The University of Michigan
College of Engineering
Curriculum Committee

Agenda
December 21, 2004
1:30-3:30 p.m.
GM Room
Fourth Floor Lurie Engineering Center

1. Approval of Minutes from December 07, 2004 Meeting

2. BME Program Change--Revised

3. Curriculum Committee Representation for Tech Comm Program

4. Proposed Change in Pass/Fail Rule—from ARWG

5. Correction of ChE Sample Schedule to account for Physics 140 Prerequisites – Susan Montgomery

6. Change in ChE 341 Prerequisites – Susan Montgomery

7. Course Approval Forms

University of Michigan
College of Engineering
Curriculum Committee Meeting
Tuesday December 7, 2004
1:30-3:00 p.m.
Lurie Engineering Center GM Room
Minutes

Jeff Fessler called the meeting to order at 1:40 p.m.

Members Present: J.Fessler, C.Cesnik, J. Day, G. Herrin, J., S. Holleran, J. Holloway, G. Hulbert, C. Lastoskie , S. Montgomery, M. Parsons, J. Patel, H. Peng, R. Robertson, S.Takayama

Members Absent: S. Pang, P. Samson (AOSS), L. Thompson

Guests: Kathleen Vargo, Pam Linderman, Kurt Hill, Doug Noll

Motion to approve the minutes of the last meeting

The minutes of the last meeting were approved

Academic Rules Working Group Update

Kathleen Vargo, Pam Linderman and Kurt Hill from the Academic Rules Working Group presented information regarding the *Proposed Residency Requirement, the "30 of 36" requirement*, and *Triple Undergraduate Degrees in CoE.*
Proposals regarding these issues were included in the meeting packet.
The first item was the Proposed *Residency Requirement*.
Discussion
Mike Parsons made a motion to approve the proposed statement in item with the change to: ***The student must complete at least 50 credit hours of coursework offered by The University of Michigan-Ann Arbor Campus (excludes Prescribed programs)*** Seconded. **Motion Carried (approved)**

The second item was the *"30 of 36" requirement*.
Discussion.
It was decided to leave the "30 of 36" the way it is.

The third item was *Triple Undergraduate Degrees in CoE.*
Discussion.
Jeff Fessler stated that he had presented with the spirit of this memo (to not offer triple degrees) and did not meet with much approval.
Susan Montgomery suggested that any student wanting a third degree can do a prescribed program. Kathleen Vargo noted that using the Prescribed Program is a good compromise.

It was decided that the ARWG would think about this and come up with a proposal.

BME Program Change

This proposed program change was included in the meeting packet.
Shu Takayama introduced this proposed program. The main thing they are doing is to strengthen the concentration areas they have by reducing the number of concentrations, introduce more life sciences into the curriculum, let the students have more shared experiences and have earlier faculty contact.
These changes came about since Biomedical Engineering had relied on other departments for their courses.
The SGUS program will still practically stay the same.
Discussion.
Some changes to this program were requested. This proposed program will be revised and presented at the next Curriculum Committee meeting.

Course Approval Forms

These Courses Were Approved:

AOSS 451 Modification – Changed Prerequisites from: AOSS 401 ***to:*** AOSS 401 or equivalent or permission of instructor; Changed Credit & Contact Hours from: 3 ***to: 4***.

AUTO 599 Modification – Changed course to be repeatable in the same term.

Jeff Fessler called for a motion to approve the following courses. This was moved and seconded.

Motion Carried (approved)

These Courses Were Tabled:

BME 211 New Course

BME 221 New Course

BME 231 New Course

BME 311 New Course

BME 321 New Course

BME 331 New Course

BME 332 New Course

BME 417(X-Listed with EECS 417) Modification – Changing Prerequisites from: EECS 206 and 215 or Graduate Standing ***to: BiomedE 211, EECS 215 or EECS 314 or Graduate Standing***

BME 430 Modification – Changing terms of offering from: yearly ***to alternate years***

BME 450 Modification – Changing Prerequisites from: none ***to: Biomed E211, Biomed E221, BiomedE 231, ENGR 100 and senior standing***

BME 456(X-Listed with ME 456) Modification – Changing Title, Changing Description, Changing Prerequisites from: ME 211, ME 240 ***to: BiomedE 231 or ME 211 and ME 240***

BME 458(X-Listed with EECS 458) Modification – Changing Prerequisites from: none ***to: BiomedE 211 or EECS 314 or Graduate Standing***

BME 476(X-Listed with ME 476) Modification – Changing Prerequisites from: ME 330 or Equivalent, or consent of instructor ***to: BiomedE 531 or ME 320 or ChemE 341. Recommended BiomedE 221***

BME 479 Modification – Changing Prerequisites from: Math 216, ME 330 or permission of Instructor ***to: BiomedE 331 or ME 320 or Chem E 341. Recommended BiomedE 221***

BME 482(X-Listed with NERS 482) Deletion

BME 483 Deletion

BME 485 Deletion

BME 530 Modification – Changing terms of offering from: yearly ***to alternate years***

BME 550 Modification – Changing terms of offering from: WN ***to: FA***

BME 552 New Course

BME 561 Modification – Changing terms of offering from: WN ***to: FA***

BME 575 (X-Listed with Dentistry) Modification – Deleting BME as x-listing

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

Next Meeting
Tuesday, December 21, 2004
1:30-3:30 p.m.
GM Room – Fourth Floor LEC

Biomedical Engineering Program Changes

Submitted to the College of Engineering Curriculum Committee, December 2004

1. Introduction

Executive Summary

The Biomedical Engineering (BiomedE) Department is proposing changes to be effective in the 2005-2006 academic year. They will fundamentally change the relationship between BiomedE students and faculty by streamlining the concentration areas and introducing an array of second- and third-year classes that are taught by BiomedE faculty. Prior to these program changes, most second- and third-year classes have been offered in other departments. This will bring BiomedE students into earlier contact with the faculty and help to create a shared experience amongst students. Perhaps more importantly, these changes will lead to more integration of biomedical and life sciences into the curriculum. These changes mark the last stages of the transition of the BiomedE department from a graduate training department into a department with balanced undergraduate and graduate education programs.

History and Summary of Current BiomedE Curriculum

Forty years ago, the Biomedical Engineering (BiomedE) Program at the UM was founded as a graduate degree program administered by the Rackham School of Graduate Studies and jointly sponsored by the College of Engineering (CoE) and Medical School. In 1996, the program was reorganized into the Biomedical Engineering Department in the CoE. In 2000, the CoE faculty voted to create a new undergraduate (B.S.E.) degree in Biomedical Engineering with the first class of undergraduate students entering in Fall 2001. By Spring 2004, the program has awarded B.S.E. degrees to 34 students with another 45 students on track to receive B.S.E. degrees in the 2004-2005 academic year.

Prior to the introduction of the undergraduate degree in BiomedE, the BiomedE department had (and continues to have) 6 M.S. level areas of concentration (Biomaterials, Biomechanics, Bioelectrical, Biotechnology, Biomedical Imaging, and Rehabilitation Engineering and Ergonomics). The department also established several Sequential Graduate Undergraduate Studies (SGUS) programs with numerous other departments and programs. The B.S.E. in BiomedE was initially introduced to take advantage of these graduate concentration areas. Accordingly, the undergraduate degree was introduced as a "self-SGUS" program for which students could earn a B.S.E. and M.S.E. in one of the BiomedE concentration areas in a 5 year period. The undergraduate degree was initiated in this manner for several reasons:

1. It made use of concentrations providing depth along a specific subdiscipline within biomedical engineering.
2. It allowed the program to take advantage of existing graduate courses geared towards these concentrations.

3. It allowed the program to take advantage of existing undergraduate courses in other departments, particularly those in programs for which we had already established an SGUS program.
4. It allowed the program to limit enrollment while experience with the undergraduate program is obtained and the number of faculty remained limited. This enrollment limit has been implemented as a 3.2 GPA requirement that must be met before students can enroll in BiomedE.

Rationale for Changes to the BiomedE Curriculum

While the BiomedE department is happy with its initial experiences with the undergraduate program, it was almost immediately clear that major modifications would be necessary. The reasons are:

1. There was very limited biological content in many of the engineering courses for second and third year students. This was, in part, due to the reliance on courses from other departments.
2. By relying on other departments' offerings, our curriculum was required to change continuously as other departments updated and modified their curricula.
3. Lack of core BiomedE courses shared by all students reduced the sense of community felt amongst BiomedE students. This sentiment was reflected in exit interviews by graduating students and in other student comments.
4. By relying on other departments' offerings, the old curriculum delayed contact between BiomedE faculty and students until the junior year. This sentiment was reflected in exit interviews by graduating students and also by BiomedE faculty.
5. The large number of concentrations made it difficult to develop strong 300-level courses for all concentrations.
6. The curriculum lacked a course in organic chemistry. This created a prerequisite issue for Bio 310 Biochemistry, for which Chem 210 Structure and Reactivity I was a prerequisite. Additionally, a sizable number of BiomedE students are potentially interested in medical school and organic chemistry is required for medical school admissions.

2. Development of a New BiomedE Undergraduate Curriculum

On May 17, 2002, the Biomedical Engineering department held a faculty meeting dedicated to discussing the undergraduate program, including the possibility of major revisions to the undergraduate program. At that meeting, most major principles of the proposed revisions were discussed, including reducing the number of concentrations, adding new 200- and 300-level courses, and maintaining a strong core of BiomedE courses used in the original curriculum. On August 26, 2002, Department Chair Matthew O'Donnell issued a memo creating three curricular working groups: the Bioelectrical, Biochemical, and Biomechanical groups. These groups each met several times over a two year period to outline the development of new courses and requirements in each concentration area. The major components of the proposed BiomedE undergraduate curriculum were preliminarily approved by the BiomedE faculty on February 6, 2004 with formal approval of the final version on September 17, 2004.

The proposed changes to the BiomedE undergraduate curriculum are presented to the CoE Curriculum committee by the BiomedE Undergraduate Education Committee: Douglas Noll (chair), Scott Hollister, Alan Hunt, and Shuichi Takayama, and supported by Susan Bitzer and Amy Bleiler.

Summary of changes to the undergraduate BiomedE program include:

1. The number of concentrations has been reduced from 6 to 3: Bioelectrical, Biochemical, and Biomechanical concentrations. They have all been substantially modified relative to the current curriculum.
2. Three new 200-level classes have been added to the core curriculum and are required of all students. They will expose students to work in the three concentration areas prior to the time where they must select a concentration area. These are:
    a. BiomedE 211 – Circuits and Systems for Biomedical Engineering
    b. BiomedE 221 – Biophysical Chemistry and Thermodynamics
    c. BiomedE 231 – Introduction to Biomechanics
3. The development of new 300-level "foundation courses" within the concentration areas:
    a. BiomedE 311 – Biosystems and Signals (Bioelectrical concentration)
    b. BiomedE 321 – Bioreaction Engineering and Design (Biochemical concentration)
    c. BiomedE 331 – Introduction to Biofluid Mechanics (Biochemical and Biomechanical concentrations)
    d. BiomedE 332 – Introduction to Biosolid Mechanics (Biomechanical concentration)
4. The development of other new courses that are technical electives within the concentration areas and :
    a. BiomedE 552 – Biomedical Optics
5. Addition of organic chemistry and laboratory: Chem 210/211 Structure and Reactivity I. With this requirement, we have eliminated the formerly required lower level chemistry laboratory, Chem 125 General Chemistry Laboratory. This is a small deviation from the standard CoE core, but is similar to changes already adopted by Chemical Engineering.
6. Restructuring of the SGUS program so that with appropriate selection of electives, students can still obtain the B.S.E. and M.S. degrees within a 5 year period. Typical progressions are:
    a. Undergraduate Bioelectrical → Graduate Bioelectrical or Biomedical Imaging
    b. Undergraduate Biochemical → Graduate Biotechnology or Biomaterials
    c. Undergraduate Biomechanical → Graduate Biomechanical or Rehab Engineering and Ergonomics
7. Other changes:
    a. For our probability and statistics requirement, we now allow Stats 412 Introduction to Probability and Statistics as an alternate to IOE 265 Probability and Statistics for Engineers.
    b. With the introduction of BiomedE 332 Introduction to Biosolid Mechanics, BiomedE 456 – Biosolid Mechanics: Modeling and Applications has been modified to make the material more advanced and to cover more biomechanics applications material.

8. Changes in prerequisites related to new courses in the BiomedE curriculum
    a. BiomedE 417 – Electrical Biophysics
    b. BiomedE 450 – Biomedical Design
    c. BiomedE 456 – Biosolid Mechanics: Modeling and Applications
    d. BiomedE 458 – Biomedical Instrumentation and Design
    e. BiomedE 476 – Biofluid Mechanics
    f. BiomedE 479 – Biotransport
9. Elimination of upper division classes that will no longer be taught
    a. BiomedE 482 –Fundamentals of Ultrasonics with Medical Applications
    b. BiomedE 483 –Introduction to Magnetic Resonance Imaging
    c. BiomedE 485 – Introduction to Optical Imaging
10. Other changes unrelated to the new curriculum
    a. BiomedE 430 – Rehabilitation Engineering and Assistive Technology:
       - Change in offering to alternate years
    b. BiomedE 530 – Rehabilitation Engineering and Technology Lab
       - Change in offering to alternate years
    c. BiomedE 575 – Seminar in Biomaterials
       - Class not taught recently, deletion of cross-listing

<u>Aspects of the undergraduate BiomedE program that will remain unchanged:</u>

1. Use of the CoE common core curriculum with the exception of basic chemistry lab course, Chem 125, as described above.
2. Continued use of concentration areas to provide depth along a specific subdiscipline within biomedical engineering
3. Continued requirement of basic biology, biochemistry and statistics:
    a. Bio 162 – Introduction to Biology
    b. Bio 310 – Biochemistry
    c. IOE 265 or Stats 412.
4. Four strong, upper division BiomedE courses remain as part of the core curriculum required of all students:
    a. BiomedE 418 – Quantitative Cell Biology
    b. BiomedE 419 – Quantitative Physiology
    c. BiomedE 450 – Biomedical Design
    d. BiomedE 458 – Biomedical Instrumentation and Design

3. The Proposed BiomedE Undergraduate Curriculum

BiomedE Undergraduate Core Curriculum

Subjects required by all programs

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 Math

Biology 162, Intro to Biology	5
Chemistry 210/211, Structure & Reactivity I	5
Biology 310, Intro to Biological Chemistry	4
IOE 265, Prob & Stats for Engrs (F, W) or Stats 412, Intro to Prob & Stats (F,W, Sp)	3-4
	17-18

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 418, Quantitative Cell Biology (W)	4
BiomedE 419, Quantitative Physiology (F)	4
BiomedE 450, Biomedical Design (F, W)	4
BiomedE 458, Biomedical Instrumentation & Design (F, W)	4
	28

BSE Concentration Requirements and Electives	**20**
Unrestricted Electives	**9-10**
Total	**128**

Biochemical Concentration

Concentration Requirements (11 credits)

BiomedE 331, Intro to Biofluid Mechanics (F)	4 cr. hrs
BiomedE 321, Bioreaction Engineering & Design (W)	3
MatScie 250, Principles of Engineering Materials (F, W)	4
or MatScie 220, Introduction to Material and Manufacturing (F, W)	

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 (4 credits)

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

Option Electives (at least 2 credits)

BiomedE 332, Intro to Biosolid Mechanics (W05)	4
BiomedE 410, Biomedical Materials (F)	4
BiomedE 476, Advanced Biofluid Mechanics (W)	3
BiomedE 479, Biotransport (W)	4
BiomedE 556, Molecular & Cellular Biomechanics (F)	3
BiomedE 561, Biological Micro- & Nanotechnology (F)	3
BiomedE 584, Tissue Engineering (F)	3
CEE 582, Environmental Microbiology (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

Biomechanical Concentration

Concentration Requirements (12 credits)

BiomedE 331, Intro to Biofluid Mechanics (F)	4 cr. hrs.
BiomedE 332, Intro to Biosolid Mechanics (W05)	4
MoveSci 230, Musculoskeletal Anatomy (F, W) or BiomedE 401, Human Body (F)	4

At least two courses from this group (6-8 credits)

BiomedE 456, Biosolid Mechanics: Modeling and Applications (F05)	3
BiomedE 476, Advanced Biofluid Mechanics (W)	4
BiomedE 479, Biotransport (W)	4
IOE 463, Work Measurement & Prediction (F)	2
IOE 491, Applied Physical Ergonomics (F)	2
IOE 433, Occupational Ergonomics (IOE has no plans to teach 1/04)	3
BiomedE 534, Occupational Biomechanics (W04)	3

Concentration Electives

BiomedE 456, Biosolid Mechanics: Modeling and Applications (F05)	3
BiomedE 476, Advanced Biofluid Mechanics (W)	4
BiomedE 479, Biotransport (W)	4
IOE 433, Occupational Ergonomics (IOE has no plans to teach 1/04)	3
BiomedE 534, Occupational Biomechanics (W04)	3
IOE 436, Human Factors in Computer Systems (W)	4
IOE 438, Occupational Safety Management (W)	2
IOE 463, Work Measurement & Prediction (F)	2
IOE 491, Applied Physical Ergonomics (F)	2
MoveSci 435, Biomechanics of Human Locomotion (F every other year & will first be offered F04)	3
MechEng 499, Biomechanics for Engineers (W)	3
MechEng 360, Modeling of Dynamic Systems (F, W)	4

Bioelectrical Concentration

Concentration Requirements (12 credits)

BiomedE 311, Biosystems & Signals (W)*	4 cr. hrs.
BiomedE 417, Electrical Biophysics (W)	4
EECS 401, Probabilistic Methods in Engineering (F, W)	4

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

BiomedE 552, Biomedical Optics (F)	3
EECS 414, Intro to MEMS (F)	4
EECS 320, Semiconductor Devices (F, W)	4
BiomedE 4xx, Neurosystems (to be created)	3

Concentration Electives (at least 4 credits):

BiomedE 331, Intro to Biofluid Mechanics (F)	4
BiomedE 552, Biomedical Optics (F)	3
EECS 283, Programming for Engineers (W)	4
EECS 311, Analog Electronics (F)	4
EECS 312, Digital Integrated Circuits (W)	4
EECS 320, Electronic Devices (F, W)	4
EECS 334, Principles of Optics (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 451, Digital Signal Processing (F, 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 (W)	3
NERS 481, Radiation Imaging (W)	2

*The EECS system sequence (EECS 206 and 306) will be considered an acceptable substitute for BME 311. This sequence will constitute 8 cr. and the concentration electives will be reduced by 4 cr.

Sample Schedules

Proposed BME Undergraduate Curriculum - College & Core

Semester	1		2		3		4		5		6		7		8	
Course 1	Math 115	4	Math 116	4	Math 215	4	Math 216	4	Stats*	4	BME 418	4	BME 419	4	BME 450	4
Course 2	Chem 130	3	Phys 140/141	5	Phys 240/241	5	Bio 162	5	Chem 210/211	5	Bio 310	4	BME 458	4		
Course 3	Engin 100	4	Engin 101	4	BiomedE 221	4	BiomedE 231	4	BiomedE 211	4						
Course 4	Hu/SS	4	Hu/SS	4	Hu/SS	4	Hu/SS	4								

Stats*: Either Stats 412 (3) or IOE 265 (4)

LEGEND:

College requirements	BME Core - Common to all Concentrations
Concentration classes (20 Cr)	Free Electives

Proposed BME Undergraduate Curriculum - Biochemical Concentration

Semester	1		2		3		4		5		6		7		8		
Course 1	Math 115	4	Math 116	4	Math 215	4	Math 216	4	Stats*	4	BME 418	4	BME 419	4	BME 450	4	
Course 2	Chem 130	3	Phys 140/141	5	Phys 240/241	5	Bio 162	5	Chem 210/211	5	Bio 310	4	BME 458	4	Biochem Lab/Elec	5	
Course 3	Engin 100	4	Engin 101	4	BiomedE 221	4	BiomedE 231	4	BiomedE 211	4	BiomedE 321	3	MatSci 250	4	Biochem Elective	4	
Course 4	Hu/SS	4	Hu/SS	4	Hu/SS	4	Hu/SS	4	BiomedE 331	4	Free Elective	3	Free Elective	3	Free Elective	3	
Core		15		17		17		17		13		8		8		4	99
Conc		0		0		0		0		4		3		4		9	20
Free		0		0		0		0		0		3		3		3	9
Total		15		17		17		17		17		14		15		16	128

Proposed BME Undergraduate Curriculum - Biomechanical Concentration

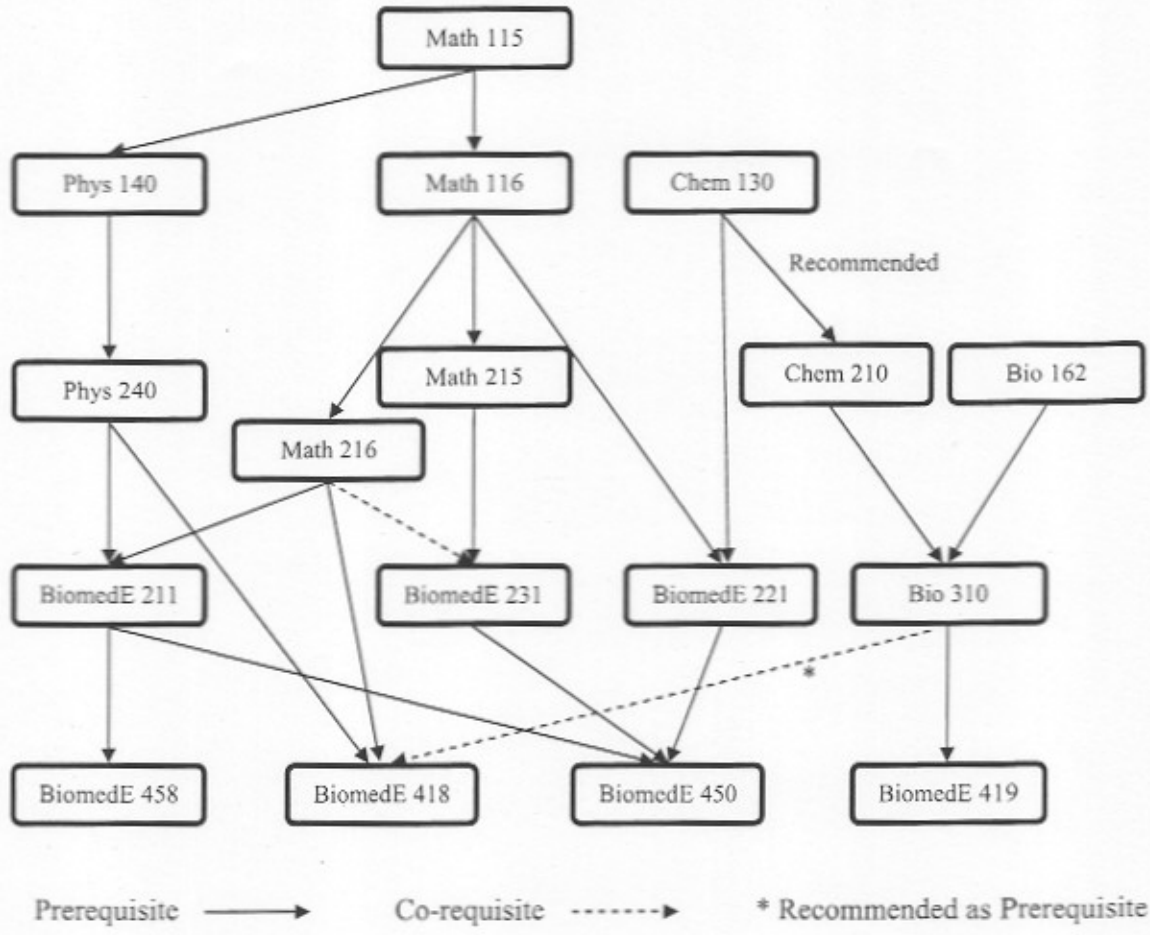
Semester	1		2		3		4		5		6		7		8		
Course 1	Math 115	4	Math 116	4	Math 215	4	Math 216	4	Stats*	4	BME 418	4	BME 419	4	BME 450	4	
Course 2	Chem 130	3	Phys 140/141	5	Phys 240/241	5	Bio 162	5	Chem 210/211	5	Bio 310	4	BME 458	4	Biomech Elective	4	
Course 3	Engin 100	4	Engin 101	4	BiomedE 221	4	BiomedE 231	4	BiomedE 211	4	BiomedE 332	4	Anatomy	4	Biomech Elective	4	
Course 4	Hu/SS	4	Hu/SS	4	Hu/SS	4	Hu/SS	4	BiomedE 331	4	Free Elective	3	Free Elective	3	Free Elective	3	
Core		15		17		17		17		13		8		8		4	99
Conc		0		0		0		0		4		4		4		8	20
Free		0		0		0		0		0		3		3		3	9
Total		15		17		17		17		17		15		15		15	128

Proposed BME Undergraduate Curriculum - Bioelectrical Concentration

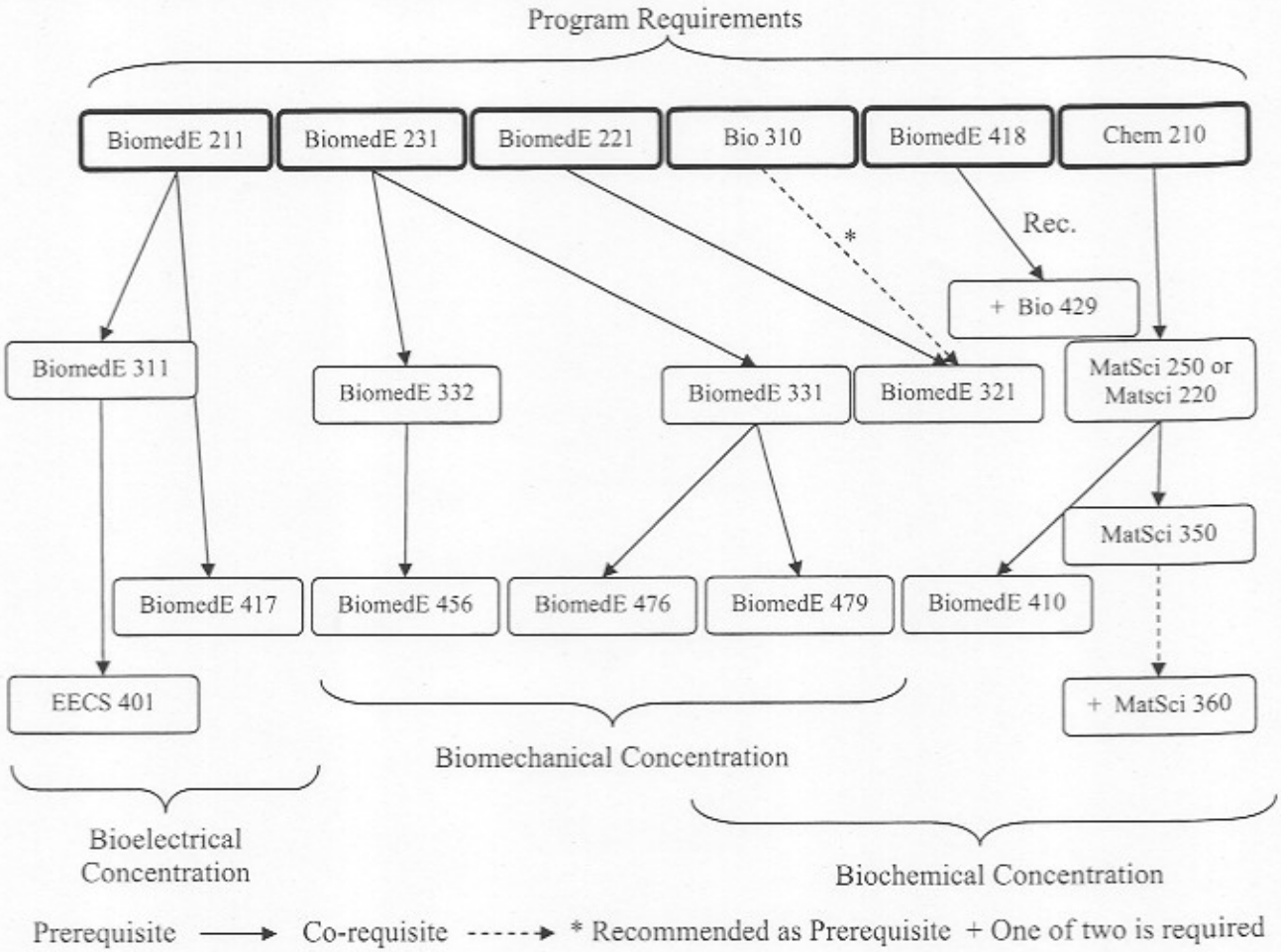
Semester	1		2		3		4		5		6		7		8		
Course 1	Math 115	4	Math 116	4	Math 215	4	Math 216	4	Stats*	4	BME 418	4	BME 419	4	BME 450	4	
Course 2	Chem 130	3	Phys 140/141	5	Phys 240/241	5	Bio 162	5	Chem 210/211	5	Bio 310	4	BME 458	4	BiomedE 417	4	
Course 3	Engin 100	4	Engin 101	4	BiomedE 221	4	BiomedE 231	4	BiomedE 211	4	BiomedE 311	4	EECS 401	4	BioElec Elective	4	
Course 4	Hu/SS	4	Hu/SS	4	Hu/SS	4	Hu/SS	4	Free Elective	3	Free Elective	3	BioElec Elective	4	Free Elective	3	
Core		15		17		17		17		13		8		8		4	99
Conc		0		0		0		0		0		4		8		8	20
Free		0		0		0		0		3		3		0		3	9
Total		15		17		17		17		16		15		16		15	128

4. Prerequisite Mapping

Prerequisite pathways for required program courses:



Prerequisite pathways for concentration requirements:



Prerequisite Equivalencies

BiomedE students will generally be required to take the prerequisites as shown and equivalencies will be accepted only after an approved petition to the BiomedE Undergraduate Education Committee or by the equivalencies designated by the CoE transfer office.

For non-BiomedE students wishing to take 300- and 400-level BiomedE classes as electives, the following prerequisites will be accepted:
BiomedE 311 – EECS 215 or EECS 314
BiomedE 321 – ChemE 330 and Bio 310
BiomedE 331, 332 – ME 211
BiomedE 417, 458 – EECS 215 or EECS 314
BiomedE 456 – ME 211 and ME 240
BiomedE 476, 479 – ME 320 or ChemE 342

5. Program Outcomes

The BiomedE program outcomes required by ABET have previously been approved by the BiomedE department. Included in the following table are course by program outcome mappings for the new courses (in BOLD) and for existing program requirements and electives taught in the BiomedE department.

	BME Undergraduate Course Numbers																	
Education outcomes	**211**	**221**	**231**	**311**	**321**	**331**	**332**	410	417	418	419	430	450	456	458	476	479	**552**
1. Apply math, science, eng.	**X**	**X**	**X**	**X**	**X**	**X**	**X**	X	X	X	X	X	X	X	X	X	X	**X**
2. Experimental design; data analysis							**X**				X		X		X	X		
3. Design system, component or process					**X**								X		X			
4. Work on teams			**X**		**X**								X		X			
5. Identify, formulate, solve BME problems	**X**	**X**	**X**		**X**	**X**	**X**	X	X	X	X		X	X	X	X	X	**X**
6. Prof./ethical responsibility													X					
7. Communicate effectively			**X**		**X**		**X**				X	X	X		X			**X**
8. Societal impact of engineering solutions	**X**											X	X					
9. Life-long learning					**X**								X		X			
10. Know contemporary issues		**X**		**X**	**X**	**X**				X	X	X	X		X		X	
11. Use updated BME skills and tools	**X**			**X**			**X**			X	X	X	X		X		X	
12. Provides breadth and depth		**X**		**X**	**X**			X	X	X	X		X	X	X		X	
13. Solves problems at interface of engineering and biology		**X**	**X**	**X**	**X**	**X**	**X**	X	X	X	X	X	X	X	X	X	X	**X**
14. Measure & interpret living systems data, address problems					**X**	**X**				X	X		X		X		X	

6. Course Changes

Documentation of course changes, including Course Approval Request forms, Step II forms, syllabi, and other information are attached.

UNIVERSITY OF MICHIGAN
COLLEGE OF ENGINEERING
OFFICE OF ACADEMIC SUPPORT SERVICES

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MEMORANDUM

TO: CoE Curriculum Committee

FROM: Academic Rules Working Group (ARWG)
(K.Hill, P.Linderman, M.Perlin, T.Reardon, K.Stolaruk, K.Vargo)

DATE: December 13, 2004

RE: **Proposed Change in Pass/Fail Rule**

The Academic Rules Working Group met to discuss and recommend a change in the current Pass/Fail Rule in the 2004-05 College of Engineering Bulletin. This rule impacts CoE undergraduate students only.

The recommendation was initially sent to Levi Thompson, Associate Dean for Undergraduate Education and Gary Herrin, Assistant Dean for Undergraduate Education. The deletion of credit limits was discussed at the Undergraduate Program Advisors meeting of December 9, 2004. Discussion ensued, questions were answered and no objections to the proposed change were expressed.

The rule is currently on page 47-49, 1st paragraph in the 2004-05 CoE Bulletin and states: (text being recommended for deletion is bolded)

> "Elective courses in Humanities and Social Sciences or courses to be used as Unrestricted Electives can be taken pass/fail. The pass/fail total is not to exceed **four courses or 14 credit hours and is limited to** two courses per term or one in a Spring or Summer half term. Any course that is offered only on a pass/fail basis will not be counted in the above totals. Engineering 100, Engineering 101, and Senior Technical Communication courses cannot be elected as pass/fail courses. Courses elected pass/fail which exceeds the limitations stated above **cannot be applied in any way to a degree program and** will revert to the grade earned."

Students are now more than ever taking advantage of the various educational options the CoE offers: dual degrees (two degrees within the college), combined degrees (dependent degrees between CoE and another UM-AA school/college), LSA Minors, SGUS, etc. Enforcing a limit on the amount of pass/fail courses or credit a student receives in the Humanities/Social Science and Unrestricted categories seems unnecessary at this time. We do feel that the limiting per full term and half-term the number of courses a student may elect Pass/Fail should remain.

We fail to understand the philosophy of not allowing the student to use a course for their degree that has violated the rule. Recognizing that the student should know the rules and procedures of their CoE Bulletin, changing the pass/fail course to graded seems a strong enough enforcement.

Therefore, ARWG recommends the 1st paragraph read:

> "Elective courses in Humanities and Social Sciences or courses to be used as Unrestricted Electives can be taken pass/fail. The pass/fail total is not to exceed two courses per term or one in a Spring or Summer half term. Any course that is offered only on a pass/fail basis will not be counted in the above totals. Engineering 100, Engineering 101, and Senior Technical Communication courses cannot be elected as pass/fail courses. Courses elected pass/fail which exceeds the limitations stated above will revert to the grade earned."

If the proposed change is approved, we recommended that students be grandfathered into it.

Thank you for the opportunity of expressing our recommendation.

kmv

Proposed BSE Chemical Engineering curriculum 2004

	Hours	1	2	3	4	5	6	7	8
Subjects required by all programs									
Mathematics 115+,116+,215,216 +	16	4	4	4	4				
Engineering 100, Introduction to Engineering	4	4							
Engineering 101, Computing +	4		4						
Chemistry 130+	3	3							
Physics 140/141+, 240 /241	10		5		5				
Humanities and Social Sciences	16	4				4		4	4
(to include a course in economics)									
Advanced Science									
Biology / life science elective [1]	3						3		
Chem 210, 211, Struct and Reactiv I and Lab +	5		5						
Chem 215,216, Struct and Reactiv II and Lab +	5			5					
Chem 261, Introduction to Quantum Chemistry +	1				1				
Chem 241/2 Analytical Chemistry	4					4			
Related Technical Subjects									
Materials elective (MSE 250 or MSE 220)	4							4	
Technical Electives [2]	6							4	2
Program Subjects									
ChemE 230, Material & Energy Balances +	4			4					
ChemE 330, Thermodynamics +	3				3				
ChemE 341, Fluid Mechanics +	4				4				
ChemE 342, Heat and Mass Transfer +	4					4			
ChemE 343, Separation Processes +	3					3			
ChemE 344, Reaction Engr and Design +	4						4		
ChemE 360, ChemE Lab I +	4						4		
ChemE 460, ChemE Lab II	4								4
ChemE 466, Process Control and Dynamics	3							3	
ChemE 487, Chem Proc Sim and Design	4								4
	37								
Free Electives	10			3			4		3
Total	**128**	15	18	16	17	15	15	15	17

(1) See department for list of courses that satisfy the Biology/Life Science elective requirement.

(2)Technical electives must include a minimum of 2 credits of engineering elective, with the other 4 credits coming from engineering electives, advanced science, or advanced math courses. See department for list of courses that meet the engineering electives, advanced science and advanced math requirements. At least one course must be outside of Chemical Engineering. Engineering courses are to be at the 200 or higher level. Courses in AOSS are not considered engineering courses for this purpose. See department for other exceptions.

(+) Students must earn a "C-" or better in prerequisite courses indicated by the (+)

COURSE APPROVAL FORMS

For December 21, 2004 CoE CC Meeting

CHE 341 Modification – Changing prerequisites from: Physics 140, P/A ChE 230 and Math 216
to: Phys 140, ChE 230, Math 215, P/A by Math 216

EECS 590 New Course

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

Print

Form Number 1465

Action Requested

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

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

Date 12/14/2004
Effective Winter 2005

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Div # / Course Number	Home Department: Chemical Engineering / Div #: CHE / Course Number: 341
Cross Listed Course Information	Cross Listed Course Information
Course Title	Course Title: Fluid Mechanics
TITLE ABBREVIATION — Time Sched Max = 19 Spaces	Fluid Mechanics
TITLE ABBREVIATION — Transcript Max = 20 Spaces	FLUID MECH
Course Description	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.
PROGRAM OUTCOMES: ☐a ☐b ☐c ☐d ☐e ☐f ☐g ☐h ☐i ☐j ☐k	**PROGRAM OUTCOMES:** ☒a ☐b ☒c ☐d ☒e ☐f ☐g ☐h ☐i ☐j ☒k
Degree Requirements: ○ Degree Requirement ○ Core Course ○ Free Elective ○ Tech Elective ○ Other	Degree Requirements: ◉ Degree Requirement ○ Core Course ○ Free Elective ○ Tech Elective ○ Other
X Prerequisites: Physics 140, P/A ChE 230 and Math 215 ○ Enforced ○ Advised	Prerequisites: Phys 140, ChE 230, Math 215, P/A by Math 216 ○ Enforced ◉ Advised
Credit Restrictions	Credit Restrictions
Level of Credit: ☐ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min/Max; Contact Hrs/Wk; Number of Wks	Level of Credit: ☒ Undergrad only ☐ Rackham Grad ☐ Non-Rckhm Grad ☐ Ugrad or Rckhm Grad ☐ Ugrad or Non-Rckhm Grad ☐ All Credit types ☐ Rckhm Grad w/add'l Work; Credit Hours Min 4 Max 4; Contact Hrs/Wk 5; Number of Wks 14
C. Repeatability (Indl Research, Dir. Study, Dissertation): Is this course repeatable? ○ Yes ◉ No; Maximum Hours? ____ Maximum Times? ____; Can it be repeated in the same term? ○ Yes ○ No	Printing Information (Optional): ☒ Print the course in the Bulletin ☒ Print the course in the Time Schedule
Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☐ Dis ☐ Ind ☐ Other ____; Graded Section: ◉ Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other; Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y; Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension	Terms & Freq. of Offering: ☐ I ■ II ☐ IIIa ☐ IIIb ☐ III; ■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years; Half term ☐ 1st ☐ 2nd
	Cognizant Faculty Member: Sharon Glotzer; Title: Associate Professor
	Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

Approval

☐ Curriculum Comm. _____
☐ Faculty _____
☐ Rackham _____
☐ Cross listed Unit 1 _____
☐ Cross listed Unit 2 _____

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept: Clare Lynch for Ronald G. Larson, Chair
Cross-listed Dept(s). _____

Form Number

1465

SUPPORTING STATEMENT

In the past the only math prerequisite for ChE 341 was Math 216. Our department conducted a study of the mathematics prerequisites for all our core courses, based on feedback from a student who had taken ChE 341 after taking Math 216 but not Math 215. We realized that the material in Math 215 is also key to the understanding of ChE 341 material, and so are adding it as a prerequisite.

In addition, we are changing the ChE 230 co-requisite to a prerequisite, as it is in the best interest of the students to take ChE 230 prior to ChE 341.

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

Detail the Special requirements

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

Print

Form Number 1463

Action Requested

(•) New Course
( ) Modification of Existing Course
( ) Deletion of Course

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

Date 12/6/2004
Effective Fall 2005

A. CURRENT LISTING	B. REQUESTED LISTING
Home Department / Div # / Course Number	Home Department: EECS / Div #: 252 / Course Number: 590
Cross Listed Course Information	Cross Listed Course Information
Course Title	Course Title: Advanced Programming Languages
TITLE ABBREVIATION — Time Sched Max = 19 Spaces	Adv Prog Lang
TITLE ABBREVIATION — Transcript Max = 20 Spaces	Adv Prog Lang
Course Description	Course Description for Official Publication (Max = 50 words): Fundamental concepts in programming languages as well as recent topics and trends in PL research. Topics include semantics, type systems, program verification using theorem provers, software model checking, and program analysis. Course focuses on applying PL concepts to improve software reliability. Course includes semester long individual research project.
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 ○ Tech Elective ○ Core Course ○ Other ○ Free Elective	Degree Requirements: ○ Degree Requirement (•) Tech Elective ○ Core Course ○ Other ○ Free Elective
Prerequisites: ○ Enforced ○ Advised	Prerequisites: EECS 281or 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: — / —	Credit Hours Min / Max: 4 / 4
Contact Hrs/Wk: ____ Number of Wks: ____	Contact Hrs/Wk: 4 Number of Wks: 15

C.

Repeatability (Indi Research, Dir. Study, Dissertation): Is this course repeatable? ○ Yes (•) No; Maximum Hours? ____ Maximum Times? ____; Can it be repeated in the same term? ○ Yes ○ No	Printing Information (Optional): ☒ Print the course in the Bulletin ☒ Print the course in the Time Schedule
Class Type(s): ☒ Lec ☐ Rec ☐ Sem ☐ Lab ☒ Dis ☐ Ind ☐ Other ____ Graded Section: (•) Lec ○ Rec ○ Sem ○ Lab ○ Dis ○ Ind ○ Other Grading: ☒ A-E ☐ CR/NC ☐ S/U ☐ P/F ☐ Y Location: ☒ Ann Arbor ☐ Biological Station ☐ Camp Davis ☐ Extension	Terms & Freq. of Offering: ☐ I ■ II ☐ IIIa ☐ IIIb ☐ III; ■ Yearly ☐ Alter Years ☐ Even Years ☐ Odd Years; Half term ☐ 1st ☐ 2nd
	Cognizant Faculty Member: Chandradekhar Boyapati Title: Asst. Professor; Grad Course: Attach nomination if Cognizant Faculty is not a regular graduate faculty

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

Submitted By: ■ Home Dept. ☐ Cross-listed Dept.
Name, Signature & Department
Home Dept. EECS
Cross-listed Dept(s). ____

Form Number

1463

SUPPORTING STATEMENT

This is the first graduate course in Programming Languages. It covers fundamental concepts in Programming Languages as well as recent topics and trends in PL research. The course focuses on applying PL concepts to software reliability.

The University of Michigan EECS department does not have a regular Programming Languages course, so this course fills an important hole in the curriculum. This course was taught as a EECS 598 in Winter 2004, when it was also approved for software area qualification and as an MS and PhD kernel course.

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

Detail the Special requirements

EECS 598-3: Advanced Programming Languages (Winter 2005)

Basic Information
Instructor: Chandrasekhar Boyapati
Lec: T Th 3:00-4:30, 136 EWRE
Rec: F 3:00-4:00, 153 EWRE (Recitations will be held only occasionally.)
Credits: 4

For CSE Ph.D. students, counts as a software kernel course and towards software area qualification.
For CSE Master's students, counts as a 500-level course and as a software kernel course.
For CS-ENGR and CS-LSA undergraduate students, counts as an upper-level CS technical elective.

Course Overview
The motivation behind this course is the need for reliable software. Software is rapidly becoming the foundation for our entire civil infrastructure. All activities including transportation, telecommunications, energy, medicine, and banking rely on the correct working of software systems. As software becomes more pervasive in our infrastructure, failures of software can cause more and more damage. Hence the increasing need for reliable software. Software reliability also has a significant impact on our economy. Studies estimate that bugs in software cost businesses worldwide about $175 billion annually. Making software reliable is one of the most important problems facing computer science today. Making software reliable is also one of the most challenging problems, primarily because of the inherent complexity of large software systems.

This course covers basic and advanced topics in programming languages, and shows how good programming languages can significantly improve the reliability of software systems. This course has three objectives: 1) To understand fundamental concepts in programming languages, 2) To study some recent topics and trends in PL research, and 3) To gain experience planning and carrying out a modest PL research project.

Topics

- Mathematical Foundations: Sets, Relations, Functions, Inductive Proof Techniques
- Defining a Programming Language: Syntax, Operational Semantics, Operational Reasoning
- Making a Programming Language Safe
  - Type Systems: Type Safety, Type System for Java, Type System for Java Bytecodes, Type Inference, Recent Advances
  - Formal Verification: Specifying Assertions, Checking Assertions, Hoare Rules, Verification Conditions, Recent Advances
  - Software Model Checking: Bounded Exhaustive Testing, Dealing With State Space Explosion, Recent Advances
  - Program Analysis: Data Flow Analysis, Abstract Interpretation, Alias Analysis, Recent Advances

Recommended Textbooks
Benjamin Pierce: *Types and Programming Languages*
Glynn Winskel: *Formal Semantics of Programming Languages*

Grading

10%: Paper Summaries and Class Participation
30%: Assignments
60%: Individual Research Project

bchandra@eecs.umich.edu

598 (590)

EECS 598-3: Programming Languages (Winter 2004)

Basic Information
Instructor: Chandrasekhar Boyapati
Lec: T Th 2:00-3:30, 153 EWRE
Rec: F 2:00-3:00, 3427 EECS (Recitations will be held only occasionally.)
Credits: 4

This course will count towards software area qualification and as an MS and PhD kernel course.

Course Overview
This course covers basic and advanced topics in programming languages, and shows how good programming languages can significantly improve the reliability of software systems. This course has three objectives: 1) To understand fundamental concepts in programming languages, 2) To study some recent topics and trends in PL research, and 3) To gain experience planning and carrying out a modest PL research project.

Textbooks
Benjamin Pierce: *Types and Programming Languages*
Glynn Winskel: *Formal Semantics of Programming Languages*

DETAILED OUTLINE

Grading
10%: Paper Summaries and Class Participation
25%: Assignments
65%: Individual Research Project

Schedule

Fundamentals of Type Systems

L1 **Jan 06** **Introduction, Operational Semantics, Inductive Proof Techniques**

Handout
Assignment 1

L2 **Jan 08** **Introduction to Type Systems**

Reading
Hoare: Hints for Programming Language Design
Pierce: Chapters 3, 8

Optional Reading
Wegner: Programming Languages - The First 25 Years
Wirth: On the Design of Programming Languages
Nauer: Report on the Algorithmic Language ALGOL 60

28

Homework Due

Nothing

L3 **Jan 13** **Lambda Calculus**

Reading
Pierce: Chapter 5

Homework Due
Assignment 1

Handout
Assignment 2

L4 **Jan 15** **Simply Typed Lambda Calculus**

Reading
Pierce: Chapter 9

Homework Due
Nothing

L5 **Jan 20** **Extensions to Simply Typed Lambda Calculus**

Reading
Cardelli: Type Systems
Pierce: Chapter 11

Homework Due
Assignment 2

Handout
Assignment 3

L6 **Jan 22** **References, Subtyping**

Reading
Liskov & Wing: A Behavioral Notion of Subtyping (TOPLAS 1994)
Pierce: Chapters 13, 15

Homework Due
Nothing

L7 **Jan 27** **Type Soundness of a Subset of Java**

Reading
Stata & Abadi: A Type System for Java Bytecode Subroutines (POPL 1998)
Pierce: Chapter 19

Optional Reading
Wright & Felleisen: A Syntactic Approach to Type Soundness (Information & Computing 1994)

29

Homework Due

Nothing

Applications of Type Systems

L8 **Jan 29** **Parametric Polymorphism**

Reading
Myers et al: Parameterized Types for Java (POPL 1997)

Optional Reading
Kennedy et al: Design and Implementation of Generics for the .NET Common Language Runtime (PLDI 2001)

Homework Due
Assignment 3
Paper Summary (120 Words)

L9 **Feb 03** **Safe Multithreading**

Reading
Boyapati & Rinard: A Parameterized Type System for Race-Free Java Programs (OOPSLA 2001)

Optional Reading
Boyapati et al: Ownership Types for Object Encapsulation (POPL 2003)

Homework Due
Paper Summary (120 Words)

L10 **Feb 05** **Safe Memory Management**

Reading
Hicks et al: Safe and Flexible Memory Management in Cyclone (University of Maryland TR, 2003)

Optional Reading
Boyapati et al: Ownership Types for Safe Region-Based Memory Management in Real-Time Java (PLDI 2003)

Homework Due
Paper Summary (120 Words)

Handout
Project Suggestions

L11 **Feb 10** **Tracking Aliasing**

Reading
Walker & Morrisett: Alias Types for Recursive Data Structures (TIC 2000)

Optional Reading
Pierce: Chapters 23, 24, 26

Homework Due
Paper Summary (120 Words)

L12 Feb 12 **Protocol Checking**

Reading
DeLine & Fahndrich: Enforcing High Level Protocols in Low-Level Software (PLDI 2001)

Optional Reading
Ramalingam et al: Deriving Specialized Program Analyses for Certifying Component-Client Conformance (PLDI 2002)

Homework Due
Paper Summary (120 Words)

L13 Feb 17 **Information Flow Control**

Reading
Myers: JFlow: Practical Mostly-Static Information Flow Control (POPL 1999)

Optional Reading
Zdancewic et al: Secure Program Partitioning (TOCS 2002)

Homework Due
Paper Summary (120 Words)

L14 Feb 19 **Enforcing Security Policies**

Reading
Evans & Twyman: Flexible Policy-Directed Code Safety (Oakland 1999)

Optional Reading
Walker: A Type System for Expressive Security Policies (POPL 2000)

Homework Due
One Page Project Proposal (Includes Problem Statement, Research Goals, Schedule)
Paper Summary (120 Words)

Happy Winter Break!

L15 Mar 02 **Safe Mobile Code**

Reading
Amme et al: SafeTSA: A Type Safe and Referentially Secure Mobile-Code Representation (PLDI 2001)

Optional Reading
Cytron et al: Efficiently Computing the SSA Form (TOPLAS 1991)

Homework Due
Paper Summary (120 Words)

L16 Mar 04 **Safe Low Level Code**

Reading
Crary et al: TALx86: A Realistic Typed Assembly Language (WCSSS 1999)

Optional Reading
Shao et al: A Type System for Certified Binaries (POPL 2002)

Homework Due
Paper Summary (120 Words)

L17 Mar 09 Safety for Legacy Code

Reading
Necula: CCured: Type-Safe Retrofitting of Legacy Code (POPL 2002)

Optional Reading
Evans: Static Detection of Dynamic Memory Errors (PLDI 1996)

Homework Due
Paper Summary (120 Words)

L18 Mar 11 Type Inference

Reading
Aiken: Introduction to Set Constraint-Based Program Analysis (Science of Computer Programming 1999)

Optional Reading
Knoblock: Type Elaboration and Subtype Completion for Java (TOPLAS 2001)

Homework Due
Four Page Project Motivation & Literature Survey
Paper Summary (120 Words)

Program Verification

L19 Mar 16 Axiomatic Semantics

Reading
Winskel: Chapters 2, 6.1-6.4

Optional Reading
Floyd: Assigning Meaning to Programs (Symposium in Applied Mathematics 1967)

Homework Due
Nothing

L20 Mar 18 Axiomatic Semantics

Reading
Winskel: Chapters 6.5-6.7, 7.1-7.3

Optional Reading
Hoare: An Axiomatic Basis for Computer Programming (CACM 1969)

Hoare: Proof of a Program FIND (CACM 1971)

Homework Due
Nothing

L21 Mar 23 **Axiomatic Semantics**

Reading
Dijkstra: Guarded Commands, Nondeterminancy and Formal Derivation of Programs (CACM 1975)
Winskel: Chapters 7.4-7.7

Homework Due
Nothing

L22 Mar 25 **Program Verification With Theorem Provers**

Reading
Moore: Proving Theorems about Java-Like Byte Code (LNCS 1997)

Optional Reading
Kaufmann & Moore: An Industrial Strength Theorem Prover for a Logic Based on Common Lisp (TSE 1997)

Homework Due
One Page Progress Report
Paper Summary (120 Words)

L23 Mar 30 **Program Verification With Theorem Provers**

Reading
Flanagan at al: Extended Static Checking for Java (PLDI 2002)

Optional Reading
Leavens at al: Preliminary Design of JML: A Behavioral Interface Specification Language for Java (Iowa State University TR, 1998)

Homework Due
Paper Summary (120 Words)

L24 Apr 01 **Program Verification With Theorem Provers**

Reading
Necula et al: Safe Kernel Extensions Without Run-Time Checking (OSDI 1996)

Optional Reading
Appel: Foundational Proof-Carrying Code (LICS 2001)

Homework Due
Paper Summary (120 Words)

L25 Apr 06 **Software Model Checking**

Reading
Godefroid: Model Checking for Programming Languages Using VeriSoft (POPL 1997)

Optional Reading
Visser et al: Model Checking Programs (ASE 2000)

Homework Due
Paper Summary (120 Words)

L26 Apr 08 **Software Model Checking**

Reading
Musuvathi et al: CMC: A Pragmatic Approach to Model Checking Real Code (OSDI 2002)

Optional Reading
Ball et al: Automatic Predicate Abstraction of C programs (PLDI 2001)

Homework Due
Paper Summary (120 Words)

L27 Apr 13 **Software Model Checking**

Reading
Boyapati et al: Korat: Automated Testing Based on Java Predicates (ISSTA 2002)

Optional Reading
Daniel Jackson: Alloy: A Lightweight Object Modelling Notation (TOSEM 2002)

Homework Due
Paper Summary (120 Words)

L28 Apr 15 **Conclusion**

Homework Due
Paper (Maximum Ten Pages, Including Figures, References, and Appendices) (ACM Format)

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