all personal consumption. This course will explore the service industries in the US (e.g., transportation, health care, retailing, restaurants, education, emergency services) with a view toward developing models that allow planners to reduce costs and enhance customer service. Topics to be covered include facility location planning for services (e.g., ambulances, fire stations, repair facilities, cell phone facilities), resource allocation problems, inventory management issues in the service sector, workforce planning and scheduling, yield and demand management, queueing analysis and design of service systems, call center management, and vehicle routing in the service industries.

In addition to learning about the service industry, the course has a secondary objective of introducing students to the non-textboook literature. Some of the course will be based on case studies that were documented in *Interfaces*, a journal published by INFORMS, the Institute for Operations Research and the Management Sciences. This journal is designed to be accessible to a broad range of readers including undergraduate and graduate students, working engineers and managers. Students will be exposed to a number of papers in the literature spanning a variety of problems in the service sector and a number of different industries. Students will learn to read such papers critically.

COURSE REQUIREMENTS:

Students will be graded on the following:

Homework assignments (approximately one per week)	25% total
Two midterm exams	15% each - 30% total
Written summary of a paper in the literature	10% of total
Final exam	35% total

The first midterm exam will be during the week of February 13 and the second will be during the week of March 19. The FINAL exam will be during the regularly scheduled time, as per the university guidelines for final exams. This time is Wednesday, April 25, 2012, from 4-6 pm ⊗⊗⊗⊗.

Students are expected to come to all classes (unless they notify me in advance that they will not be able to attend a particular class). Students are expected to have read the assigned readings from the text (and any other material) and to be **prepared to discuss the readings in class.** Some readings will also form the basis for homework assignments.

INSTRUCTOR and GSI:

Mark S. Daskin
Industrial and Operations Engineering Department
IOE 1877A
Phone: 734-764-9410 (email is strongly preferred. See note below about email.)
Email: msdaskin@umich.edu

Katharina Ley
IOE 1785 (Office hours will be in 1783 next door)
Email: katley@umich.edu

Because of the large volume of emails that I receive, please send all emails with the following text at the beginning of the subject line: IOE 491. This will help me respond in a timely manner. I suggest you do this for the GSI, Katharina Ley, as well.

OFFICE HOURS:

Daskin: Tuesday and Wednesday 1-3
Katharina Ley Friday 10-12 noon

REQUIRED TEXT:

Almost all readings and most problem assignments will be taken from the following text:

Daskin, M. S., 2010, Service Science, John Wiley, New York, NY.

The website for the book is:
http://www-personal.umich.edu/~msdaskin/servicescience/

In addition students will be given papers from journals such as *Interfaces* which will be required reading.

OTHER TEXTS: (not required!!)

Chang, C. M., 2010, Service Systems Management and Engineering: Creating Strategic Differentiation and Operational Excellence, John Wiley, New York, NY.

Fitzsimmons, J. A. and M. J. Fitzsimmons, 2004, Service Management: Operations, Strategy and Information Technology, Irwin/McGraw Hill, Boston.

Katzan, J., 2008, Service Science: Concepts, Technology and Management, iUniverse, Inc., New York.

UNIVERSITY OF MICHIGAN DISABILITY STATEMENT:

The University of Michigan is committed to providing equal opportunity for participation in all programs, services and activities. Request for accommodations by persons with disabilities may be made by contacting the Services for Students with Disabilities (SSD) Office located at G 664 Haven Hall. The SSD phone number is 734-763-3000. Once your eligibility for an accommodation has been determined you will be issued a verified individual services accommodation (VISA) form. Please present this form to me at the start of the term or at least two weeks prior to the accommodation date (test, project, etc...)

ADDITIONAL POTENTIAL READINGS:

The course will also be based on readings from the literature (mostly from the journal *Interfaces*). Links to these papers will be posted on C-Tools as we encounter them in the course. These readings are listed below. **Not all of them will be used in this course and there may be others that are added as the course progresses.**

Location Modeling:

1. Gavirneni, S., L. Clark, and G. Pataki, 2004, "Schlumberger optimizes receiver location for automated meter reading," *Interfaces*, 34:3, 208-214.

2. Dekle, J., M. S. Lavieri, E. Martin, H. Emir-Farinas, and R. L. Francis, 2005, "A Florida County Locates Disaster Recovery Centers," *Interfaces*, 35:2, 133-139.

3. Sen, A., Bhatia, D. and K. Dogan, 2010, "Applied Materials Uses Operations Research to Design Its Service and Parts Network, *Interfaces*, 40:4, 253-266.

4. Duran, S., M. A. Gutierrez and P. Keskinocak, 2011, "Pre-Positioning of Emergency Items for CARE International," *Interfaces*, 41:3, pp. 223-237.

Resource Allocation:

5. Miranda, J., 2010, "eClasSkeduler: A Course Scheduling System for the Executive Education Unit at the Universidad de Chile," *Interfaces*, 40:3, 196-207.

Yield Management and Demand Management:

6. Ernst, A. T., M. Horn, M. Krishnamoorthy, P. Kilby, P. Degenhardt and M. Moran, 2007, "Static and dynamic order scheduling for recreational rental vehicles at tourism holdings limited," *Interfaces*, 37:4, 334-341.

Workforce Management:

7. Bodin, L. and A. Panken, 2003, "High tech for a higher authority: The placement of graduating rabbis from Hebrew Union College - Jewish Institute of Religion," *Interfaces*, **33**:3, pp. 1-11.

6. Shrimpton, D. and A. M. Newman, 2005, "The US Army Uses a Network Optimization Model to Designate Career Fields for Officers," *Interfaces*, **35**:3, 230-237.

7. Martin, C. H., 2004, "Ohio University's College of Business Uses Integer Programming to Schedule Classes," *Interfaces*, **34**:6, 460-465.

8. Gordon, L. and E. Erkut, 2004, "Improving Volunteer Scheduling for the Edmonton Folk Festival," *Interfaces*, **34**:5, 367-376.

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Call Centers:

14. Whitt, W., 2007, "What you should know about queueing systems to set staffing requirements in service systems," *Naval Research Logistics*, **54**:5, 476-484.

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Airline Scheduling:

16. Desrosiers, J., A. Lasry, D. McInnis, M. M. Solomon, and F. Soumis, 2000, "Air Transat Uses ALTITUDE to Manage Its Aircraft Routing, Crew Pairing, and Work Assignment," *Interfaces*, **30**:2, pp. 41-53.

Auctions:

17. Rothkopf, M. H., and S. Park, 2001, "An Elementary Introduction to Auctions," *Interfaces*, **31**:6, pp. 83-97.

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Districting:

19. Duran, G., R. Epstein, C. Martinez, G. A. Zamorano, 2011, "Quantitative Methods for a New Configuration of Territorial Units in a Chilean Government Agency Tender Process," *Interfaces*, **41**:3, pp. 263-277.

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Other Topics:

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

Form Number 2338
Date 9/25/2012
Effective Term Winter 2013
Course Offer Freq ☒ Indefinitely ☐ One term only

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

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

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Course Number	Home Department: NAVARCH Naval Arch & Marine Engin / Course Number: 525
☐ Cross Listed Course Information	Cross Listed Course Information
☐ Course Title	Course Title: Drag Reduction Techniques
TITLE ABBREVIATION — Time Sched Max = 19 Spaces:	TITLE ABBREVIATION — Time Sched Max = 19 Spaces: Drag Reduction Tech
TITLE ABBREVIATION — Transcript Max = 20 Spaces:	TITLE ABBREVIATION — Transcript Max = 20 Spaces: Drag Reduction Tech
☐ Course Description	Course Description for Official Publication (Max = 50 words): This course addresses active and passive techniques of friction drag reduction. Active methods discussed include air layers and cavities, polymer and gas/bubble injection, and super-hydrophobic and other coating technologies. Passive techniques covered include hull form optimization and appendages such as stern flaps, lifting bodies, and bulbous bows.
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 ○ Free Elective ○ Other ○ Core Course ○ Tech Elective	**Degree Requirements** ○ Degree Requirement ◉ Free Elective ○ Other ○ Core Course ○ Tech Elective
Prereq ○ Enforced ○ Advised	Prereq NA 320 ○ Enforced ◉ Advised
☐ Credit Restrictions	Credit Restrictions: None
Level of Credit ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min ___ 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

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

C.

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: Marc Perlin
Title: 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.	Naval Arch & Marine Engin	
Cross-listed Dept(s).		

Form Number

2338

SUPPORTING STATEMENT

Over the last several years research on friction drag reduction for surface ships and sub-surface vehicles and projectiles has progressed sufficiently such that effective methods are available. Due to several factors, ship and vehicle builders and owners, both commercial and military are necessarily interested in these technologies. These factors include reduced operational costs due to fuel savings or conversely increased speeds at commensurate fuel costs/consumption, reduced pollution due to reduced fuel consumption per distance traveled, and most recently to adhere to new IMO standards (i.e. the Energy Efficiency Design Index) while maintaining the ability to safely power from adverse weather conditions. For these reasons a course on drag reduction technologies is both timely and necessary.

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

Detail the Special requirements

No special resources are required; the Marine Hydrodynamics Laboratory presently has the capabilities to demonstrate the various techniques through numerous platforms and facilities constructed for drag reduction research (i.e. the very purpose for which this course is taught).

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

Winter 2012 Final
4 students responded out of the total enrolled 9

Instructor with Comments Report

2012-04-06 - 2012-04-18 Report ID: MSR04734

Instructor: Perlin,Marc
NAVARCH 590 004

		Responses from your Students**							Other Users of This Item*					
									University Wide			School/College		
		5 SA	4 A	3 N	2 D	1 SD	NA	Your Median	75% Above	50% Above	25% Above	75% Above	50% Above	25% Above
1	Overall, this was an excellent course.	2	1	0	0	0	0	4.75	3.92	4.27	4.70	4.17	4.43	4.72
2	Overall, the instructor was an excellent teacher.	4	0	0	0	0	0	5.00	4.13	4.60	4.85	4.25	4.64	4.83
3	I learned a great deal from this course.	2	1	0	0	0	0	4.75	4.00	4.33	4.70	4.23	4.50	4.78
4	I had a strong desire to take this course.	2	1	0	0	0	0	4.75	3.63	4.13	4.60	4.13	4.50	4.75
15	I increased my ability to apply math and science knowledge to engineering problems.	2	1	0	0	0	0	4.75	4.00	4.23	4.50			
17	I increased my ability to analyze and interpret data.	3	0	0	0	0	0	5.00	4.00	4.30	4.50			
20	My confidence in my design abilities increased because of this course.	1	2	0	0	0	0	4.25	3.92	4.25	4.64			
23	I increased my ability to formulate, and solve engineering problems.	2	1	0	0	0	0	4.75	4.00	4.18	4.50			
32	This course increased my desire to learn more about this subject in the future.	3	0	0	0	0	0	5.00	3.88	4.13	4.56			
35	I increased my ability to apply engineering tools and methods.	2	1	0	0	0	0	4.75	4.03	4.20	4.50			
121	I gained a good understanding of concepts/principles in this field.	2	1	0	0	0	0	4.75	3.94	4.19	4.50			
122	I learned to apply principles from this course to new situations.	2	1	0	0	0	0	4.75	4.00	4.25	4.58			
142	I was stimulated to do outside reading about the course material.	2	0	1	0	0	0	4.75	n/a	n/a	n/a			
199	The instructor explained material clearly and understandably.	4	0	0	0	0	0	5.00	4.00	4.50	4.79			
201	The instructor gave clear explanations.	4	0	0	0	0	0	5.00	4.08	4.50	4.78			
216	The instructor acknowledged all questions insofar as possible.	3	1	0	0	0	0	4.83	4.23	4.59	4.83			
229	The instructor used class time well.	2	1	1	0	0	0	4.50	4.10	4.50	4.75			
230	The instructor seemed well prepared for each class.	2	2	0	0	0	0	4.50	4.30	4.67	4.86			
232	Work requirements and grading system were clear from the beginning.	2	1	0	0	0	0	4.75	4.00	4.33	4.67			
239	The amount of work required was appropriate for the credit received.	2	1	0	0	0	0	4.75	3.94	4.20	4.50			
367	The instructor had a realistic definition of good performance.	3	1	0	0	0	0	4.83	4.10	4.50	4.80			

Written Comments

902 Which aspects of this course did you like best?

Student 1
NA

Student 2
NA

Student 3
I felt I gained a good understanding of where current research is for drag reduction. I also thought that having student presentations at the end of the semester was a fitting end.

Student 4
Taught more than just drag reduction, skills to interpret technical papers and experiments

Winter 2012 Final
4 students responded out of the total enrolled 9

Instructor with Comments Report

2012-04-06 - 2012-04-18 Report ID: MSR04734

Instructor: Perlin,Marc
NAVARCII 590 004
Written Comments

903 Which aspects of this course did you like least?

Student 1
NA

Student 2
Student presentations should be spread out to cover the entire term. Some additional material might be helpful, and I wish the rest of the course material could have been covered.

Student 3
NA

Student 4
Two paper reviews would be better I think

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

BIOMEDE 499/350: 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: putnam@umich.edu

Location: LBME 1310 (CAEN Computing Lab)

Office Hours: By appointment, as needed.

Credits: 3
This course will eventually be a required part of the BME curriculum. However, in the first year, the course can be counted towards the "concentration elective" requirements for each of the three concentrations in the BME major.

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" solutions of biomedical engineering problems and 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.

The course will rely more on active, experiential learning than on traditional didactic lectures and passive learning. Lecture time will be designed to impart some 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. You will then have dedicated time during the lecture periods to actively use the relevant software packages! Through the PBL-based design vignettes, students will gain familiarity with three different software packages: **Matlab, SolidWorks, and COMSOL**.

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

Required Textbooks: There are no required textbooks.

Prerequisites: BIOMEDE 211 (Circuits and Systems for BME),
BIOMEDE 221 (Biophysical Chemistry and Thermodynamics)
BIOMEDE 231 (Intro to Biomechanics)
Corequisites: BIOMEDE 241 (Biomedical Engineering Undergraduate Lab)

Software Requirements: The three major software packages that we will use in this course are *Matlab, SolidWorks, and COMSOL.*

Matlab is a mathematics package that provides a high-level programming language, an interactive computing environment, and functions for algorithm development, data analysis/visualization and numeric computation. http://www.mathworks.com/

SolidWorks is a computer-aided design software package widely used in engineering in general, and biomedical industry in particular. http://www.solidworks.com/

COMSOL is a modeling package for the simulation of any physical process you can describe with partial differential equations (PDEs). It features state-of-the-art solvers that address complex problems quickly and accurately, while its intuitive structure is designed to provide ease of use and flexibility. http://www.comsol.com/

If you have no experience or familiarity with these software packages, do not fear – the point of this class is to teach you how to use them and give you the opportunity to become experts in them BEFORE senior design!

All 3 packages are available on CAEN Windows-based computers.

Tentative Lecture Topics (a more detailed schedule will be provided):

1. Introduction to engineering problem solving and algorithms.
2. Design cycle: Problem identification, conceptual model, mathematical model, coding, and application.
3. Problem formulation and algorithmic design.
4. PBL Module #1
    a. Matlab tutorial
    b. 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
6. PBL Module #3
    a. Computational tool tutorial (COMSOL)
    b. Background physiology and mechanics related to module #3

The PBL modules this semester will have distinctive emphasis on biochemical, biomaterials, and biomechanics problems, as these are the topics with which your

instructor is most familiar. There are no plans for a dedicated bioelectric module at this time.

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 Assignment #1	10% (Matlab)
	PBL Assignment #2	20% (SolidWorks)
	PBL Assignment #3	30% (COMSOL)
	Midterm exam	20%
	Integrated Design Report	20%

Further details will be provided on the content of your PBL assignments and the deliverables (i.e., what you have to hand in and when) as we move along.

Academic Honesty and the Honor Code:
The University of Michigan's College of Engineering Honor Code binds students enrolled in this course. For more details, please log onto the following URL:
http://www.engin.umich.edu/org/encl/code.html

Course Profile: Biomedical Engineering Program

COURSE #: BIOMEDE 350	**COURSE TITLE:** INTRODUCTION TO BIOMEDICAL ENGINEERING DESIGN
TERMS OFFERED: Fall and Winter	**PREREQUISITES:** Junior standing **COGNIZANT FACULTY:** A. Putnam
TEXTBOOK/REQUIRED MATERIAL: Course pack.	**DATE OF PREPARATION:** 3/15/2010
	SCIENCE/DESIGN: 1/2
CATALOG 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.	**COURSE 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 b. 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 6. PBL Module #3 a. Image analysis tutorial (Simpleware) b. 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 OBJECTIVES*	1. To expose students to key aspects of the process of designing a biomedical device or biotechnology product. 2. To provide students with the technical fundamentals to perform design. 3. To impart general knowledge of problem solving skills and algorithm design. 4. To expose students to relevant software packages commonly used in biomedical engineering design and analyses. 5. To provide students with practical experience in the use of software tools through "virtual" team-based design of biomedical devices and technologies.

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.
ASSESSMENT TOOLS	1. Midterm and final exams for individual students related to the course theory and background. 2. Problem-based learning modules (4 total) 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 ENGINEERING
Course Approval Request
College Curriculum Committee, 1420 Lurie Engineering Center Building

Form Number: 2359
Date: 10/10/2012
Effective Term: Winter 2013
Course Offer Freq: ☒ Indefinitely ☐ One term only

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

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

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department:	Home Department: BIOMEDE Biomedical Engineering
Course Number:	Course Number: 418
☐ Cross Listed Course Information:	Cross Listed Course Information:
☐ Course Title:	Course Title: Quantitative Cell Biology
TITLE ABBREVIATION — Time Sched Max = 19 Spaces:	Quant Cell Biology
TITLE ABBREVIATION — Transcript Max = 20 Spaces:	Quant Cell Biology
☐ Course Description:	Course Description for Official Publication (Max = 50 words): This course introduces the fundamentals of cell structure and functioning. The goal is to provide a general background in cell biology, with emphasis placed on physical aspects that are of particular interest to engineers.
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: MCDB 310, Biological Chemistry 415, 515, or Chem 351 and Physics 240, and Math 216 ○ Enforced ◉ Advised
☐ Credit Restrictions	Credit Restrictions
Level of Credit ☐ Undergrad only ☒ Ugrad or Rckhm Grad ☐ R ☐ Rackham Grad ☐ Ugrad or Non-Rckhm Grad ☐ 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 Hours Min 4 Max 4; Contact Hrs/Wk 4; Number of Wks 14	Credit Hours Min 3 Max 3; Contact Hrs/Wk 3; Number of Wks 14

X

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

C

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

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

Grading: ☒ A-E ☐ CR/NC ☐ P/F ☐ S/U

Course Is Y Graded ☐

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

Cognizant Faculty Member	Title
Ariella Shikanov	Assistant Professor
Shuichi Takayama	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.	Biomedical Engineering	DC
Cross-listed Dept(s)		

Form Number

2359

SUPPORTING STATEMENT

Feedback from students has indicated that there is considerable overlap in several courses taken by BiomedE undergraduate students, particularly in the areas of cell and extracellular matrix biology. We therefore will remove some of this content from BiomedE 418, Quantitative Cell Biology, and change the course to three credit hours from the current four credit hours.

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

Detail the Special requirements

Biomedical Engineering 418: Quantitative Cell Biology

SYLLABUS

(DRAFT)

Instructor: Ariella Shikanov

Credits: 3

Course Topics:

1. Introduction to the cell structure, imaging tools.
2. Bacteria and eukaryotic cells
3. Multicellular organisms
4. Timing scales in the cell cycle
5. Bacteriophage and molecular biology
6. Chemical kinetics and enzymes
7. Energy and the life of cell
8. Mechanical and chemical equilibrium
9. Entropy
10. Exam (midterm)
11. A second look at the receptor-ligand and enzyme-substrate binding
12. Macromolecules with multiple states
13. Random walks and the structure of macromolecules
14. The chemistry of water
15. Biological membranes
16. Life in crowded and disordered environments
17. Cellular adhesions and extracellular matrix (ECM)
18. Rate equations and dynamics in the cell
19. Examples of current cell biology research that uses quantitative cell biology approaches.
20. Cellular fast response, bacterial chemotaxis.
21. Review before the final exam

Changes made for the 3-credit course:

1. Students will have only one midterm and one final exam instead of three exams in the 4-credit class.

2. Removed some the class on ECM and the expanded class on eukaryotic cell sensoring.

Biomedical Engineering 418: Quantitative Cell Biology

SYLLABUS

Instructor: Ariella Shikanov

Credits: 4

Course Topics:

1. Introduction to the cell structure, imaging tools.
2. Bacteria, eukaryotic cells and multicellular organisms
3. Timing scales in the cell cycle
4. Chemical kinetics and enzymes
5. Energy and the life of cell
6. Mechanical and chemical equilibrium
7. Exam 1
8. Entropy
9. A second look at the receptor-ligand and enzyme-substrate binding
10. Macromolecules with multiple states
11. Random walks and the structure of macromolecules
12. The chemistry of water
13. Biological membranes
14. Exam 2
15. Life in crowded and disordered environments
16. Cellular adhesions and extracellular matrix (ECM)
17. Rate equations and dynamics in the cell
18. Examples of current cell biology research that uses quantitative cell biology approaches
19. Dynamics of molecular motors
20. Chemical and informational organization in the cell
21. Cellular fast response, bacterial chemotaxis
22. Review before the final exam

Course Profile: Biomedical Engineering Program

COURSE #: BIOMEDE 418	**COURSE TITLE:** QUANTITATIVE CELL BIOLOGY
TERMS OFFERED: Fall and Winter	**PREREQUISITES:** Biochemistry and Intro Physics, Chem and Calculus
TEXTBOOK/REQUIRED MATERIAL: "Molecular Cell Biology," Lodish et al., 6th edition. (Hunt); Physical Biology of the Cell, R. Phillips, et al. (Takayama)	**COGNIZANT FACULTY:** A. Shikanov **DATE OF PREPARATION:** 10/12
INSTRUCTOR(S): A. Shikanov	**SCIENCE/DESIGN:** 3/0
CATALOG DESCRIPTION: This course introduces the fundamentals of cell structure and functioning. The goal is to provide a general background in cell biology, with emphasis placed on physical aspects that are of particular interest to engineers.	**COURSE TOPICS:** Introduction to cell structure; bacterial flagella; introduction to Eukaryotic cells; intracellular organelles; electron transport in chloroplasts and mitochondria; ATP synthase; cytoskeleton; protein synthesis and processing; mitosis; cell cycle; signal transduction; extracellular matrix; cell adhesion systems; microfilament regulation and myosin.

COURSE OBJECTIVES*	1. Teach students fundamentals of cellular biology. [12, 14] 2. Show students how to formulate quantitative models of cellular processes. [1, 5, 10, 11, 12, 13, 14] 3. Contrast descriptive and quantitative models of cellular processes. [1, 5, 8, 10, 11, 12, 13, 14] 4. Prepare students to understand advanced topics in molecular and cellular biology using quantitative tools. [1, 5, 8, 10, 11, 12, 13, 14] 5. Introduce students to systems approach in biology. [12, 13, 14]

COURSE OUTCOMES*	1. Identify and describe the morphology, biochemistry and biological roles of major cellular structures. [12, 13, 14] 2. Apply diffusion equations, chemistry, and biochemistry to model membranes in order to understand how they constrain and facilitate cellular functions such as electron transport, electrical activity, and regulation of intracellular chemistries. [1, 5, 8, 10, 11, 12, 13, 14] 3. Introduce Reynolds' number and consider how diffusion and the fact that momentum can be neglected constrain and facilitate cellular transport and morphologic changes. [1, 5, 12, 13, 14] 4. Consider how processes such a signal transduction and cell division can be modeled quantitatively. This will include considering what new experimental data would have the greatest impact on the models' predictive values. [1, 5, 8, 10, 11, 12, 13, 14] 5. Consider the evolution of cellular structures. Apply evolution principals to understand mechanisms underlying cellular processes. [10, 12, 14] 6. Provide an introduction to how the mechanical properties of cells can be determined by invasive manipulation by microneedles, viscous flow, or optical tweezers, or by non-invasive observation of thermal motion. [1, 5, 12, 13] 7. Apply statistical mechanics to model the energetics of mitochondria and electrically active cells. [1, 5, 12, 13] 8. Provide an introduction to how electrical properties of cells can be studied using voltage clam and patch clamp techniques. Introduce continuous cable model to describe the electrical properties of cells. [1, 5, 8, 10, 11, 12, 13]
ASSESSMENT TOOLS	1. Homework assignments. [1, 5, 8, 10, 11, 12, 13, 14] 2. Exams. [1, 5, 8, 10, 11, 12, 13, 14] 3. Student discussion and questions. [1, 5, 8, 10, 11, 12, 13, 14] 4. Student evaluation of course. [1, 5, 8, 10, 11, 12, 13, 14]

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

Form Number: 2349
Date: 9/14/2012
Effective Term: Winter 2013
Course Offer Freq: ☒ Indefinitely ☐ One term only

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

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

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department:	Home Department: IOE Industrial & Operations Engin
Course Number:	Course Number: 419
☐ Cross Listed Course Information:	Cross Listed Course Information:
☐ Course Title:	Course Title: Service Operations Management
TITLE ABBREVIATION — Time Sched Max = 19 Spaces:	TITLE ABBREVIATION — Time Sched Max = 19 Spaces: Service Oper Mgmt
TITLE ABBREVIATION — Transcript Max = 20 Spaces:	TITLE ABBREVIATION — Transcript Max = 20 Spaces: Service Oper Mgmt
☐ Course Description:	Course Description for Official Publication (Max = 50 words): Introduction to optimization, queueing, and spreadsheet-based simulation modeling applications in the service industries. Topics covered will include facility location modeling, short-term workforce management, long-term workforce planning, resource allocation, inventory applications in service systems, customer scheduling, call center design, and vehicle routing.
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 ( ) Free Elective ( ) Other ( ) Core Course ( ) Tech Elective	Degree Requirements: ( ) Degree Requirement ( ) Free Elective ( ) Other ( ) Core Course (•) Tech Elective
Prereq: ( ) Enforced ( ) Advised	Prereq: IOE 310 and IOE 316 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	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 ____	Credit Hours Min 3 Max 3: Contact Hrs/Wk 3 Number of Wks 14

Repeatability (Indi Research, Dir. Study, Dissertation: Is this course repeatable? ( ) Yes (•) No Max Hours? 3 Max Times? 1 Can it be repeated in the same term? ( ) Yes (•) No

C.

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: Mark S Daskin
Title: Professor/Dept Chair
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. IOE Mark S. Daskin
Cross-listed Dept(s).
Chair Signature

Form Number

2349

SUPPORTING STATEMENT

see attached

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

Detail the Special requirements

COURSE PROFILE

Degree Program: IOE **Date:** 9/2712

Prepared by: Mark S. Daskin

COURSE #: IOE 419	**COURSE TITLE:** SERVICE OPERATIONS MANAGEMENT
TERMS OFFERED: Winter	**For each prerequisite below, "E" denotes Enforced and "A" denotes Advised.**
TEXTBOOKS/REQUIRED MATERIAL: *Service Science*	**PREREQUISITES:** IOE 310 or equiv (E), IOE 316 or equiv (E)
INSTRUCTOR(S): Mark Daskin	**COGNIZANT FACULTY:** Mark Daskin
CoE BULLETIN DESCRIPTION: Introduction to optimization, queueing, and spreadsheet-based simulation modeling applications in the service industries. Topics covered will include facility location modeling, short-term workforce management, long-term workforce planning, resource allocation, inventory applications in service systems, customer scheduling, call center design, and vehicle routing.	**COURSE TOPICS:** Review of linear, integer, and multi-objective optimization. Review of queueing theory including time-dependent queues. Formulation and solution of classical facility location, inventory and vehicle routing models applied to service systems. Network and integer programming models of workforce management. Use of queueing models to analyze service system design issues.
COURSE STRUCTURE/SCHEDULE (i.e., Lecture: 3 per week @ 50 minutes; or 2 per week at 80 minutes)	

COURSE OBJECTIVES	Links shown in brackets are to departmental educational outcomes: 1 To formulate linear, integer linear, and mixed-integer linear programs for modeling service systems. [1,5] 2 To solve mathematical programming, queueing, and simple simulation models using Excel. [1] 3 To understand the differences between key facility location models as applied to service systems.[1,5] 4 To develop and solve optimization problems for workforce management and planning. [1,5] 5 To read and evaluate technical literature in service systems. [9] 6 To present a topic orally involving mathematical modeling of service systems. [4,7]
COURSE OUTCOMES For each course outcome, links to the Course Objectives a identified.	1. Use mixed integer linear programming (MILP) to analyze facility location problems in services [1,2, 3] 2. Use MILP together with queueing theory to analyze multiobjective tradeoffs in workforce management [1,2, 4] 3. Use newsvendor problem to analyze tradeoffs in workforce management and related service decisions [2, 4] 4. Read and understand literature in service systems. [5, 6] 5. Understand and use multiobjective optimization in the context of service sector decisions [1, 2, 3, 4] 6. Use spreadsheet modeling (optimization and probabilistic modeling) to analyze service systems [2]
ASSESSMENT TOOLS For each assessment tool, links to the course outcomes are identified.	1. Homework assignments to be given every 7-10 days [1,2,3,5,6] 2. 2 quizzes [1,2,3,5] 3. Final exam [1,2,3,5] 4. Written and oral critique of at least one paper in the literature on services [4] 5. Standard course evaluations as presented in numerical and qualitative feedback [1, 2, 3, 4, 5, 6]

Justification for a new course
Service Operations Management
Mark S. Daskin

Why is this course needed?

The service industry accounts for about 75% of the US employment and almost 60% of all personal consumption. This course will explore the service industries in the US (e.g., transportation, health care, retailing, restaurants, education, emergency services) with a view toward developing models that allow planners and service system operators to reduce costs and enhance customer service. The course will focus on generic problems faced by many service providers including such topics as

- facility location planning for services (e.g., ambulances, fire stations, repair facilities, cell phone towers),
- resource allocation problems (including problems in higher education),
- inventory management issues in the service sector,
- workforce planning and scheduling, yield and demand management,
- queueing analysis and design of service systems,
- call center management,
- customer scheduling issues, and
- vehicle routing in the service industries.

The course will expand on our students' knowledge of optimization (IOE 310) and stochastic modeling (IOE 316). Specific new methodologies to be covered include queueing theory (including the numerical analysis of time dependent queueing problems) and multiobjective optimization modeling.

How does this course improve the undergraduate curriculum?

The course adds to the offerings in the OR/PDL area of the department for students interested in applying the methodological material taught in some of the 300-level courses including IOE 310 and IOE 316. In addition, the course is unique in that it explicitly discusses the service sector of the economy as opposed to manufacturing.

The course is designed to address the following educational objectives of the program:

1. an ability to apply knowledge of mathematics, science, and engineering;
5 an ability to identify, formulate, and solve industrial and operations engineering problems;
7. an ability to communicate effectively;
8. the broad education necessary to understand the impact of engineering solutions in a global and societal context;
9. a recognition of the need for, and an ability to engage in life-long learning;

It will do this through a combination of homework assignments, quizzes and a final exam along with a written and oral presentation (in a team context) of a paper in the literature on service systems.

How does this course meet the needs of our students and society?

Many of our students enter careers in the service sector including education, consulting, healthcare, law and government service. This course will prepare them for positions in these industries by enhancing their fundamental knowledge of common problems faced by these industries and organizations.

IOE 491 - Service Operations Management
Course Outline
Winter, 2012

TENTATIVE COURSE OUTLINE

Week	Dates	Topic	Readings
1	Jan 4,9, 2012	Introduction -- What are services? What is the service sector?	Chapter 1
2	Jan 11-18, 2012	Service delivery and network design, Introduction to location models	Sections 4.1-4.4
	Jan. 16, 2012	**Martin Luther King Day -- No Class**	
3	Jan 23-25, 2012	Multi-objective modeling and Multi-objective location modeling	Section 2.8, Section 4.5
4	Jan 30-Feb 1, 2012	Districting in services	Section 4.6
5	Feb 6-8, 2012	Inventory Issues in the service Industries	Chapter 5
6	Feb 13-15, 2012	Resource Allocation Problems in the service industries	Chapter 6
7	Feb 20-22,2012	Short-term workforce scheduling	Chapter 7, sections 7.1-7.4
	Feb 27-29, 2012	**VACATION**	
8	Mar 5-7, 2012	Review of queueing models	Chapter 3
9	Mar 12-14, 2012	Review of queueing theory continued	Chapter 3
10	Mar 19-21, 2012	Linking scheduling and service performance	Sections 7.5 and 7.6
11	Mar 26-28, 2012	Long-term workforce planning	Chapter 8
12	Apr 2-4, 2012	Call center design	Section 9.3
13	Apr 9-11,2012	Priority queues and customer scheduling	Sections 9.1, 9.2, and 9.4
14	Apr. 16, 2012	Vehicle routing OR Course Review	Chapter 10
15	Apr. 25, 2012	**FINAL EXAM 4-6 pm**	