UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

EP.10.33

Office of the Provost and Vice Chancellor
for Academic Affairs

Swanlund Administration Building
601 East John Street
Champaign, IL 61820

January 4, 2010

Abbas Aminmansour, Chair
Senate Committee on Educational Policy
Office of the Senate
228 English Building, MC-461

Dear Professor Aminmansour:

Enclosed is a copy of a proposal from the College of Engineering to revise the undergraduate curriculum in Bioengineering.

This proposal has been approved by the College of Engineering Executive Committee. It now requires Senate review.

Sincerely,

Kristi A. Kuntz
Assistant Provost

KAK/dkk

Enclosures

c: R. Dennis
M. Insana
C. Livingstone
M. Pleck
M. Rood
T. Saif
B. Sutton

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

College of Engineering

Office of the Dean
306 Engineering Hall, MC-266
1308 West Green Street
Urbana, IL 61801

December 2, 2009

Kristi Kuntz
Assistant Provost
217 Swanlund Administration Building
MC-304

Via: Ilesanmi Adesida, Engineering College

Dear Ms. Kuntz:

The College of Engineering Executive Committee has reviewed and approved the following:

Revisions to Undergraduate Curriculum in Bioengineering

Attached is a copy of the request.

Sincerely yours,

Samuel N. Kamin, Secretary
Executive Committee

Approval Recommended:

Ilesanmi Adesida, Dean
College of Engineering

12/2/09
Date

SNK/rd
Enclosure
c: Michael Insana
Taher Saif
Michael Pleck
Mark Rood
Brad Sutton
Robin Dennis

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Proposal to the Senate Educational Policy Committee

PROPOSAL TITLE: Revision to the Curriculum for the B.S. degree in Bioengineering Administered by the Department of Bioengineering in the College of Engineering

SPONSOR: Brad Sutton, Assistant Professor, Department of Bioengineering
217-244-5154, bsutton@illinois.edu

COLLEGE CONTACT: Charles Tucker III, Associate Dean, College of Engineering
217-244-3822, ctucker@illinois.edu

BRIEF DESCRIPTION:

This proposal is to revise the B.S. degree curriculum in Bioengineering to accomplish the following: (1) update the curriculum to incorporate core bioengineering courses that have been developed since the curriculum was approved at the Department's inception in December 2003; (2) reduce the number of total hours from 132 to 128 as recommended by the College of Engineering Executive Committee, Ad-hoc Subcommittee on Undergraduate Education (February 8, 2008); (3) address a section of the curriculum comprised largely of upper level engineering courses for which most bioengineering students do not have sufficient prerequisite content; and (4) provide 48 hours of Engineering content in preparation for review and accreditation from the Accreditation Board for Engineering and Technology (ABET). In summary, the proposed revisions are as follows per the sections outlined in the Programs of Study:

Orientation and Professional Development

- Remove BIOE 436—Bioengineering Professionalism[1,2] (2 hours) from the Orientation and Professional Development section; redesignate this course number in the Bioengineering Technical Core and revise title to BIOE 436—Senior Design II (2 hours). Please note that BIOE 436 was included in the original degree proposal but was never proposed as a course in this context.

Net hour change in curriculum: 2 hours removed (ABET engineering hours unchanged)

Foundational Mathematics and Science courses

- Replace PHYS 213—Univ Physics: Thermal Physics (2 hours) with ME 300—Thermodynamics (3 hours).

Net hour change in curriculum: 1 hour added (3 ABET engineering hours added)

Bioengineering Technical Core

- Replace BIOE 431—Cell & Syst Reaction to Injury[3] (3 hours) with BIOE 476—Tissue Engineering[4] (3 hours).
- Redesignate BIOE 435—Bioengineering Senior Design[1,2] (4 hours) to BIOE 435—Senior Design I (2 hours).
- Add BIOE 436—Senior Design II[1,2] (2 hours).
- Replace ECE 205—Elec & Electronic Circuits (3 hours) with BIOE 205—Circuits & Systems in Bioengrg[4] (4 hours).
- Replace MCB 402—Sys & Integrative Physiology (3 hours) with BIOE 302—Modeling Human Physiology[4] (3 hours).
- Delete the comment "(may be substituted)" from the notation for MCB—404 Sys & Integrative Physiol Lab.
- Drop MCB 450—Introductory Biochemistry or MCB 354—Biochem & Phys Basis of Life (3 hours) and CHEM 233—Elementary Organic Chem Lab I (2 hours).

Net hour change in curriculum: 4 hours removed (5.5 ABET engineering hours added)

Bioengineering Technical Core Electives

- Revise section from selection of 6 hours from departmentally approved list of technical core electives allocated across four categories and instead require BIOE 301—Introductory Biomechanics[4] (3 hours) and TAM 335—Fluid Dynamics (4 hours).

Net hour change in curriculum: 1 hour added (1 ABET engineering hour added)

Track Electives

- Replace the pre-approved Biomolecular Track with Therapeutics Engineering. Drop Computational and Systems Biology as a pre-approved Track.

Net change in curriculum: 0 hours added (ABET engineering hours unchanged)

Footnotes about status of BIOE courses discussed above:

[1] Course as conceived in original curriculum proposal 2003, taught as a special topics pilot for previous and current graduating classes. Course under preparation.

[2] Permission has been granted by the Registrar's Office to reuse course numbers for BIOE 435 and BIOE 436 since the original courses were never approved.

[3] Course as conceived in original curriculum proposal 2003, never offered in special topics trial form, nor is a proposal planned.

[4] Approved course.

JUSTIFICATION:

Bioengineering incorporates a thorough understating of biology with a breadth of engineering knowledge across multiple engineering disciplines. Bioengineering undergraduate curriculums are significantly challenged to cover the large amount of material that bioengineers need to master within the allotted degree program hours. The B.S. degree curriculum in Bioengineering was approved by the Illinois Board of Education in December of 2003 to be 132 hours, the maximum allowable. The curriculum as it was originally proposed included foundational mathematics; physical and life science courses; a large component of courses from affiliated engineering disciplines; and a small proposed core

of bioengineering courses integrating biology with principles of engineering from these affiliated disciplines. The selection of core bioengineering courses to be developed was small due in large part to lack of faculty available to develop courses.

At the time the curriculum was proposed, the Department understood that undergraduate programs within the College of Engineering were moving toward a standard of 128 hours. To reduce the number of hours in the Bioengineering curriculum while incorporating sufficient coursework in the life sciences to maintain a thorough understanding of the application area, the Undergraduate Curriculum Committee determined that it would be necessary to develop additional bioengineering courses which incorporated basic principles of engineering with a bioengineering orientation. This strategy is included in the recommendations of the Vanderbilt-Northwestern-Texas-Harvard/MIT Engineering Research Center (VaNTH ERC) funded by the National Science Foundation to focus on bioengineering educational technologies (*Conference Proceedings 2005 Annual Meeting of the Institute of Biological Engineering (IBE)).* Based on this recommendation, and as instructional staffing resources were available, three additional courses have been developed: BIOE 205—Circuits & Systems in Bioengrg, BIOE 301—Introductory Biomechanics, and BIOE 302—Modeling Human Physiology. All three have been campus-approved after being offered in pilot form 2 or more times over the past 3 years as special topics sections of BIOE 298 and BIOE 398. (BIOE 201 and 302 will be offered the first time in spring 2010; BIOE 301 in fall 2010.)

Please note that reducing the program hours from 132 to 128 is accomplished by dropping the requirement of MCB 450—Introductory Biochemistry or MCB 354—Biochem & Phys Basis of Life (3 hours) and CHEM 233—Elementary Organic Chem Lab I (2 hours) which is total subtraction of 5 hours that do not qualify as ABET engineering hours; and replacing ECE 205—Elec & Electronic Circuits (3 hours) with BIOE 205—Circuits & Systems in Bioengrg (4 hours) which is an addition of 1 ABET engineering hour. The net total to the program of those two changes is to subtract 4 hours from the program. The remaining curriculum revisions support the necessity to provide 48 ABET engineering hours for the purposes of ABET accreditation review (see Appendix A) while incorporating sufficient life sciences in the curriculum to support the application area. In addition, following the first full implementation of the four year curriculum, minor revisions are needed to address issues that have arisen in the core elective area.

Orientation and Professional Development

- Remove BIOE 436—Bioengineering Professionalism (2 hours) from the Orientation and Professional Development section; redesignate this course number in the Bioengineering Technical Core and revise title to BIOE 436—Senior Design II (2 hours). Please note that BIOE 436 was included in the original degree proposal but was never proposed as a course in this context.

BIOE 436 was included in the original degree proposal but has not gone through the course approval process. The course has been piloted as a special topics course for the past two years. The original intent of the course was to provide a general overview of professional and ethics topics related to the field of bioengineering. As originally proposed, the course would contribute zero ABET engineering hours. With a reduction in program hours and the need to provide 48 ABET engineering hours in the curriculum, Bioengineering can no longer afford to include this course. The Department will redesignate this course number to provide a second semester course for Senior Design. As the BIOE 435—Bioengineering Senior Design course has been developed in its BIOE 498 pilot format for the past 2 years, the Department has determined that Senior Design needs to be taught in 2 semesters for student learning and execution purposes. The first semester includes some professionalism and ethics topics but the context is direct application to product/project design. The second semester is the actual product development and

presentation. This would honor the intent of what was envisioned in BIOE—436 Professionalism but would provide a context of applied engineering principles. Senior Design remains at 4 hours total with a revision in title. BIOE 435—Senior Design I (2 hours) taught in fall semester. BIOE 436—Senior Design II (2 hours) taught in spring semester.

Foundational Mathematics and Sciences

- Replace PHYS 213—Univ Physics: Thermal Physics (2 hours) with ME 300—Thermodynamics (3 hours).

Replacing PHYS 213 with ME 300 would add 3 ABET engineering hours to the curriculum and provide coverage of the fundamental topic of thermodynamics from an engineering, problem solving, and design perspective.

Bioengineering Technical Core

- Replace BIOE 431—Cell & Syst Reaction to Injury (3 hours) with BIOE 476—Tissue Engineering (3 hours).

BIOE 431—Cell and Syst Reaction to Injury was originally envisioned as a capstone life science course to be partnered with the engineering oriented Senior Design course. This course was included in the original curriculum proposal but was never developed nor piloted. For spring 2008 and 2009, the course was substituted, by a curriculum modification form, with a BIOE 498 special topics course in Biomaterials (CRN 48545). For spring 2010, it will be substituted with BIOE 476—Tissue Engineering. With a reduction in course program hours, Bioengineering can no longer afford to allocate 3 hours that do not qualify as ABET engineering hours to this course, and instructional staff to develop the course did not materialize. Therefore, it is proposed that BIOE 431 be replaced with BIOE 476—Tissue Engineering (3 ABET engineering hours). This is an existing course in the course catalog, and Bioengineering has appropriate staff to teach this course beginning in spring 2010.

- Redesignate BIOE 435—Bioengineering Senior Design (4 hours) to BIOE 435—Senior Design I (2 hours).

Justification noted in Orientation and Professional Development section. Course approval form for BIOE 435 is being submitted for review in spring semester 2010.

- Add BIOE 436—Senior Design II (2 hours).

Justification noted in Orientation and Professional Development section. Course approval form for BIOE 436 is being submitted for review in spring semester 2010.

- Replace ECE 205—Elec & Electronic Circuits (3 hours) with BIOE 205—Circuits & Systems in Bioengrg (4 hours).
- Replace MCB 402—Sys & Integrative Physiology (3 hours) with BIOE 302—Modeling Human Physiology (3 hours).

The Bioengineering Department is proposing that BIOE 205—Circuits & Systems in Bioengrg (approved in spring 2009) replace ECE 205—Elec & Electronic Circuits and, BIOE 302—Modeling Human Physiology (approved in spring 2009) replace MCB 402—Sys & Integrative Physiology. These two course substitutions are part of the department's efforts to create courses that integrate fundamental engineering concepts with biological systems. Additionally, BIOE 205 is a prerequisite for BIOE 302, allowing human physiological systems to be modeled in BIOE 302 based on a systems engineering

approach that is developed in BIOE 205. The substitution of BIOE 205 for ECE 205 represents the need to integrate systems approaches to biological systems at the core of the Bioengineering education. The focus on circuits without biological systems in ECE 205 makes the course unsuitable for the majority of Bioengineering majors given the decreased number of hours in which to provide the curriculum.

- Delete the comment "(may be substituted)" from the notation for MCB—404 Sys & Integrative Physiol Lab.

This course should follow the same process of course substitution that any other course in the curriculum would follow. The statement is not necessary and may mislead students into thinking that there is a special substitution procedure for this course.

- Drop MCB 450—Introductory Biochemistry or MCB 354—Biochem & Phys Basis of Life (3 hours) and CHEM 233—Elementary Organic Chem Lab I (2 hours).

Although ideally, MCB 450—Introductory Biochemistry/MCB 354—Biochem & Phys Basis of Life and CHEM 233—Elementary Organic Chem Lab I are important courses for bioengineering, it is felt that students can be successful across the identified career paths for bioengineers without these courses. In addition, a significant number of Bioengineering students pursue a Chemistry minor and will take these courses as part of the minor curriculum.

Bioengineering Technical Core Electives

- Revise section from selection of 6 hours from departmentally approved list of technical core electives allocated across four categories and instead require BIOE 301—Introductory Biomechanics (3 hours) and TAM 335—Fluid Dynamics (4 hours).

In the original proposal to IBHE, it was envisioned that the Department would be able to provide students with a list of engineering electives in four different categories: Thermodynamics, Biomechanics, Biomaterials, or Fluid Dynamics. In implementation of this portion of the curriculum, the Department has discovered significant challenges in maintaining a viable list across all four of these categories. In addition, as these are largely upper-level engineering courses, most have prerequisite courses that cannot be incorporated per se in the Bioengineering curriculum. It is now proposed that this section be replaced with two required courses: Introductory Biomechanics (currently taught as BIOE 398 and proposed as BIOE 301 for fall 2010 implementation) and TAM 335—Fluid Mechanics. Introductory Biomechanics includes the topics of statics and dynamics with a focus on biological applications. TAM 335 has always been included in the list of acceptable core elective courses, and Bioengineering students have been taking TAM 335 for the past two years with BIOE 398—Introductory Biomechanics providing the prerequisite content. The average course grade is a "B".

Track Electives

- Replace the pre-approved Biomolecular Track with Therapeutics Engineering. Drop Computational and Systems Biology as a pre-approved Track.

Biomolecular as a track in Bioengineering is much confused with Biomolecular as a concentration in the undergraduate program of Chemical and Biomolecular Engineering. To alleviate confusion, Bioengineering would like to replace this track option with Therapeutics Engineering which encompasses drug design and metabolism as well as transport methods for delivery through a series of established courses offered in interrelated departments. The pre-approved Track in Computational and Systems Biology must be dropped from the curriculum. In order to meet ABET requirements for 48 hours of engineering, all 15 hours allocated in the Track electives must be ABET engineering hours. At this time,

it is not possible to designate 15 ABET engineering hours in Computational and Systems Biology and include the pre-requisite content in linear algebra and statistics that students need to be proficient in this area. The updated list of pre-approved tracks in Bioengineering, along with the course recommendations effective for Fall 2009, is given in Appendix B and includes: Biomechanics, Cell and Tissue Engineering, Imaging and Sensing, and Therapeutics Engineering.

BUDGETARY AND STAFF IMPLICATIONS:

a. *Additional staff and dollars needed* – No additional staff or budget is required to implement the changes outlined in this proposal. Enrollment in new BIOE courses can be managed with existing instructional staff and resources. Although three new Bioengineering courses have been added to the curriculum in this proposal (BIOE 205, BIOE 301, BIOE 302), these campus-approved courses have been taught by Bioengineering instructors and faculty as special topics sections of BIOE 298 and BIOE 398 two or more times over the last three years. No additional staff and budget is needed to continue these offerings by integrating them into the curriculum.
b. *Internal reallocations* – No change in class size, teaching load, or student-faculty ratio within the Bioengineering Department current instructional staff is indicated by the changes outlined in this proposal. All necessary instructional faculty to teach the courses in the revised BIOE curriculum are already in place.
c. *Effect on course enrollment in other units and explanations of discussions with representatives of those departments* – Bioengineering enrolls a maximum of 50 students per year. ME 300 is taught in both fall and spring semester. Therefore, a maximum of 25 Bioengineering students per semester would be expected to take this course. Additional enrollment from Bioengineering students has been discussed with MechSE. A letter of understanding from MechSE is attached to this proposal (see Appendix C).
d. *Impact on the University Library* – No impact to the University Library is indicated by the changes outlined in this proposal.
e. *Impact on computer use, laboratory use, equipment, etc.* – No additional impact to computer use, laboratory use, or equipment is anticipated with the changes outlined in this proposal.

DESIRED EFFECTIVE DATE: Fall 2010

STATEMENT FOR PROGRAMS OF STUDY CATALOG: Appendix D

CLEARANCES:

Signatures:

Unit Representative: _____ Date: 9/24/09

College Representative: _____ Date: 12/2/09

Graduate College Representative: _____ Date: _____

Provost Representative: _____ Date: _____

Educational Policy Committee Representative: _____ Date: _____

APPENDIX A
ABET ENGINEERING HOURS

Course	Current Curriculum: ABET Hours	Revised Curriculum: ABET Hours
BIOE 120—Introduction to Bioengineering	1	1
BIOE 201—Conservation Principles Bioeng	3	3
BIOE 202—Cell & Tissue Engineering Lab	1	1
BIOE 205—Circuits & Systems in Bioengrg	n/a	4
BIOE 301—Introductory Biomechanics	n/a	3
BIOE 302—Modeling Human Physiology	n/a	1.5
BIOE 414—Biomedical Instrumentation	3	3
BIOE 415—Biomedical Instrumentation Lab	2	2
BIOE 435—Senior Design	4	n/a
BIOE 435—Senior Design I (with title revised)	n/a	2
BIOE 436—Professionalism	0	n/a
BIOE 436—Senior Design II (with title revised)	n/a	2
BIOE 431—Cell & Syst Reaction to Injury	0	n/a
BIOE 476—Tissue Engineering	n/a	3
BIOP 401—Introduction to Biophysics	0	0
CHEM 102—General Chemistry I	0	0
CHEM 103—General Chemistry Lab I	0	0
CHEM 104—General Chemistry II	0	0
CHEM 105—General Chemistry Lab II	0	0
CHEM 232—Elementary Organic Chemistry I	0	0
CHEM 233—Elementary Organic Chem Lab I	0	0
CS 101—Intro Computing: Engrg & Sci	0	0
ECE 205—Elec & Electronic Circuits	3	n/a
ENG 100—Engineering Orientation	0	0
IE 300—Analysis of Data	0	0
MATH 221—Calculus I	0	0
MATH 231—Calculus II	0	0
MATH 241—Calculus III	0	0
MATH 285—Intro Differential Equations	0	0
MCB 150—Molec & Cellular Basis of Life	0	0
MCB 354—Biochem & Phys Basis of Life or MCB 450—Introductory Biochemistry	0	n/a
MCB 402—Sys& Integrative Physiol	0	0
MCB 404—Sys & Integrative Physiol Lab	0	0
ME 300—Thermodynamics	n/a	3
PHYS 211—University Physics: Mechanics	0	0
PHYS 212-University Physics: Elec & Mag	0	0
PHYS 213—University Physics: Thermal	0	0
PHYS 214—Univ Physics: Quantum Physics	0	0
TAM 335—Fluid Mechanics	avail as Core Elec	4
Core Electives: 6 hours	6	n/a
Track Electives: 15 hours	15	15
Total	38	47.5

Program Note:
A BIOE course is being piloted that would provide content replacement for IE 300 with 1 engineering hour; bringing Total engineering hours to 48.5

Biomechanics Track:
Total Track Hours must equal 15

Biomechanics applies mechanical sciences to biological systems at the nano-, micro-, and macro-scales. Students in this track will study static and dynamic properties of cells, soft and hard tissues, extra-cellular matrix, and biomaterials. Materials studies will be on how materials interact with the human body. Students will also gain an understanding of stability and control of mechanical systems. Application areas include medical device design and implantable prosthetics for treating conditions related to disease and aging, occupational and physical therapy aids, and quantitative physiology.

Students following this track take:

TAM 210 Introduction to Statics (2 hr)
Prerequisite: PHYS 211; credit or concurrent registration in MATH 241 or MATH 243

TAM 212 Introductory Dynamics (3 hr)
Prerequisite: TAM 210 or TAM 211

TAM 251 Introductory Solid Mechanics (3 hr)
Prerequisite: TAM 210 or TAM 211

and Select remaining hours from:

BIOE 461/ TAM 461 Cellular Biomechanics (4 hr)
Prerequisite: TAM 251 or equivalent

ME 481 Whole-Body Musculoskel Biomech (3 hr)
Prerequisite: TAM 212 and TAM 251

ME 482 Musculoskel Tissue Mechanics (3 hr)
Prerequisite: TAM 251

TAM 445 Continuum Mechanics (4 hr)
Prerequisite: TAM 251; MATH 241 or MATH 380

ME 330 Engineering Materials (4 hr) – Recommended for Prosthetics and Orthodics
Restricted to 2 BIOE Registrations per semester; contact BIOE Dept office

The recommended Core Elective to prepare for this track is:

TAM 335 Introductory Fluid Mechanics (4 hr)
Prerequisite: TAM 212 (BIOE 398 PW is sufficient)

The following is recommended as a free elective:

GE 101 Engineering Graphics & Design (3 hr)

Cell and Tissue Engineering Track:
Total Track Hours must equal 15

Cell & Tissue Engineering describes the combined use of cells, materials, and biochemical factors to induce the growth of functional tissues for medical applications. Students in this track of study learn about how cells control and are controlled by the cellular microenvironment. BIOE students are trained in cell selection and culture, scaffold and bioreactor designs, biosensors, and assessments of cellular and tissue responses. Application areas include tissue engineering for medical repair and replacement.

Students following this track select from:
CHBE 472 Techniques in Biomolecular Engineering (3 hr)
Prerequisite: CHEM 202, CHEM 203, CHEM 204 or equivalent; MATH 220 or MATH 221; PHYS 211, PHYS 214 or equivalent; MCB 450

ECE 416 Biosensors (3 hr)
Prerequisite: ECE 329 (BIOE has instructor consent)

MSE 470 Design and Use of Biomaterials (3 hr)
Prerequisite: MSE 406 (BIOEs approved to take without MSE 406); MCB 252

MSE 473 Biomolecular Materials Science

MSE 474 Biomaterials and Nanomedicine (3 hr)
Prerequisite: CHEM 236 (same as CHEM 232) or MSE 457; MCB 450

TAM 461/BIOE 461 Cellular Biomechanics (4 hr)
Prerequisite: TAM 251 or equivalent

The recommended Core Elective to prepare for this track is:
TAM 335 Fluid Mechanics (4 hr)
Prerequisite: TAM 212 (BIOE 398 PW is sufficient)

Imaging and Sensing Track:
Total Track Hours must equal 15

Imaging & Sensing focuses on the instrumentation and methodologies of image science and bio-nano-technologies applied to the diagnosis and treatment of human disease. This track provides a foundation for those choosing to design, build, use and evaluate diagnostic systems, including advanced targeted imaging, biological microscopy and bio-photonics, integrated functional imaging, and point-of-care sensing and delivery technologies. Students can elect to receive interdisciplinary training in electronic systems, signal and image processing, radiation-tissue interactions, contrast media chemistry, lab-on-a-chip diagnostics, microfluidic devices, and specific imaging modalities including MRI, x-ray, ultrasonic, optical and nuclear imaging instruments.

Students following this track take:
ECE 210 Analog Signal Processing (4 hr): **Registration restricted; contact BIOE Dept**

ECE 329 Intro Electromagnetic Fields (3 hr)

and Select remaining hours from:
ECE 280 Biomedical Imaging (3 hr)
Prerequisite: MATH 285 or MATH 286

ECE 410 Digital Signal Processing I (4 hr)
Prerequisite: ECE 210 (BIOE 205 is sufficient)

ECE 420 Digital Signal Processing Laboratory (2 hr)
Prerequisite: ECE 410

ECE 416 Biosensors (3 hr)
Prerequisite: ECE 329

ECE 460 Optical Imaging (3 hr)
Prerequisite: ECE 329; credit or concurrent registration in ECE 313 or STAT 400

ECE 467 Biophotonics (3 hr)
Prerequisite: One of ECE 455, ECE 460, PHYS 402

ECE 473 Fundamentals of Engineering Acoustics (3 hr)
Prerequisite: MATH 285 or MATH 286

ECE 474 Ultrasonic Techniques (3 hr)

ECE 480 Magnetic Resonance Imaging (3 hr)
Prerequisite: ECE 410

ECE 486 Control Systems (4 hr)
Prerequisite: ECE 210 (BIOE 205 sufficient)

PHYS 402 Light (4 hr)
Prerequisite: MATH 285; PHYS 102 (includes PHYS 101) or PHYS 214 (includes PHYS 211 and PHYS 212)

Therapeutics Engineering Track:
Total Track Hours must equal 15

Therapeutics Engineering builds understanding of bodily responses to implantable materials and drug delivery devices. The focus is on biomaterial selection and synthesis as well as an in depth study of drug design, manufacturing, and delivery. BIOE students are trained in nano-materials, material properties, transport phenomena, biochemical engineering, and metabolic engineering. Application areas include individualized therapeutics, biomimetics, and drug delivery systems.

Students following this track select from:
CHBE 472 Techniques in Biomolecular Engineering (3 hr)

Prerequisite: CHEM 202, CHEM 203, CHEM 204 or equivalent; MATH 220 or MATH 221; PHYS 211, PHYS 214 or equivalent; MCB 450

MSE 474 Biomaterials and Nanomedicine (3 hr)
Prerequisite: CHEM 236 (same as CHEM 232) or MSE 457; MCB 450

CHBE 474 Metabolic Engineering (3 hr)
Prerequisite: Students must have equivalent knowledge of MATH 225

MSE 470 Design and Use of Biomaterials (3 hr)
Prerequisite: MSE 406 (BIOEs approved to take without MSE 406); MCB 252

MSE 450 Polymer Science and Engr (3 hr)
Prerequisite: None stated

CHBE 494HJK Biotransport (3 hr)
Prerequisite: None stated

The recommended Core Elective to prepare for this track is:
CHBE 421 Momentum and Transfer (4 hr)

APPENDIX C: EFFECT ON COURSE ENROLLMENT IN OTHER UNITS

Projected course enrollment impact has been discussed with Mechanical Science and Engineering (MechSE) for ME 300. An email letter from MechSE is provided.

------ Forwarded Message
From: "Phillips, James W" <jwp@illinois.edu>
Date: Wed, 16 Sep 2009 09:50:26 -0500
To: "Sutton, Brad" <bsutton@illinois.edu>, "Glumac, Nick G" <glumac@illinois.edu>
Cc: "Dullerud, Geir E" <dullerud@illinois.edu>, "Ferreira, Placid Mathew" <pferreir@uiuc.edu>, "Dennis, Robin A" <dennisr@illinois.edu>
Subject: RE: ME 300

Dear Brad,

Thanks again for your note regarding ME 300 for the students in your proposed revision of the Bioengineering undergraduate program. I've discussed your request with our new department head, Placid Ferreira, and we see a small but manageable impact on our teaching obligations with the addition of 35–50 students per year in ME 300. We normally have two lectures per semester in both fall and spring, and we offer the course in the summer as well. Therefore, the additional number of students per lecture section would be about 8–12. We are currently running near the lecture room capacity in 1320 DCL, so on occasion we may have to open up another lecture section. Nevertheless, we will do our best to accommodate your students.

Best regards,

Jim Phillips

James W. Phillips, PhD, PE
Professor and Associate Head
Department of Mechanical Science and Engineering
University of Illinois at Urbana-Champaign
152 Mechanical Engineering Building
1206 West Green Street
Urbana, IL 61801-2906

Appendix D: Statement for the Programs of Study Catalog

The *Overview of Curricular Requirements* section shown with Track Changes markup to the existing 2009-10 Programs of Study statement to facilitate comparison with the *Brief Description* section of the proposal narrative. The *Suggested Sequence* is shown in final form without Track Changes since it is just an implementation of the *Overview of Curricular Requirements* and would have extensive mark-up clutter if shown.

Bioengineering

bioen.illinois.edu

Interim Head: Michael F. Insana
Department Office: 3120 Digital Computer Lab, 1304 West Springfield Avenue, (217) 333-1867

Curriculum in Bioengineering

bioen.illinois.edu

For the Degree of Bachelor of Science in Bioengineering

~~Bioengineering combines the analytical and experimental methods of the engineering profession with the biological and medical sciences to achieve a more detailed understanding of biological phenomena and to develop new techniques and devices.~~

~~The curriculum is divided into four components. The largest component, that of the basic mathematics and sciences, dominates the first two years of study. It includes mathematics, physics, and chemistry, and is capped with upper-level life science courses. The Bioengineering component imbues a quantitative approach employing engineering analysis and design to problems drawn largely from the life sciences. It concludes with a capstone engineering design or research experience, a capstone life science course, and a biomedical professionalism and ethics course. The track component includes a focused set of courses in which each student develops depth in one area of bioengineering. The fourth component comprises the general education and free elective course work that gives balance to a student's education.~~

Bioengineers use tools from biology, chemistry, physics and math to solve engineering problems that arise in biological systems related to biomaterials, biomechanics and prosthetics, tissue engineering, molecular modeling, imaging, bioinformatics, nanomedicine, synthetic biology, and drug delivery. Bioengineering incorporates a thorough understanding of biology with a breadth of engineering knowledge across multiple engineering disciplines. Our graduates work in such fields as healthcare, pharmaceuticals, medical devices, consumer products, hospitals and clinics, government regulatory agencies, academia, laboratory and research facilities, product and process development, quality and regulatory services, and operations and manufacturing.

The curriculum includes integration of principles of biology and engineering in coursework such as biomechanics, modeling of human physiology, bioinstrumentation, and tissue engineering. During the third and fourth years, students take technical electives in a focused subdiscipline of bioengineering. A year-long senior capstone design course

provides experience in applying engineering fundamentals to biological problems submitted by faculty members, clinicians, and industrial firms.

Overview of Curricular Requirements

The curriculum requires 128~~132~~ hours for graduation and is organized as shown below.

Technical grade point average requirements for graduation and advanced-level course registration apply to students in this curriculum. These rules are summarized at the College of Engineering's undergraduate advising Web site

Orientation and Professional Development

These courses introduce the opportunities and resources your college, department, and curriculum can offer you as you work to achieve your career goals. They also provide the skills to work effectively and successfully in the engineering profession.

Hours	Requirements
1	BIOE 120—Introduction to Bioengineering
~~2~~	~~BIOE 436—Bioengineering Professionalism~~
0	ENG 100—Engineering Orientation
1~~3~~	Total

Foundational Mathematics and Science

These courses stress the basic mathematical and scientific principles upon which the engineering discipline is based.

Hours	Requirements
3	CHEM 102—General Chemistry I
1	CHEM 103—General Chemistry Lab I
3	CHEM 104—General Chemistry II
1	CHEM 105—General Chemistry Lab II
4	MATH 221—Calculus I[1]
3	MATH 231—Calculus II
4	MATH 241—Calculus III
3	MATH 285—Intro Differential Equations
4	PHYS 211—University Physics: Mechanics
4	PHYS 212—University Physics: Elec & Mag

~~2~~	~~PHYS 213—Univ Physics: Thermal Physics~~
2	PHYS 214—Univ Physics: Quantum Physics
32 ~~34~~	Total

1. MATH 220—Calculus may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.

Bioengineering Technical Core

These courses stress fundamental concepts and basic laboratory techniques that comprise the common intellectual understanding of bioengineering.

Hours	Requirements
3	BIOE 201—Conservation Principles Bioeng
2	BIOE 202—Cell & Tissue Engineering Lab
4	BIOE 205—Circuits & Systems in Bioengrg
3	BIOE 301—Introductory Biomechanics
3	BIOE 302—Modeling Human Physiology
3	BIOE 414—Biomedical Instrumentation
2	BIOE 415—Biomedical Instrumentation Lab
~~3~~	~~BIOE 431—Cell & Syst Reaction to Injury~~
2 ~~4~~	BIOE 435—~~Bioengineering~~ Senior Design I
2	BIOE 436—Senior Design II
3	BIOE 476—Tissue Engineering
3	BIOP 401—Introduction to Biophysics
3	CHEM 232—Elementary Organic Chemistry I
~~2~~	~~CHEM 233—Elementary Organic Chem Lab I~~
3	CS 101—Intro Computing: Engrg & Sci
~~3~~	~~ECE 205—Elec & Electronic Circuits~~
3	IE 300—Analysis of Data
4	MCB 150—Molec & Cellular Basis of Life

3	MCB 402—Sys & Integrative Physiology
2	MCB 404—Sys & Integrative Physiol Lab (may be substituted)
3	MCB 450—Introductory Biochemistry or MCB 354—Biochem & Phys Basis of Life
3	ME 300—Thermodynamics
4	TAM 335— Fluid Mechanics
6	Technical core electives selected from departmentally approved list of technical core elective courses.
52	Total

Track Electives

Students must complete 15 hours of study which show coherence, focus, and purpose within a bioengineering context. Students may choose from among the following pre-approved tracks:

- Biomechanics
- Biomolecular
- Cell and Tissue Engineering
- Computational and Systems Biology
- Imaging and Sensing
- Therapeutics Engineering

Alternately a student may devise a special track and set of courses which must be approved by the Bioengineering Department. In either case, overage hours in required courses may be counted toward the 15-hour minimum.

Hours	Requirements
15	Track electives selected from a departmentally approved list of track elective courses.

Social Sciences and Humanities

The social sciences and humanities courses, as approved by the College of Engineering, ensure that students have exposure in breadth and depth to areas of intellectual activity that are essential to the general education of any college graduate.

Hours	Requirements
18	Electives in social sciences and humanities approved by the College of Engineering and satisfying the campus general education requirements for social sciences and humanities, including cultural studies western and non-

	western.

Composition

These courses teach fundamentals of expository writing.

Hours	Requirements
4	RHET 105—Principles of Composition
	Advanced Composition. May be satisfied by completing a course with the Advanced Composition designation in either the social sciences and humanities or the free elective categories.
4	Total

Free Electives

These unrestricted electives, subject to certain exceptions as noted at the College of Engineering advising Web site, give the student the opportunity to explore any intellectual area of unique interest. This freedom plays a critical role in helping students to define research specialties or to complete minors.

Hours	Requirements
6	Free electives. Additional unrestricted course work, subject to certain exceptions as noted at the College of Engineering advising Web site, so that there are at least 128~~132~~ credit hours earned toward the degree.

Suggested Sequence

The schedule that follows is illustrative, showing the typical sequence in which courses would be taken by a student with no college course credit already earned and who intends to graduate in four years. Each individual's case may vary, but the position of required named courses is generally indicative of the order in which they should be taken.

First Year

Hours	First Semester
1	BIOE 120—Introduction to Bioengineering
3	CHEM 102—General Chemistry I
1	CHEM 103—General Chemistry Lab I
0	ENG 100—Engineering Orientation
4	MATH 221—Calculus I[1]
4	RHET 105—Principles of Composition **or** MCB 150—Molec & Cellular Basis of Life[2]

3	Elective in social sciences or humanities[3]
16	Total

Hours	Second Semester
3	CHEM 104—General Chemistry II
1	CHEM 105—General Chemistry Lab II
3	MATH 231—Calculus II
4	MCB 150—Molec & Cellular Basis of Life **or** RHET 105—Principles of Composition[2]
4	PHYS 211—University Physics: Mechanics
3	Elective in social sciences or humanities[3]
18	Total

Second Year

Hours	First Semester
3	BIOE 201—Conservation Principles Bioeng
3	CS 101—Intro Computing: Engrg & Sci
4	MATH 241—Calculus III
4	PHYS 212—University Physics: Elec & Mag
3	Elective in social sciences or humanities[3]
17	Total

Hours	Second Semester
2	BIOE 202—Cell &Tissue Engineering Lab
4	BIOE 205—Circuits & Systems in Bioengrg
3	CHEM 232—Elementary Organic Chemistry I
3	MATH 285—Intro Differential Equations
3	Elective in social sciences or humanities[3]

15	Total

Third Year

Hours	First Semester
3	BIOE 301—Introductory Biomechanics
3	BIOE 414—Biomedical Instrumentation
2	BIOE 415—Biomedical Instrumentation Lab
3	ME 300—Thermodynamics
2	PHYS 214—Univ Physics: Quantum Physics
3	Track elective[4]
16	Total

Hours	Second Semester
3	BIOE 302—Modeling Human Physiology
3	BIOE 476—Tissue Engineering
3	IE 300—Analysis of Data
2	MCB 404—Sys & Integrative Physiol Lab
3	Track elective[4]
3	Elective in social sciences or humanities[3]
17	Total

Fourth Year

Hours	First Semester
2	BIOE 435—Senior Design I
3	BIOP 401—Introduction to Biophysics
4	TAM 335 Fluid Mechanics
6	Track electives[4]
15	Total

Hours	Second Semester
2	BIOE 436—Senior Design II
3	Track elective[4]
3	Elective in social sciences or humanities[3]
6	Free electives
14	Total

1. MATH 220—Calculus may be substituted, with four of the five credit hours applying toward the degree. MATH 220 is appropriate for students with no background in calculus.
2. RHET 105 may be taken in the first or second semester of the first year as authorized. The alternative is MCB 150.
3. Each student must satisfy the 18-hour social sciences and humanities requirements of the College of Engineering and the campus general education requirements for social sciences and humanities.
4. To be selected from a departmentally approved list of track elective courses if a pre-approved track is chosen. Alternately a student may devise a special track which must be approved by the Bioengineering Department.

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Senate Educational Policy Committee
Proposal Check Sheet

PROPOSAL TITLE (Same as on proposal): Revision To The Curriculum For The B.S. Degree In Bioengineering Administered By The Department Of Bioengineering In The College Of Engineering

PROPOSAL TYPE (Please select all that apply below):

A. ☒ **Program and degree proposals**

1. This proposal is for a graduate program or degree

   ☐ Yes ☒ No

2. **Degree** proposal (e.g. B.S.A.E., M.S.C.E.)

   ☐ New degree - - please name new degree name: _____

   ☒ Revision of an existing degree - - please name of the existing degree to be revised: B.S. Bioengineering

3. **Major** proposal (disciplinary focus e.g. Mathematics, Mechanical Engineering)

   ☐ New major - - please name new major: _____

   ☐ Revision of an existing major - - please indicate the name of the existing major to be revised: _____

4. **Concentration** proposal (e.g. Financial Planning)

   ☐ New concentration - - please name new concentration: _____

   ☐ Revision of an existing concentration - - please name the existing concentration to be revised: _____

5. **Minor** proposal (e.g. Cinema Studies)

   ☐ New minor - - please name new concentration: _____

   ☐ Revision of an existing minor - - please name the existing concentration to be revised: _____

6. ☐ Proposal for terminating an existing degree, major, concentration or minor

   Please name and nature of the existing degree, major, concentration or minor: _____

7. ☐ Proposal for a multi-institutional degree between Illinois (UIUC) and a foreign institution

   Please name the existing Illinois degree or program: _____

   Please name the partnering institution: _____

B. ☐ **Proposal for renaming existing academic units** (college, school, department, or program)

   Please provide the unit's current name: _____

   Please provide the unit's proposed new name: _____

C. ☐ **Proposal for re-organizing existing units** (colleges, schools, departments, or programs)

   ☐ Change in status of an existing and approved unit (e.g. change from a program to department). Please indicate current unit name including status: _____

   ☐ Transfer an existing unit

   Please provide the current unit's name and home: _____

   Please provide the new home for the unit: _____

   ☐ Merge two or more existing units (e.g. merge department A with department B)

   Name and college of unit one to be merged: _____

   Name and college of unit two to be merged: _____

   ☐ Terminate an existing unit. Please provide the current unit's name and status: _____

D. ☐ **Other educational policy proposals** (e.g. academic calendar, grading policies, etc.)

   Please indicate the nature of the proposal: _____

Draft Minutes
College of Engineering Executive Committee (EC) Meeting
Tuesday, 1:00 p.m., December 1, 2009
301 Engineering Hall

Present:

V. Coverstone (Admin)	B. Heuser (NPRE)	M. Rood (CEE)
B. Cunningham (BioE)	D. Jones (ECE)	R.S. Sreenivas (IESE)
G. Dullerud (MechSE)	P. Kalita (ABE)	C. Tucker (Admin)
P. Goldbart (Phys)	S. Kamin (CS)	J. Weaver (MatSE)

Absent:

I. Adesida (Admin)	B. Conway (AE)	H. Zhao (ChBE)
N. Cheng (MNTL)	M. Wong (CSL)	

* = alternate

---

1. The meeting was called to order at 1:05, Mark Rood presiding.

2. Approval of the Draft Minutes from Nov. 17, 2009.
The minutes were approved unanimously.

3. New/Old Business
___MSE 475
The MatSE department has been withdrawn this proposal, with regret, due to the loss of faculty who could have taught it.

4. Course Outlines/Proposals/Reports
a. New/Revised Course Outlines and Program Proposals
__MATSE M. Eng. Proposal (Revised Resubmission) and MATSE B.S.-M. Eng. Proposal (Revised Resubmission)
The proposal was explained by V. Coverstone. A discussion ensued about the college-wide M. Eng. degree program that is being developed; this would be distinct from any "M. Eng. in X" degree programs that might be proposed by individual departments. The original versions of these proposals were reviewed and approved, with revisions, by an ad hoc committee in Spring, 2009; that report was reviewed during the deliberations. There was then a good deal of discussion on the issue of internships; these are required in this degree program, but there was concern over whether students will definitely be able to find them. *The committee report was approved unanimously.*

b. Subcommittee Reports
__MSE 489
There was considerable discussion about prerequisites for this course. The original reviewing committee suggested that the prerequisites were at too low a level (Chem 102 and Phys 211). The proposer (John Abelson) then removed all prerequisites, stating that the course number was sufficient to indicate the level of the course; but this change obviously runs counter to the suggestion by the reviewers. It was agree that Mark Rood will discuss whether "senior standing" would be a reasonable prerequisite, and then discuss the issue with Abelson; the EC will consider this course again at the next meeting.

__BIOE 581

The ad hoc committee report was approved unanimously. (The EC requested that Michael Pleck review comments from the ad hoc committee on the availability of current forms on the COE web page; see the bottom of page 2 of the report.)

__BIOE B.S. Curriculum Revision Subcommittee report

The proposal reduces degree requirements to 128 hours, adds some new BioE courses as requirements, and makes revisions to meet ABET accreditation standards. After some discussion of the merits of BioE 205 vs. ECE 205, the committee voted. *The ad hoc committee report was approved unanimously (one abstention).*

5. The meeting adjourned at 2:20.

The minutes have not yet been approved.
Respectfully submitted,

Sam Kamin, Secretary

cc: Robin Dennis
Michael Pleck