



COLLEGE OF ENGINEERING

OFFICE OF THE DEAN

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Date: December 21, 2009

To: UD Faculty Senate

From: Michael Chajes, PhD, PE
Dean of the College of Engineering

Re: Creation of a new degree: Bachelor of Biomedical Engineering (BBE)

I am writing to recommend approval by the faculty senate of the proposed undergraduate degree in biomedical engineering and to confirm the College of Engineering's commitment to this program.

For several years our college's External Advisory Council has recommended we establish a new program in biomedical engineering. This sentiment has been reiterated by President Harker. Our college research has, in recent years, become more and more biological in focus. In the departments of Chemical Engineering, Mechanical Engineering and Materials Science & Engineering, roughly 40% of the research done involves bioengineering.

Furthermore, we have noticed an increasing number of high school students inquiring about biomedical engineering at various recruiting events. We believe the lack of an undergraduate degree in biomedical engineering is affecting our ability to recruit the best students to the University of Delaware. A recent poll of freshmen in our Introduction to Engineering class found 50 students interested in majoring in biomedical engineering this year. Hence, we believe student interest will be strong.

Most prestigious engineering colleges offer degrees in bioengineering or biomedical engineering. This tends to be a popular major, often the most popular major for those interested in engineering. It is especially popular for those interested in going on to do graduate work in biomedical research or for premedical (or pre-allied health) degrees.

With the advent of new initiatives in health sciences at the University of Delaware, such a degree is especially timely. This degree will be an important step as our college seeks to forge new relationships with partners in the Delaware Health Sciences Alliance.

The faculty of the college discussed this new program (note: this new degree would be administered as a new program, not a department) at a regular college faculty meeting. We had a subsequent vote and it was strongly approved by the faculty via mail ballot on December 18, 2009. I support this initiative, which is well designed and documented. I think it has all the qualities needed to make it a success. I therefore highly recommend it for approval by the Faculty Senate.

Attached are the following documents:

1. Academic Program Approval Form
2. Resolution for the Faculty Senate Agenda
3. Curriculum listing in the proper format for the Undergraduate and Graduate Catalog, including fulfillment of University, college and departmental requirements.
4. Detailed proposal (includes the headings listed below and the sub-heading in the following outline: Description; Rationale and Demand; Enrollments, Admissions, and Financial Aid; Curriculum Specifics; Resources Available; Resources Support; Implementation and Evaluation.

Appendices: Accreditation Criteria; Transfer/Retention Policy; and Letters of Approval from Contributing or Affected Departments, including:

- Letters from the Deans of Agriculture & Natural Resources, Arts & Science, Business & Economics, Earth Ocean & Environment, and Health Sciences.
- Letters from the Chairs of the Departments of Chemical Engineering, Electrical & Computer Engineering, Materials Science & Engineering, Mechanical Engineering, Biological Sciences, Chemistry, Physics, Mathematics, Computer & Information Sciences, Biomechanics & Movement Sciences, English and Philosophy are provided.



COLLEGE OF ENGINEERING

OFFICE OF THE DEAN

University of Delaware
Newark, Delaware 19716-3101
Ph: 302/831-2401
Fax: 302/831-8179
<http://www.engr.udel.edu>

TO: Engineering Faculty

FROM: Michael L. Vaughan, Senior Assistant Dean, Academic Affairs
College of Engineering

DATE: December 21, 2009

SUBJECT: Results of Voting Ballot BBE Major Proposal

On December 10, 2009 a description/justification and flowchart for a proposed bachelor's degree program in Biomedical Engineering along with a ballot was sent to the voting faculty of the College by Dean Michael Chajes. The votes were collected by Crystal Maccari, Administrative Assistant to the Dean, and the results are as follows:

Resolved that the College of Engineering approves a new major; Bachelor of Biomedical Engineering (BBE):

For: 67

Against: 1

Abstain: 2

Non Votes: 35

Therefore, the resolution has passed by a majority vote of the Engineering Faculty.

MLV/cm

UNIVERSITY FACULTY SENATE FORMS

Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. For more information, call the Faculty Senate Office at 831-2921.

Submitted by: Thomas Buchanan phone number 831-2401

Department: College of Engineering email address buchanan@udel.edu

Action: Approve New Major Bachelor of Biomedical Engineering (BBE)

(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc)

Effective term 10F

(use format 04F, 05W)

Current degree _____

(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc)

Proposed change leads to the degree of: _____

(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc)

Proposed name: _____

Proposed new name for revised or new major / minor / concentration / academic unit
(if applicable)

Revising or Deleting:

Undergraduate major / Concentration: _____

(Example: Applied Music – Instrumental degree BMAS)

Undergraduate minor: _____

(Example: African Studies, Business Administration, English, Leadership, etc)

Graduate Program Policy statement change: _____

(**Must attach** your Graduate Program Policy Statement)

Graduate Program of Study: _____

(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

Graduate minor / concentration: _____

Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, highlighting the changes made to the original policy document.

List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?

There are six new courses:

BMEG 301—Systems Physiology I: Human physiology from a quantitative viewpoint. Anatomy and pathology, where appropriate. Functional/structural aspects of mammalian nervous and musculoskeletal systems. Neural biophysics. Prerequisites: BISC 207, BISC 208 and PHYS 207

BMEG 302—Systems Physiology II: Cellular mechanisms of and quantitative systems approach to human cardiovascular, respiratory, renal, digestive, endocrine, and metabolic physiology. Prerequisite: BMEG 301

BMEG 310—Bioengineering Mechanics: Introduction to statics, dynamics and mechanics of solids with application to biomedical problems. Prerequisite: PHYS 207 and MATH 243

BMEG 320—Cell & Tissue Transport: Fundamental and biomedical applications of fluid mechanics. Introduction to diffusive and convective heat and mass transfer with biomedical applications. Prerequisite: PHYS 207 and MATH 305

BMEG 330—Medical Instrumentation/Electronics: Circuit analysis and network theorems with application to biomedical problems. Bode plots; Fourier analysis; introduction to medical imaging. Prerequisite: PHYS 208

BMEG 450—Biomedical Engineering Design: Open-ended team-designed projects in the medical devices or research arena. Systems approach requiring design strategy and concepts, including reliability, safety, ethics, economic analysis, marketing, FDA regulations, and patents. Open to BMEG seniors only

Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education: <http://www.ugs.udel.edu/gened/>

This program will train students to think critically and solve problems, as that is an important part of engineering. Students will be required to learn how to write reports effectively, work independently, and work in teams on projects. They will be taught ethical behavior and will be encouraged to expand their intellectual curiosity to other fields through open-ended projects.

Identify other units affected by the proposed changes:

(Attach permission from the affected units. If no other unit is affected, enter "None")

Faculty will be drawn largely from the college of engineering to teach these six new courses. That will affect most units in the College of Engineering. Other departments will teach the remaining courses, which will affect them only if those students were not already expected to be taking those courses. It is expected that this program will draw students away from other engineering majors, reducing the load on those departments.

Describe the rationale for the proposed program change(s):

The faculty in the College of Engineering at the University of Delaware are actively engaged in biomedical research. Approximately one third of all research expenses are related to biological themes and our single largest funding organization is currently the NIH.

This research spans the entire college as every department has some faculty engaged in bio-related research. Thus, since biomedical engineering has become a field of its own at many universities, and since we have many faculty working in this field, it stands to reason that we should offer this to our students.

Among the students, there is considerable interest in a biomedical engineering major. At many of our competing universities where biomedical engineering is offered, it has become the most popular engineering major (e.g., Johns Hopkins, UPenn). We are frequently asked at recruiting events such as Delaware Days, Blue & Gold Saturdays, and Discovery Days why we do not offer degrees in biomedical engineering and we believe we are losing students because we do not offer a degree in this field. A recent survey of our freshman class in the required Introduction to Engineering course asked students what type of engineering they would like to major in and we included biomedical engineering in the list. Approximately 50 choose that over other disciplines currently offered.

Thus, we believe we have the student interest and the faculty expertise to put together such a program.

Program Requirements:

(Show the new or revised curriculum as it should appear in the Course Catalog. If this is a revision, be sure to indicate the changes being made to the current curriculum and **include a side-by-side comparison** of the credit distribution before and after the proposed change.)

Biomedical Engineering Program

Fall

Spring

Freshman 4-cr MATH 241—Analytic Geometry & Calculus A
 4-cr CHEM 103—General Chemistry I
 3-cr CISC 106—General Computer Science for Engineers
 2-cr EGGG 101—Introduction to Engineering
 3-cr ENGL 110—Critical reading & Writing
 16-cr

4-cr MATH 242—Analytic Geometry & Calculus B
 4-cr CHEM 104—General Chemistry II
 4-cr BISC 207—Introductory Biology I
 3-cr GenEd 1 (colloquium)
 15-cr

Soph 4-cr MATH 243—Analytic Geometry & Calculus C
 4-cr CHEM 321—Organic Chemistry I
 4-cr BISC 208—Introductory Biology II
 4-cr PHYS 207—Fundamentals of Physics I
 16-cr

3-cr MATH 305—Applied Math for Chemical Engineers
 4-cr CHEM 322—Organic Chemistry II
 4-cr PHYS 208—Fundamentals of Physics II
 3-cr ELEG 305—Signals and Systems
 3-cr GenEd 2
 17-cr

Junior 3-cr MSEG 302—Materials Science for Engineers
 3-cr CHEM 527—Introduction to Biochemistry
 4-cr *BMEG 310—Bioengineering Mechanics*
 3-cr *BMEG 301—Systems Physiology I*
 3-cr Tech Elec 1
 16-cr

3-cr CHEG 404—Engineering Probability & Statistics
 3-cr *BMEG 330—Medical Instrumentation/Electronics Lab*
 3-cr MEEG 483—Orthopaedic Biomechanics
 3-cr *BMEG 302—Systems Physiology II*
 3-cr *BMEG 320—Cell & Tissue Transport*
 15-cr

Senior 4-cr *BMEG 450—Biomedical Engineering Design*
 3-cr MSEG 460—Biomaterials & Tissue Engineering
 3-cr Tech Elec 2
 3-cr GenEd 3
 3-cr GenEd 4
 16-cr

3-cr ELEG 479—Intro to Medical Imaging Systems
 3-cr PHIL 444—Medical Ethics
 3-cr Tech Elec 3
 3-cr Tech Elec 4
 3-cr GenEd 5
 15-cr

126 credits total

Technical Electives

4-cr BISC 276 Human Physiology
 3-cr BMSC 630 Human Movement Control
 3-cr CHEG 620 Biochemical Engineering
 3-cr CHEG 621 Metabolic Engineering
 3-cr CHEM 443 Physical Chemistry
 3-cr ELEG 418 Digital Control Systems
 3-cr ELEG 471 Mathematical Physiology
 3-cr ELEG 478 Introduction to Nano and Biophotonics
 3-cr ELEG 680 Immunology for Engineers
 3-cr MEEG 482 Clinical Biomechanics
 3-cr MEEG 485 Control of Human Movement
 3-cr MEEG 612 Biomechanics of Human Movement
 3-cr MSEG 630 Intro to Sci & Eng of Polymer Systems

Notes:

- 1) *items in italics will be new courses*
- 2) The following substitutions may be made for students desiring more advanced training in mathematics: MATH 351 & (352 or 353) may be substituted for MATH 305 and one Tech Elec (NB: MATH 351 does not directly replace MATH 305—both courses in the MATH 351/352 or 351/353 sequence are needed)

ROUTING AND AUTHORIZATION: (Please do not remove supporting documentation.)

Department Chairperson Director T. G. S. file Date 12/22/09

Dean of College Mark Chen Date 12/22/09

Chairperson, College Curriculum Committee Mark Chen Date 12/22/09

Chairperson, Senate Com on UG or GR Studies _____ Date _____

Chairperson, Senate Coordinating Com _____ Date _____

Secretary, Faculty Senate _____ Date _____

Date of Senate Resolution _____ Date to be Effective _____

Registrar _____ Program Code _____ Date _____

Vice Provost for Academic Affairs & International Programs _____ Date _____

Provost _____ Date _____

Board of Trustee Notification _____ Date _____

Revised 10/23/2007 /khs

***RESOLUTION FOR THE
FACULTY SENATE AGENDA***

**Resolution for the Faculty Senate
to Establish an
Undergraduate Degree in Biomedical Engineering**

WHEREAS, the UD Path to Prominence in section III in the subsection entitled *Create the University Health Initiative* states that UD will “become a recognized leader in health sciences” and “the University will expand its health and medical education,”

WHEREAS, the strategic plan of the College of Engineering states “To train students for careers in multidisciplinary fields, the College should develop new undergraduate degree programs and even full-scale departments in areas such as bioengineering,”

WHEREAS, student demand for a degree in biomedical engineering has been growing with 50 freshmen undeclared engineering students expressing interest in majoring in biomedical engineering Fall of 2009,

WHEREAS, a proposed program modeled on the best practices of the top ten ranked biomedical engineering programs and tailored to the strengths of UD’s College of Engineering has been created,

WHEREAS, the proposed program will not represent a significant increase in engineering students but rather a redistribution of students within the college, minimizing its disruption to the university,

WHEREAS, students in the this program would not be taking new engineering courses until their junior year, allowing ample time for preparation for new courses,

WHEREAS, the new program will substantially benefit the reputation of University of Delaware by establishing us as a leader in biomedical engineering education and strengthen our partnership in Health Science Alliance,

RESOLVED, that the Faculty Senate approves provisionally, for four years, the establishment of a new major leading to the Bachelor of Biomedical Engineering (BBE) degree, effective September 1, 2010.

***CURRICULUM LISTING FOR
UNDERGRADUATE CATALOG***

Bachelor of Biomedical Engineering (BBE)

Sue Zatto

Telephone: (302) 831-7543

E-mail: zatto@udel.edu

<http://www.bme.udel.edu>

Faculty Listing: <http://www.bme.udel.edu/directory/faculty.html>

The Biomedical Engineering Program is an interdisciplinary academic program in the College of Engineering that offers a Bachelor of Biomedical Engineering, including an Honors Degree option. Biomedical Engineering is defined by the National Institutes of Health (NIH) as follows: "Biomedical Engineering integrates physical, chemical, mathematical, and computational sciences and engineering principles to study biology, medicine, behavior and health. It advances fundamental concepts, creates knowledge from the molecular to the organ systems levels, and develops innovative biologies, materials, processes, implants, devices, and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health."

The aim of our program is to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research. Our program is designed to provide students with sufficient biomedical coursework for advanced training at medical school or physical therapy school or other allied health professions. Core biomedical courses are taught early in the program so that students will be well prepared to do well on the MCAT or GRE exam. The program also presents a broad background in chemical, mechanical and electrical engineering so that students will be prepared for graduate school in engineering. The breadth of engineering skills will also train students for careers in biomedical engineering industries, such as in medical devices or pharmaceuticals. Finally the program is also structured to provide students with the skills to enter careers in biomedical research with a quantitative engineering emphasis.

Technical electives in the program are designed to give students specialized experience in particular areas of biomedical engineering such as biomaterials or biomechanics or biochemical engineering. This allows students to specialize in Particular sub-disciplines or to broaden their skill-base.

DEGREE: BACHELOR OF BIOMEDICAL ENGINEERING
MAJOR: BIOMEDICAL ENGINEERING

CURRICULUM CREDITS

UNIVERSITY REQUIREMENTS

ENGL 110	Critical Reading and Writing (minimum grade C-)	3
First Year Experience (FYE)		0-4
Discovery Learning Experience (DLE)		3
Multi-cultural Courses		3

MAJOR REQUIREMENTS

Breadth Requirements 18

See: College Breadth Requirements. One of the breadth requirement courses may fulfill the University multicultural requirement ([See List](#)). A list of current breadth requirement courses can be obtained at:

<http://www.engr.udel.edu/adsup/advise/gen-ed-req.html>

BISC 207	Introductory Biology I	4
BISC 208	Introductory Biology II	4
BMEG 301	Systems Physiology I	3
BMEG 302	Systems Physiology II	3
BMEG 310	Bioengineering Mechanics	4
BMEG 320	Cell & Tissue Transport	3
BMEG 330	Medical Instrumentation/Electronics	3
BMEG 450	Biomedical Engineering Design	4
CHEG 404	Engineering Probability & Statistics	3
CHEM 103	General Chemistry I	4
CHEM 104	General Chemistry II	4
CHEM 321	Organic Chemistry I	4
CHEM 322	Organic Chemistry II	4
CHEM 527	Introduction to Biochemistry	3
CISC 106	General Computer Science for Engineers	3
EGGG 101	Introduction to Engineering	2
ELEG 305	Signals & Systems (previously <i>Linear Systems I</i>)	3
ELEG 479	Intro to Medical Imaging Systems	3
MATH 241	Analytic Geometry & Calculus A	4
MATH 242	Analytic Geometry & Calculus B	4
MATH 243	Analytic Geometry & Calculus C	4
MATH 305*	Applied Mathematics for Chemical Engineers	3
MEEG 483	Orthopaedic Biomechanics	3
MSEG 302	Materials Science for Engineers	3
MSEG 460	Biomaterials & Tissue Engineering	3
PHIL 444	Medical Ethics	3
PHYS 207	Fundamentals of Physics I	4
PHYS 208	Fundamentals of Physics II	4
Technical Electives		12

* For students desiring more advanced training in mathematics, the 2-course sequence of MATH 351 & MATH 352 or MATH 351 & MATH 353 may be substituted for MATH 305 and one Technical Elective.

TECHNICAL ELECTIVES

The student must take five Technical Electives (15 credits) from the following list. Note that independent study, senior research and additional courses for satisfying this requirement can be approved by the advisor

BISC 276	Human Physiology	4
BMSC 630	Human Movement Control	3
CHEG 620	Biochemical Engineering	3
CHEG 621	Metabolic Engineering	3
CHEM 443	Physical Chemistry	3
ELEG 418	Digital Control Systems	3
ELEG 471	Mathematical Physiology	3
ELEG 478	Introduction to Nano and Biophotonics	3
ELEG 680	Immunology for Engineers	3
MEEG 482	Clinical Biomechanics	3
MEEG 485	Control of Human Movement	3
MEEG 612	Biomechanics of Human Movement	3
MSEG 630	Introduction to Science & Engineering of Polymer Systems	3
MSEG 632	Principles of Polymerization	3
MSEG 635	Principles of Polymer Physics	3
UNIV 401	Senior Thesis	2-4
UNIV 402	Senior Thesis	2-4

HONORS BACHELOR OF BIOMEDICAL ENGINEERING

A recipient of Honors Bachelor of Biomedical Engineering must satisfy the following:

- All requirements for the Bachelor of Biomedical Engineering degree.
- All generic University requirements for the Honors Degree. Graduate courses approved for this purpose by the department may be counted as Honors courses.

BIOMEDICAL ENGINEERING FACULTY

<u>Suresh G. Advani</u>	George W. Laird Professor of Mechanical Engineering
<u>Sunil Kumar Agrawal</u>	Professor of Mechanical Engineering
<u>Maciek R. Antoniewicz</u>	Assistant Professor of Chemical Engineering
<u>Kenneth Barner</u>	Professor and Chairman of Electrical & Computer Engineering
<u>Thomas S. Buchanan</u>	George W. Laird Professor of Mechanical Engineering
<u>Takashi Buma</u>	Assistant Professor of Electrical & Computer Engineering
<u>David L. Burris</u>	Assistant Professor of Mechanical Engineering
<u>Daniel K. Cha</u>	Professor of Civil & Environmental Engineering
<u>Pei C. Chiu</u>	Professor of Civil & Environmental Engineering
<u>Sylvain G. Cloutier</u>	Assistant Professor of Electrical & Computer Engineering
<u>Steven K. Dentel</u>	Professor of Civil & Environmental Engineering
<u>Dominic M. Di Toro</u>	Edward C. Davis Professor of Civil & Environmental Engineering
<u>Eric M. Furst</u>	Associate Professor of Chemical Engineering
<u>Jill S. Higginson</u>	Assistant Professor of Mechanical Engineering
<u>Chin-Pao (C.P.) Huang</u>	Donald C. Philips Professor of Civil & Environmental Engineering
<u>Paul T. Imhoff</u>	Associate Professor of Civil & Environmental Engineering
<u>Xinqiao Jia</u>	Assistant Professor of Materials Science & Engineering
<u>Kristi L. Kiick</u>	Associate Professor of Materials Science & Engineering
<u>Kelvin H. Lee</u>	Gore Professor of Chemical Engineering
<u>Abraham M. Lenhoff</u>	Gore Professor of Chemical Engineering
<u>Kurt Manal</u>	Research Assistant Professor of Mechanical Engineering
<u>David Martin</u>	Karl W. & Renate Böer Professor & Chair of Materials Science & Engineering
<u>Mark Mirotznik</u>	Associate Professor of Electrical & Computer Engineering
<u>Babatunde A. Ogunnaike</u>	William L. Friend Chaired Professor of Chemical Engineering
<u>Eleftherios T. Papoutsakis</u>	Eugene DuPont Chaired Professor of Chemical Engineering
<u>Darrin J. Pochan</u>	Professor of Materials Science & Engineering
<u>Ajay K. Prasad</u>	Professor of Mechanical Engineering
<u>John F. Rabolt</u>	Karl W. and Renate Böer Professor of Materials Science & Engineering
<u>Christopher J. Roberts</u>	Associate Professor of Chemical Engineering
<u>Anne S. Robinson</u>	Professor of Chemical Engineering
<u>Michael H. Santare</u>	Professor of Mechanical Engineering
<u>Kausik Sarkar</u>	Associate Professor of Mechanical Engineering
<u>Millicent O. Sullivan</u>	Assistant Professor of Chemical Engineering
<u>Herbert Tanner</u>	Assistant Professor of Mechanical Engineering
<u>Lian-Ping Wang</u>	Professor of Mechanical Engineering
<u>Liyun Wang</u>	Assistant Professor of Mechanical Engineering
<u>Ryan Zurakowski</u>	Assistant Professor of Electrical & Computer Engineering

Biomedical Engineering Program

Fall

Spring

Freshman 4-cr MATH 241—Analytic Geometry & Calculus A
 4-cr CHEM 103—General Chemistry I
 3-cr CISC 106—General Computer Science for Engineers
 2-cr EGGG 101—Introduction to Engineering
 3-cr ENGL 110—Critical reading & Writing
 16-cr

4-cr MATH 242—Analytic Geometry & Calculus B
 4-cr CHEM 104—General Chemistry II
 4-cr BISC 207—Introductory Biology I
 3-cr GenEd 1 (colloquium)
 15-cr

Soph 4-cr MATH 243—Analytic Geometry & Calculus C
 4-cr CHEM 321—Organic Chemistry I
 4-cr BISC 208—Introductory Biology II
 4-cr PHYS 207—Fundamentals of Physics I
 16-cr

3-cr MATH 305—Applied Math for Chemical Engineers
 4-cr CHEM 322—Organic Chemistry II
 4-cr PHYS 208—Fundamentals of Physics II
 3-cr ELEG 305—Signals and Systems
 3-cr GenEd 2
 17-cr

Junior 3-cr MSEG 302—Materials Science for Engineers
 3-cr CHEM 527—Introduction to Biochemistry
 4-cr *BMEG 310—Bioengineering Mechanics*
 3-cr *BMEG 301—Systems Physiology I*
 3-cr Tech Elec 1
 16-cr

3-cr CHEG 404—Engineering Probability & Statistics
 3-cr *BMEG 330—Medical Instrumentation/Electronics Lab*
 3-cr MEEG 483—Orthopaedic Biomechanics
 3-cr *BMEG 302—Systems Physiology II*
 3-cr *BMEG 320—Cell & Tissue Transport*
 15-cr

Senior 4-cr *BMEG 450—Biomedical Engineering Design*
 3-cr MSEG 460—Biomaterials & Tissue Engineering
 3-cr Tech Elec 2
 3-cr GenEd 3
 3-cr GenEd 4
 16-cr

3-cr ELEG 479—Intro to Medical Imaging Systems
 3-cr PHIL 444—Medical Ethics
 3-cr Tech Elec 3
 3-cr Tech Elec 4
 3-cr GenEd 5
 15-cr

126 credits total

Technical Electives

4-cr BISC 276 Human Physiology
 3-cr BMSC 630 Human Movement Control
 3-cr CHEG 620 Biochemical Engineering
 3-cr CHEG 621 Metabolic Engineering
 3-cr CHEM 443 Physical Chemistry
 3-cr ELEG 418 Digital Control Systems
 3-cr ELEG 471 Mathematical Physiology
 3-cr ELEG 478 Introduction to Nano and Biophotonics
 3-cr ELEG 680 Immunology for Engineers
 3-cr MEEG 482 Clinical Biomechanics
 3-cr MEEG 485 Control of Human Movement
 3-cr MEEG 612 Biomechanics of Human Movement
 3-cr MSEG 630 Intro to Sci & Eng of Polymer Systems

Notes:

- 1) *items in italics will be new courses*
- 2) The following substitutions may be made for students desiring more advanced training in mathematics:
 MATH 351 & (352 or 353) may be substituted for
 MATH 305 and one Tech Elec
 (NB: MATH 351 does not directly replace MATH 305—both courses in the MATH 351/352 or 351/353 sequence are needed)

***BACHELOR OF BIOMEDICAL ENGINEERING
(BBE) DEGREE PROPOSAL***

Bachelor of Biomedical Engineering (BBE) Degree Proposal

This is a proposal for a new bachelors' degree in Biomedical Engineering to be offered through the College of Engineering.

Description

This proposal is to establish an undergraduate program in Biomedical Engineering. According to the National Institutes of Health (NIH), biomedical engineering is defined as follows:

“Biomedical Engineering integrates physical, chemical, mathematical, and computational sciences and engineering principles to study biology, medicine, behavior and health. It advances fundamental concepts, creates knowledge from the molecular to the organ systems levels, and develops innovative biologies, materials, processes, implants, devices, and informatics approaches for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health.” -From www.nibib.nih.gov

The aim of our program is to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research. Our program is designed to provide students with sufficient biomedical coursework for advanced training at medical school, physical therapy school or other allied health professions. Core biomedical courses are taught early in the program so that students will be well prepared to do well on the MCAT or GRE exam. The program also presents a broad background in chemical, mechanical and electrical engineering so that students will be prepared for graduate school in engineering. The breadth of engineering skills will also train students for careers in biomedical engineering industries, such as in medical devices or pharmaceuticals. Finally the program is also structured to provide students with the skills to enter careers in biomedical research with a quantitative engineering emphasis.

In the short term, the overall outcome measure for this program will be success in students entering medical, professional and graduate schools and/or finding positions in the biomedical workforce. After the program is well established, national reputation of the program will be considered as well. Learning outcomes will be assessed as per ABET standards. Although we will not plan to seek accreditation for this program initially as it lacks sufficient engineering at the expense of having a strong biomedical component (which will make it a strong pre-med degree), we plan to hold the program to the standards required for ABET accreditation in terms of assessing students' mastery of key concepts by measuring these skills in subsequent courses, as well as having feedback from an external advisory committee and “closing the loop” on program revisions and corrections in response to that feedback.

Rationale and Demand

A. Institutional Factors

This program fits well in the strategic plan of the College of Engineering where it is said the college will establish new undergraduate degrees: "To train students for careers in multidisciplinary fields, the College should develop new undergraduate degree programs and even full-scale departments in areas such as bioengineering."

It also fits with the UD Path to Prominence in section III in the subsection entitled *Create the University Health Initiative* where we say we will "become a recognized leader in health sciences" and "the University will expand its health and medical education."

This program has been created by a committee that has been working for two years. The committee consisted of faculty from each of the five departments in the College of Engineering. The first year was spent evaluating the need for such a program and exploring if UD has the resources to coordinate a degree program in biomedical engineering. The second year was spent planning the actual curriculum by examining the curricula at the top ten ranked biomedical engineering programs according to US News. Specific concerns were (1) whether to make the program ABET accredited, (2) how to create a program that had a sufficient amount of chemical, electrical and mechanical engineering so that it would reflect the expertise of the UD faculty involved, and (3) how to create an academic structure to coordinate and administer such a program.

Last year we contacted the CEO of Gore Associates to provide us with a member of our external advisory board. We also reached out to our partners at Thomas Jefferson University and Christiana Hospital to find medical and research professionals who could advise us. Thus, we feel we have a strong external advisory board.

This program should not be difficult to run. There are no new courses offered until the junior year. While one could argue that this puts a burden on departments teaching service courses (such as Math, Biology and Chemistry), this is consistent with the needs of other engineering departments and many of the students in this program would have taken those same courses had they stayed in a different engineering major.

This program should not adversely affect other programs to the college on campus. Many engineering programs (e.g., mechanical and civil engineering) have very large enrollments, far more than currently desired, and are glad to have those students distributed to a new program offering.

The six new courses to be developed will largely be taught by new faculty planned to be hired in the next few years. Many of these courses, such as BMEG 301, 302 and 450 will be team-taught.

B. Student demand

Among the students, there is considerable interest in a biomedical engineering major. At many of our competing universities where biomedical engineering is offered, it has become the most popular engineering major (e.g., Johns Hopkins, UPenn). Those students are also often those with the highest SAT scores and they tend to have a much higher concentration

of women than other engineering majors. We feel that students in the quality range will add to our overall College retention, graduation and success rates.

We are frequently asked at recruiting events such as Delaware Days, Blue & Golden Saturdays, and Discovery Days why we do not offer degrees in biomedical engineering and we believe we are losing quality potential students because we do not offer a degree in this field. A recent survey of our freshman class in the required Introduction to Engineering course asked students what type of engineering they would like to major in and biomedical engineering was included in the list. Approximately 50 out of 500 chose biomedical engineering over other engineering disciplines currently offered. This 10% affirmative response suggests that there is a viable market for the discipline even in our current student population.

Thus, we expect about 50 students per year in the program initially. Many of these will come from an internal redistribution. While we expect to attract students into this program who might not have applied to UD, it is not clear that the overall number of students in the college will change because of this new program.

We expect this new undergraduate program to appeal mainly to traditional students (i.e., not part-time students, currently employed professionals, non-traditional students, those preparing to reenter the job market, etc.)

C. Transferability

Students will be allowed to transfer into this program as per the College of Engineering's transfer policy (i.e., any student can transfer into the program). No special policy will be established beyond that which is required for all programs in the college.

That said, in the beginning three years students will not be allowed to transfer into the program for years above the level of the initial class. That is, a student will only be allowed to transfer as a freshman in 2010, as a sophomore or freshman in 2011, and as a junior, sophomore or freshman in 2012. This is because the higher-level courses (e.g., senior level courses) will not be offered initially due to the lack of students.

D. Access to graduate and professional programs

Our program is designed to provide students with sufficient biomedical coursework for advanced training at medical school or physical therapy school or other allied health professions. Core biomedical courses are taught early in the program so that students will be well prepared to do well on the MCAT or GRE exam. We have verified that the courses in this curriculum satisfy the requirement for medical school applicants.

E. Demand and employment factors

The National Academy of Engineering has predicted that by the year 2020, 30%-35% of all US industry will be medically or biologically based. Thus, a demand for engineering students with expertise in biomedical fields has been established.

F. Regional, state, and national factors

Biomedical engineering is an area of emerging technology. Just as computer science was a novel field 50 years ago and electrical engineering was a novel field 100 years ago, so is biomedical engineering a novel area today. It is a field of tremendous growth nationally and

internationally and it would be as unwise for UD not to have a program in this area as it would be not to offer degrees in electrical engineering or computer science. Nearly all of our major competitors already offer such programs.

There are no biomedical engineering programs in the state of Delaware. Since we have so many faculty trained to do work in this area, and actually doing work in this field, we have the capacity and expertise to offer such a program, which will help us attract students who might have gone to other universities.

G. Describe other strengths

The faculty in the College of Engineering at the University of Delaware are actively engaged in biomedical research. Approximately one quarter of all research expenses are related to biological themes and our single largest external research funding organization is currently the NIH.

This research spans the entire college as every department has some faculty engaged in bio-related research. Thus, since biomedical engineering has become a field of its own at most engineering colleges, and since we have many faculty working in this field, it stands to reason that we should offer our students an opportunity to study biomedical engineering.

Enrollments, Admissions, and Financial Aid

A. Enrollment

This program will begin in fall of 2010. We anticipate an enrollment of about 50 students. Since an increasing number of engineering students are admitted as *engineering undecided*, we believe we can admit according to similar guidelines and all students would take the same courses in the first semester that are taken by all engineering majors. It is our feeling that financial aid trend would follow that of our current engineering undeclared cohort as well.

B. Admission Requirements

As stated above, we will admit according to the same standards as *engineering undecided* students, as we expect that will be the main mechanism for students to enter the program, especially in the program's early years (before much marketing is done and the program is well known). Thus, most students will transfer into the program before their second semester begins.

C. Student Expenses and Financial Aid

We have no requests for special student fees at this time. However, the college is considering having student fees for all engineering programs which would apply to this program as well as all others should that move forward. In addition, there is no request for special financial aid provisions.

Curriculum Specifics

A. Institutional Factors

The degree to be awarded will be a BBE: Bachelor of Biomedical Engineering. This follows the pattern of other undergraduate degrees offered in the College of Engineering, which are

BChE-Bachelor of Chemical Engineering
 BCE-Bachelor of Civil Engineering
 BCpE-Bachelor of Computer Engineering
 BEE-Bachelor of Electrical Engineering
 BEnE-Bachelor of Environmental Engineering
 BME-Bachelor of Mechanical Engineering

B. Describe the Curriculum

The degree requires 126 credit hours of study. The basic university requirements are satisfied: ENGL 110 is required, a first year experience (EGGG 101) is required, a discovery learning experience in the form of a capstone senior design course (BMEG 450) is required, and a multi-cultural course is required. In addition, the 21 additional College of Engineering breadth requirements are satisfied.

The curriculum begins with lower division courses in math, physics, chemistry and biology. The upper division courses cover basic engineering topics in electronics, mechanics, biochemistry, physiology, materials science, and ethics. The program also contains four technical electives whereby students can choose from a list of approved biomedical engineering courses.

Below is a sample four-year program for this new degree:

	Fall	Spring
Fr	4-cr MATH 241—Analytic Geometry & Calculus A 4-cr CHEM 103—General Chemistry I CISC 106—General Computer Science for Engineers 3-cr 2-cr EGGG 101—Introduction to Engineering 3-cr ENGL 110—Critical reading & Writing <hr/> 16-cr	4-cr MATH 242—Analytic Geometry & Calculus B 4-cr CHEM 104—General Chemistry II 4-cr BISC 207—Introductory Biology I 3-cr GenEd 1 (colloquium) <hr/> 15-cr
Sph	4-cr MATH 243—Analytic Geometry & Calculus C 4-cr CHEM 321—Organic Chemistry I 4-cr BISC 208—Introductory Biology II 4-cr PHYS 207—Fundamentals of Physics I <hr/> 16-cr	3-cr MATH 305—Applied Mathematics for Chemical Engineers (see note #2) 4-cr CHEM 322—Organic Chemistry II 4-cr PHYS 208—Fund. of Physics II 3-cr ELEG 305—Signals & Systems 3-cr GenEd 2 <hr/> 17-cr
Jr	3-cr MSEG 302—Materials Science for Engineers 3-cr CHEM 527—Introduction to Biochemistry 4-cr BMEG 310—Bioengineering Mechanics 3-cr BMEG 301—Systems Physiology I 3-cr Tech Elec 1 <hr/> 16-cr	3-cr CHEG 404—Engineering Probability & Statistics BMEG 330—Medical Instrumentation/Electronics MEEG 483—Orthopaedic 3-cr Biomechanics 3-cr BMEG 302—Systems Physiology II 3-cr BMEG 320—Cell & Tissue Transport <hr/> 15-cr

Sr	4-cr	<i>BMEG 450—Biomedical Engineering Design</i>	3-cr	ELEG 479—Intro to Medical Imaging Systems
	3-cr	MSEG 460—Biomaterials & Tissue Engineering	3-cr	PHIL 444—Medical Ethics
	3-cr	Tech Elec 2	3-cr	Tech Elec 3
	3-cr	GenEd 3	3-cr	Tech Elec 4
	3-cr	GenEd 4	3-cr	GenEd 5
	16-cr		15-cr	

126 credits total

Technical Electives

- 4-cr BISC 276 Human Physiology
 - 3-cr BMSC 630 Human Movement Control
 - 3-cr CHEG 620 Biochemical Engineering
 - 3-cr CHEG 621 Metabolic Engineering
 - 3-cr CHEM 443 Physical Chemistry
 - 3-cr ELEG 418 Digital Control Systems
 - 3-cr ELEG 471 Mathematical Physiology
 - 3-cr ELEG 478 Introduction to Nano and Biophotonics
 - 3-cr ELEG 680 Immunology for Engineers
 - 3-cr MEEG 482 Clinical Biomechanics
 - 3-cr MEEG 485 Control of Human Movement
 - 3-cr MEEG 612 Biomechanics of Human Movement
 - 3-cr MSEG 630 Intro Sci/Eng of Polymer Sys
 - 3-cr MSEG 632 Principles of Polymerization
 - 3-cr MSEG 635 Principles of Polymer Physics
 - 2-4-cr UNIV 401 Senior Thesis
 - 2-4-cr UNIV 402 Senior Thesis
- Others per permission of program

Notes:

- 1) *items in italics will be new courses*
- 2) The following substitutions may be made for students desiring more advanced training in mathematics:
 - MATH 351 & 352 or MATH 351 & 353 may be substituted for MATH 305 and one Tech Elec (NB: MATH 351 does not directly replace MATH 305—both courses in the MATH 351/352 or 351/353 sequence are needed)

The specific requirements for this degree are below (in UD catalog format):

**DEGREE: BACHELOR OF BIOMEDICAL ENGINEERING
MAJOR: BIOMEDICAL ENGINEERING**

CURRICULUM	CREDITS
UNIVERSITY REQUIREMENTS	
ENGL 110 Critical Reading and Writing (minimum grade C-)	3
First Year Experience (FYE)	0-4
Discovery Learning Experience (DLE)	3
Multi-cultural Courses	3
MAJOR REQUIREMENTS	
Breadth Requirements	18

See: College Breadth Requirements. One of the breadth requirement courses may fulfill the University multicultural requirement (See List). A list of current breadth requirement courses can be obtained at:

<http://www.engr.udel.edu/adsup/advise/gen-ed-req.html>

BISC 207	Introductory Biology I	4
BISC 208	Introductory Biology II	4
BMEG 301	Systems Physiology I	3
BMEG 302	Systems Physiology II	3
BMEG 310	Bioengineering Mechanics	4
BMEG 320	Cell & Tissue Transport	3
BMEG 330	Medical Instrumentation/Electronics	3
BMEG 450	Biomedical Engineering Design	4
CHEG 404	Engineering Probability & Statistics	3
CHEM 103	General Chemistry I	4
CHEM 104	General Chemistry II	4
CHEM 321	Organic Chemistry I	4
CHEM 322	Organic Chemistry II	4
CHEM 522	Introduction to Biochemistry	3
CISC 106	General Computer Science for Engineers	3
EGGG 101	Introduction to Engineering	2
ELEG 305	Signals & Systems (previously <i>Linear Systems I</i>)	3
ELEG 479	Intro to Medical Imaging Systems	3
MATH 241	Analytic Geometry & Calculus A	4
MATH 242	Analytic Geometry & Calculus B	4
MATH 243	Analytic Geometry & Calculus C	4
MATH 305	Applied Mathematics for Chemical Engineers	3
MEEG 483	Orthopaedic Biomechanics	3
MSEG 302	Materials Science for Engineers	3
MSEG 460	Biomaterials & Tissue Engineering	3
PHIL 444	Medical Ethics	3
PHYS 207	Fundamentals of Physics I	4
PHYS 208	Fundamentals of Physics II	4
Technical Electives		12

TECHNICAL ELECTIVES

The student must take four Technical Electives (12 credits) from the following list. Note that independent study, senior research and additional courses for satisfying this requirement can be approved by the advisor.

BISC 276	Human Physiology	4
BMSC 630	Human Movement Control	3
CHEG 620	Biochemical Engineering	3
CHEG 621	Metabolic Engineering	3
CHEM 443	Physical Chemistry	3
ELEG 418	Digital Control Systems	3
ELEG 471	Mathematical Physiology	3
ELEG 478	Introduction to Nano and Biophotonics	3
ELEG 680	Immunology for Engineers	3
MEEG 482	Clinical Biomechanics	3
MEEG 485	Control of Human Movement	3
MEEG 612	Biomechanics of Human Movement	3
MSEG 630	Introduction to Science & Engineering of Polymer Systems	3
MSEG 632	Principles of Polymerization	3
MSEG 635	Principles of Polymer Physics	3
UNIV 401	Senior Thesis	2-4
UNIV 402	Senior Thesis	2-4

Notes:

- 1) General Education (21 credits): There are 5 General Educational requirement courses (15 credits) beyond the 3-credit ENGL 110 and the 3-credit PHIL 444 (Medical Ethics).
- 2) Technical Electives: (12 credits): Students are required to complete 4 courses from a list of Technical Electives.
- 3) Pre-med: The courses in this curriculum are designed to meet the entrance requirements for medical school. Furthermore, the courses are arranged so that students will have the required courses completed prior to the time that the MCAT exam would be administered.
- 4) There are six new courses that will be taught in this program: BMEG 210, 220, 301, 302, 320, and 450. Course descriptions are below:

BMEG 301—Systems Physiology I: Human physiology from a quantitative viewpoint. Anatomy and pathology, where appropriate. Functional/structural aspects of mammalian nervous and musculoskeletal systems. Neural biophysics. Prerequisites: BISC 207, BISC 208 and PHYS 207

BMEG 302—Systems Physiology II: Cellular mechanisms of and quantitative systems approach to human cardiovascular, respiratory, renal, digestive, endocrine, and metabolic physiology. Prerequisite: BMEG 301

BMEG 310—Bioengineering Mechanics: Introduction to statics, dynamics and mechanics of solids with application to biomedical problems. Prerequisite: PHYS 207 and MATH 243

BMEG 320—Cell & Tissue Transport: Fundamental and biomedical applications of fluid mechanics. Introduction to diffusive and convective heat and mass transfer with biomedical applications. Prerequisite: PHYS 207 and MATH 305

BMEG 330—Medical Instrumentation/Electronics: Circuit analysis and network theorems with application to biomedical problems. Bode plots; Fourier analysis; introduction to medical imaging. Prerequisite: PHYS 208

BMEG 450—Biomedical Engineering Design: Open-ended team-designed projects in the medical devices or research arena. Systems approach requiring design strategy and concepts, including reliability, safety, ethics, economic analysis, marketing, FDA regulations, and patents. Open to BMEG seniors only

- 5) The following substitutions may be made for students desiring more advanced training in mathematics:

- MATH 351 & 352 or MATH 351 & 353 may be substituted for MATH 305 and one Tech Elec.
(NB: MATH 351 does not directly replace MATH 305—both courses in the MATH 351/352 or 351/353 sequence are needed for this option.)

6) The following courses have been offered as 600-level courses in the past, but new 400-level versions are being created that will cover the same material albeit with less rigor: CHEG 404, MSEG 460, ELEG 479.

Resources Available

A. Learning Resources

The UD library holdings are sufficient for the program. Since so many faculty are already engaged in scholarly work in biomedical engineering, adequate journal subscriptions have been maintained.

Biomedical engineering is a very broad discipline, marrying nearly any field of engineering with nearly any field of biomedical research. We have a strong engineering library. While UD does not have a complete biomedical library as might be expected at a Medical School, it has sufficient resources for our needs and subscribes to most of the journals required for our faculty.

B. Faculty/Administrative Resources

This program would begin by giving appointments to all faculty in the College of Engineering who have identified themselves as doing research in biomedical engineering or bioengineering. That includes the following 37 full-time faculty:

<u>Suresh G. Advani</u>	George W. Laird Professor of Mechanical Engineering
<u>Sunil Kumar Agrawal</u>	Professor of Mechanical Engineering
<u>Maciek R. Antoniewicz</u>	Assistant Professor of Chemical Engineering
<u>Kenneth Barner</u>	Professor and Chairman of Electrical & Computer Engineering
<u>Thomas S. Buchanan</u>	George W. Laird Professor of Mechanical Engineering
<u>Takashi Buma</u>	Assistant Professor of Electrical & Computer Engineering
<u>David L. Burris</u>	Assistant Professor of Mechanical Engineering
<u>Daniel K. Cha</u>	Professor of Civil & Environmental Engineering
<u>Pei C. Chiu</u>	Professor of Civil & Environmental Engineering
<u>Sylvain G. Cloutier</u>	Assistant Professor of Electrical & Computer Engineering
<u>Steven K. Dentel</u>	Professor of Civil & Environmental Engineering
<u>Dominic M. Di Toro</u>	Edward C. Davis Professor of Civil & Environmental Engineering
<u>Eric M. Furst</u>	Associate Professor of Chemical Engineering
<u>Jill S. Higginson</u>	Assistant Professor of Mechanical Engineering
<u>Chin-Pao (C.P.) Huang</u>	Donald C. Philips Professor of Civil & Environmental Engineering
<u>Paul T. Imhoff</u>	Associate Professor of Civil & Environmental Engineering
<u>Xinqiao Jia</u>	Assistant Professor of Materials Science & Engineering
<u>Kristi L. Klück</u>	Associate Professor of Materials Science & Engineering
<u>Kelvin H. Lee</u>	Gore Professor of Chemical Engineering
<u>Abraham M. Lenhoff</u>	Gore Professor of Chemical Engineering
<u>Kurt Manal</u>	Research Assistant Professor of Mechanical Engineering
<u>David Martin</u>	Karl W. & Renate Böer Professor & Chair of Materials Science & Engineering
<u>Mark Mirotznik</u>	Associate Professor of Electrical & Computer Engineering
<u>Babatunde A. Ogunnaike</u>	William L. Friend Chaired Professor of Chemical Engineering

<u>Eleftherios T. Papoutsakis</u>	Eugene DuPont Chaired Professor of Chemical Engineering
<u>Darrin J. Pochan</u>	Professor of Materials Science & Engineering
<u>Ajay K. Prasad</u>	Professor of Mechanical Engineering
<u>John F. Rabolt</u>	Karl W. and Renate Böer Professor of Materials Science & Engineering
<u>Christopher J. Roberts</u>	Associate Professor of Chemical Engineering
<u>Anne S. Robinson</u>	Professor of Chemical Engineering
<u>Michael H. Santare</u>	Professor of Mechanical Engineering
<u>Kausik Sarkar</u>	Associate Professor of Mechanical Engineering
<u>Millicent O. Sullivan</u>	Assistant Professor of Chemical Engineering
<u>Herbert Tanner</u>	Assistant Professor of Mechanical Engineering
<u>Lian-Ping Wang</u>	Professor of Mechanical Engineering
<u>Liyun Wang</u>	Assistant Professor of Mechanical Engineering
<u>Ryan Zurakowski</u>	Assistant Professor of Electrical & Computer Engineering

As for administrative staff, our program would begin with a single staff member, which will be increased by the dean as the need arises.

C. External Funding

The faculty in the college of engineering have over \$7M/year in external funding from the National Institutes of Health for biomedical research. Our reputation in the field is very strong, as is our funding. As for funding for this program, we have only internal funding in the form of a UNIDEL grant.

Resources Support

A. Learning Resources

Beyond personnel, there are no new resources needed for this new program as the College of Engineering has the resources required. This program will use the College's advisement and student support infrastructure until it has the strength and stability to warrant an investment of staffing and resources to be self-supporting.

B. Personnel Resources

The College of Engineering is in the process of making cluster hires in the field of bioengineering. We anticipate adding at least four new faculty in the next three years in this area. We are planning to strengthen our research efforts in this area, as it is part of our strategic plan. However, faculty hired will be asked to teach in this new program.

C. Budgetary Needs

Budgetary needs for this program consist of administrative support: academic program director's stipend, administrator's salary, office space and advertising. These will be provided by the College of Engineering.

Implementation and Evaluation

A. Implementation Plan

This degree will be established as an interdisciplinary program. It will not be administered through one of our existing departments. Faculty will be appointed to the program through the approval of the program steering committee, which will also function as the curriculum committee once the program is established:

- Thomas Buchanan, Deputy Dean of Engineering (acting Director)
- Tak Buma, Electrical & Computer Engineering
- Dan Cha, Civil & Environmental Engineering
- Jill Higginson, Mechanical Engineering
- Kristi Kiick, Materials Science & Engineering
- Anne Robinson, Chemical Engineering

The curriculum committee, lead by the Academic Program Director, will be responsible for overseeing the program. Changes in the curriculum will be brought from the committee to the entire biomedical engineering faculty for a vote and a simple majority is required for approval. We anticipate hiring a faculty member to be Academic Program Director who would replace Dr Buchanan on this list once the program is approved. The director of this program would report to the Dean of Engineering.

Student advisement will be done through the many program-level faculty involved in the program and coordination with the College Undergraduate Advisement Center.

B. Assessment Plan

The program will be evaluated internally and through an external advisory committee.

The program has an external advisory committee that will provide feedback to the faculty on the program. Members to that external advisory committee consist of members from the biomedical community and faculty members at other institutions. Initial members are

- Michael Axe, MD, First State Orthopaedics/Christiana Hospital
- George Foutrakis, PhD, Gore & Associates
- Irving Shapiro, PhD, Thomas Jefferson University

As the program grows, we plan to broaden this board to include members from AstraZeneca, Nemours, Synthes Inc., UPenn, and others from the local biomedical industry.

Regarding the internal assessment, students in the program are evaluated with respect to their preparation for entry into the general practice of biomedical engineering and their preparation for graduate education. The evaluation is conducted primarily through performance as described below:

COURSE PERFORMANCE

- Exams (tests, quizzes, and final exams)
- Problem sets and homework
- Laboratory assignments
- Project reports (oral and written)

Instructors' reviews and comments on homework assignments and tests provide the student with feedback on their performance. Knowledge, skills, and ability to perform in the laboratory are evaluated through review of laboratory reports. Ability to work effectively in teams and to communicate correctly and effectively is evaluated through performance in laboratory work and design teams. Our half-year senior design capstone course (BMEG 450) provides a unique opportunity to evaluate students' competence during their final year. The University uses an "A" through "F" grading system, with "plus" and "minus" grades available from "A-" through "D-". A minimum average of "C," or a grade point index of 2.0 on a 4.0 scale, on all work taken at the University is required for the baccalaureate degree.

Following are the Educational Objectives:

1. Graduates will be prepared with a solid foundation in mathematics, sciences, and technical skills needed to analyze and design biomedical systems.
2. Graduates will possess strong written, oral, and graphical communication skills, and will be able to function on multi-disciplinary teams.
3. Graduates will be familiar with current and emerging socioeconomic issues and the global context in which biomedical engineering is practiced.
4. Graduates will have an understanding of professional ethics and their societal responsibilities as a practicing engineer.
5. Graduates will recognize the need for engaging in life-long learning, and will have the ability to assume leadership roles in and outside of the profession.
6. Graduates will have the necessary qualifications for employment in biomedical engineering and related professions and for entry into advanced studies.

In concert with the process to review the Educational Objectives, a process for evaluating the level of achievement of the Objectives will be implemented. The process involves input from employers, alumni, and graduating seniors and will follow a periodic cycle. Three evaluation tools will be used to gauge the level of achievement—an employer survey, an alumni survey, and a senior exit survey.

Following are the eleven Program Outcomes for the Bachelor of Biomedical Engineering degree:

Graduates of the program must have

1. the ability to apply knowledge of mathematics, science, and engineering;
2. the ability to identify, formulate, and solve engineering problems in fundamental biomedical concepts, create knowledge from the molecular to the organ systems levels, and develop innovative biologies, materials, processes, implants, devices, and informatics;
3. the ability to design and conduct laboratory experiments and to critically analyze and interpret data;

4. the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;
5. the ability to design a system, component, or process to meet the desired needs within realistic constraints for the prevention, diagnosis, and treatment of disease, for patient rehabilitation, and for improving health;
6. the ability to perform biomedical engineering design by means of problem-based experiences integrated throughout the curriculum;
7. an understanding of professional and ethical responsibility;
8. a broad education and knowledge of contemporary issues necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
9. the ability to function on multidisciplinary teams; and
10. the ability to communicate effectively.
11. Graduates of the program must recognize the need for and ability to engage in lifelong learning.

***APPENDICES: ACCREDITATION CRITERIA
TRANSFER/RETENTION POLICY AND
LETTERS OF APPROVAL***

Appendices

Accreditation Criteria

We will not be seeking ABET accreditation for this program. We have found that other leading universities (e.g., UCSD, UPenn) do not apply for accreditation for their popular biomedical engineering programs as it is difficult to incorporate enough biology and chemistry courses in a curriculum that also satisfies the Accreditation Board for Engineering and Technology. Having a strong biology component is important to us since a majority of the graduates of this program are likely to use this as a pre-med or pre-graduate school major. For that same reason, a lack of ABET accreditation should not be a problem.

Letters of Collaborative Agreement

n/a

Transfer/Retention Policy

The transfer policy will be consistent with that of all other departments in the College of Engineering (the College has a uniform policy.)

Letters of Approval from Contributing or Affected Departments

Letters from the Deans of Agriculture & Natural Resources, Arts & Science, Business & Economics, Earth Ocean & Environment, Engineering and Health Sciences are provided.

From the College of Engineering, letters of support from the Departments of Chemical Engineering, Electrical & Computer Engineering, Materials Science & Engineering, and Mechanical Engineering are provided.

From outside the College of Engineering, letters from the Chairs of the Departments of Biological Sciences, Chemistry, Physics, Mathematics, Computer & Information Sciences, Biomechanics & Movement Sciences, English and Philosophy are provided.

Other Pertinent Documents

n/a

See <http://www.udel.edu/facsen/course/index.html> for information on the approval process for provisional academic programs.



Office of the Dean
College of Arts and Sciences

22 December 2009

Michael Chajes
Dean, College of Engineering
University of Delaware

RE: Proposed Bachelor Degree Program in Biomedical Engineering

Dear Michael,

The College of Arts & Sciences supports the proposed Bachelor of Science degree in Biomedical Engineering. This program will depend on the strong support of several departments in Arts & Sciences, with the greatest short term impact on Chemistry, Biology, Math and Philosophy. As we have discussed, there are some important issues that we must resolve to accommodate your students. I am committed to working with you and Provost Apple to resolve them.

It is my understanding that in the first few years of this program, undergraduate enrollment in the College of Engineering will not grow, and that the incoming class will actually be smaller than it was this year. The initial impact on our College will be a result of the relatively larger demand for Arts & Sciences courses by students in your proposed interdisciplinary major. The greatest challenges will be instruction in Biology and Chemistry, where additional classes are required beyond those typically taken by your students.

Our most immediate concerns in Biology are a shortage of teaching laboratory space and faculty for BISC 207 and 208. This need will eventually be mitigated by the opening of the new Interdisciplinary Science and Engineering Laboratory. ISEL is scheduled to open in Fall 2013, thus we must still find a solution for the next three academic years. We believe that by teaching labs on Friday and Saturday, we can accommodate the additional biology students with significant but manageable impact on the faculty and staff involved. We must also increase the teaching capacity in Biology and funding for laboratory operating expenses. We can manage these latter issues if the tuition revenue distribution results in adequate funding to the College.

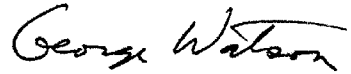
Your proposed curriculum will also increase enrollments in Chemistry, primarily in CHEM 104, CHEM 321 and 322 and CHEM 527. Each of these courses will require additional teaching capacity and the first three will have substantial increases in operating costs for the laboratory. Again, our ability to manage these operating expenses depends on the operative financial model at the time the courses are offered.

The greatest problem we face is the increased demand for organic chemistry (CHEM 321 and 322). These teaching labs must be renovated to address safety standards. Our current plan is to suspend for renovation each of three labs in succession, but with the additional students from your proposed program, this plan is no longer feasible. A potential solution will be to fast-track the air handling project and the teaching lab renovation in Drake Lab. My estimate is that we need an additional \$500k to conclude the renovation project on a timely schedule. With your support, and that of the Provost, we will seek the needed funds for this renovation.

In Mathematics, we foresee an increase in the number of Teaching Assistants needed due to a shift of enrollment into MATH 305. This will be partly compensated by savings in faculty lines due to reduced enrollment in other Math courses, but there will be a net increase in cost to the College because of differences in the way these courses are offered. The increased enrollment in Philosophy will be supported by tuition revenue to the College.

We look forward to supporting your efforts as Biomedical Engineering moves forward, and will look for your support as we work together to address the associated challenges.

Sincerely,

A handwritten signature in black ink that reads "George Watson". The signature is written in a cursive style with a large, sweeping initial "G".

George Watson
Interim Dean

From: Morgan, Robin [mailto:morgan@UDel.Edu]
Sent: Thursday, December 17, 2009 1:58 PM
To: Chajes, Michael J.
Cc: Morgan, Robin
Subject: RE: Proposed Biomedical Engineering Major

Dear Michael,

I support this new major in biomedical engineering. I would guess that there is considerable interest and opportunity for expansion.

Thanks, Robin

From: Chajes, Michael J. [mailto:chajes@UDel.Edu]
Sent: Tuesday, December 15, 2009 8:34 PM
To: Gamel-McCormick, Michael; Gempesaw, Conrado; Matt, Kathleen S.; Morgan, Robin; Targett, Nancy M.; Watson, George
Cc: Buchanan, Thomas S.; Vaughan, Michael L.
Subject: Proposed Biomedical Engineering Major

Fellow Deans,

The College of Engineering is proposing a new undergraduate major in biomedical engineering. I am writing to inform you of this proposal, and to seek your support. While it does not directly affect all of your colleges (the only required classes outside of engineering are in A&S), I think it is good for you to be aware of new majors, and I would very much like your endorsement of the program.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research. Initially, the total number of engineering students is not likely to increase due to the new major, but rather the freshman we have in our college will be distributed into 7, as opposed to 6, majors. Over time, we do expect an increase in engineering majors, and at steady state, the biomedical engineering program will likely result in the addition of between 50 and 100 new engineering freshmen.

Documentation of this program is attached. If you have any questions or concerns, please let me know.

The engineering faculty are very excited about this new major, and we have also been encouraged to pursue this degree program by our college's external advisory board.

A simple response to this e-mail indicating your support of the Biomedical Engineering major would be greatly appreciated.

Michael

P.S. I am happy to talk more about the program at our upcoming breakfast if any of you would like to learn more about it.

Michael J. Chajes, Dean
102 DuPont Hall
College of Engineering
University of Delaware
Newark, DE 19716

From: Gempesaw, Bobby [mailto:gempesaw@lerner.udel.edu]
Sent: Wednesday, December 16, 2009 10:48 AM
To: Chajes, Michael J.
Subject: FW: Proposed Biomedical Engineering Major

Michael,

I am supportive of your proposed Biomedical Engineering program. My only suggestion is that your BME students may want to take one or two business and economics courses so they have some exposure to the business discipline. After all, they will have to deal with it once they join the professional world.

Bobby

From: Chajes, Michael J. [mailto:chajes@UDel.Edu]
Sent: Tuesday, December 15, 2009 8:34 PM
To: Gamel-McCormick, Michael; Gempesaw, Conrado; Matt, Kathleen S.; Morgan, Robin; Targett, Nancy M.; Watson, George
Cc: Buchanan, Thomas S.; Vaughan, Michael L.
Subject: Proposed Biomedical Engineering Major

Fellow Deans,

The College of Engineering is proposing a new undergraduate major in biomedical engineering. I am writing to inform you of this proposal, and to seek your support. While it does not directly affect all of your colleges (the only required classes outside of engineering are in A&S), I think it is good for you to be aware of new majors, and I would very much like your endorsement of the program.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research. Initially, the total number of engineering students is not likely to increase due to the new major, but rather the freshman we have in our college will be distributed into 7, as opposed to 6, majors. Over time, we do expect an increase in engineering majors, and at steady state, the biomedical engineering program will likely result in the addition of between 50 and 100 new engineering freshmen.

Documentation of this program is attached. If you have any questions or concerns, please let me know.

The engineering faculty are very excited about this new major, and we have also been encouraged to pursue this degree program by our college's external advisory board.

A simple response to this e-mail indicating your support of the Biomedical Engineering major would be greatly appreciated.

Michael

P.S. I am happy to talk more about the program at our upcoming breakfast if any of you would like to learn more about it.

Michael J. Chajes, Dean
102 DuPont Hall
College of Engineering
University of Delaware
Newark, DE 19716

From: Targett, Nancy M.
Sent: Tuesday, December 15, 2009 9:23 PM
To: Chajes, Michael J.; Gamel-McCormick, Michael; Gempesaw, Conrado; Matt, Kathleen S.; Morgan, Robin; Watson, George
Cc: Buchanan, Thomas S.; Vaughan, Michael L.
Subject: RE: Proposed Biomedical Engineering Major

Michael,
This is outside of my primary area of expertise....but I can say that I do support the concepts of innovative programs like this that would build on the strengths that we already have in this area So, you have my endorsement
nancy

Nancy M. Targett
Dean
University of Delaware
College of Earth, Ocean, and Environment
111 Robinson Hall
Newark, DE 19716

Phone: 302-831-2841

url: <http://www.ceoe.udel.edu>

From: Chajes, Michael J.
Sent: Tuesday, December 15, 2009 8:34 PM
To: Gamel-McCormick, Michael; Gempesaw, Conrado; Matt, Kathleen S.; Morgan, Robin; Targett, Nancy M.; Watson, George
Cc: Buchanan, Thomas S.; Vaughan, Michael L.
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Michael

P.S. I am happy to talk more about the program at our upcoming breakfast if any of you would like to learn more about it.

Michael J. Chajes, Dean
102 DuPont Hall
College of Engineering
University of Delaware
Newark, DE 19716

From: Matt, Kathleen S.
Sent: Tuesday, December 15, 2009 9:16 PM
To: Chajes, Michael J.; Gamel-McCormick, Michael; Gempesaw, Conrado; Morgan, Robin; Targett, Nancy M.; Watson, George
Cc: Buchanan, Thomas S.; Vaughan, Michael L.
Subject: RE: Proposed Biomedical Engineering Major

Michael, We definitely support your new undergraduate major in Biomedical Engineering. We look forward to working with you on linkages to our programs as well. Please let us know how we can help as you move forward.

all the best, Kathy

Kathleen S. Matt, PhD
Dean, College of Health Sciences
University of Delaware
345 McDowell Hall
Newark, Delaware 19716
Office: 302-831-8370
Fax: 302-831-3490
E-Mail: ksmatt@udel.edu

From: Chajes, Michael J.
Sent: Tuesday, December 15, 2009 8:34 PM
To: Gamel-McCormick, Michael; Gempesaw, Conrado; Matt, Kathleen S.; Morgan, Robin; Targett, Nancy M.; Watson, George
Cc: Buchanan, Thomas S.; Vaughan, Michael L.
Subject: Proposed Biomedical Engineering Major

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Michael J. Chajes, Dean
102 DuPont Hall
College of Engineering
University of Delaware
Newark, DE 19716



DEPARTMENT OF
CHEMICAL ENGINEERING
OFFICE OF THE CHAIRMAN

University of Delaware
Newark, Delaware 19716-3110
Ph: 302/831-8079 or 831-8155
Fax: 302/831-8201

December 14, 2009

Thomas S. Buchanan, PhD
George W. Laird Professor and Deputy Dean of Engineering
University of Delaware
102 DuPont Hall
Newark, DE 19716

Dear Tom,

The Department of Chemical Engineering has reviewed the proposed biomedical engineering major as defined by the documentation you provided on 12/11/2009 and has voted in approval, by an overwhelming majority of the faculty, of the new major as defined on 12/11/2009 at a regularly scheduled faculty meeting. We agree to support the teaching of **CHEG 404** (Engineering Probability & Statistics) as well as the technical electives **CHEG 620 and 621** (Biochemical Engineering and Metabolic Engineering) as appropriate and needed for the proposed biomedical engineering major.

Sincerely,

A handwritten signature in black ink, appearing to read "Norman Wagner".

Norman Wagner
Chairperson, Chemical Engineering, UD



DEPARTMENT OF
MECHANICAL ENGINEERING

126 Spencer Laboratory
Newark, Delaware 19716-3140
Ph: 302/831-2421
Fax: 302/831-3619
Email: info@me.udel.edu
www.me.udel.edu

December 18, 2009

Thomas S. Buchanan, PhD
Deputy Dean of Engineering
George W. Laird Professor of Mechanical Engineering
University of Delaware
102 DuPont Hall
Newark, DE 19716
302-831-2401

Re: Biomedical Engineering Major in COE

Dear Tom,

I am writing in support of the proposed new undergraduate major in Biomedical Engineering. This program will be an important addition to the undergraduate program in the College of Engineering, broadening the opportunities for our engineering students.

As you know, the Department of Mechanical Engineering has a strong, ongoing effort in biomedical research, including a minor in Biomedical Engineering, with several courses being offered within this field. The course from Mechanical Engineering that you have proposed to include as a required course in the new program (MEEG 483—Orthopaedic Biomechanics) is offered every year in our curricula and it will not cause a problem for us to include the students from the Biomedical Engineering Program in the course. In addition, the technical electives included in the proposed Biomedical Engineering Program from Mechanical Engineering [MEEG 482, 485, and 612 (Clinical Biomechanics, Control of Human Movement, and Biomechanics of Human Movement)] are offered regularly and we would welcome the addition of the biomedical engineering students to these courses.

In all, I am looking forward for the College of Engineering to expand and include a Biomedical Program for undergraduate students and give my strongest support.

Sincerely,

A handwritten signature in black ink, appearing to read "Anette M. Karlsson".

Anette M. Karlsson, PhD
Chairperson
Department of Mechanical Engineering



DEPARTMENT OF MATERIALS
SCIENCE AND ENGINEERING
201 DUPONT HALL

University of Delaware
Newark, Delaware 19716
Ph: 302/831-2062
Fax: 302/831-4545

December 11, 2009

Associate Dean Thomas Buchanan
College of Engineering
The University of Delaware
Newark, DE 19716

Dear Dean Buchanan:

I am writing to express my enthusiasm and support of the new undergraduate degree in Biomedical Engineering that is under consideration at the University of Delaware. This is an important curriculum development that is long overdue on campus, and I look forward to the changes that will result from the formalization of this opportunity.


As you know I came to Delaware because I felt that there was an opportunity for particular growth potential in the area of Biomedical Engineering and its related disciplines. I spent the last nearly 20 years as Professor of Materials Science and Engineering, Macromolecular Science and Engineering, and Biomedical Engineering at the University of Michigan. I have seen first hand the interest and enthusiasm of undergraduate students in working on the interface between engineering and biology. My own research interests are focused on the development of electronically and ionically active tissues for interfacing bionic medical devices with living tissue.

The undergraduate degree in Biomedical Engineering at Delaware will give students the opportunity to obtain a formal education in this area, and will make it possible for us to coordinate the existing courses into a coherent set, as well as to guide future class and degree development. The ability to strengthen ties to the Delaware Biotechnology Institute, build collaborations with local partners, and build up motivated and trained alumni, all give me reason to believe this new major will be useful and successful. I look forward to participating and assisting in making this endeavor valuable in whatever way possible.

Congratulations to you and your committee for the work done to bring this curriculum to its current state of development. I anticipate that our efforts in this area have only just begun, and am looking forward to the opportunity to help create a program

of education and research that will bring additional prestige to the institution. Please let me know how I can continue to be of assistance.

Respectfully,

A handwritten signature in black ink, appearing to read 'DM', with a stylized flourish extending to the right.

David C. Martin, Ph.D.
Karl W. and Renate Böer Professor and Chair
Materials Science and Engineering
The University of Delaware

From: Barner, Kenneth E.
Sent: Tuesday, December 15, 2009 9:47 PM
To: Buchanan, Thomas S.
Cc: Chajes, Michael J.
Subject: RE: Biomedical Engineering major--approval requested

Tom:

I do indeed support the program.

Ken

From: Buchanan, Thomas S.
Sent: Friday, December 11, 2009 12:20 AM
To: Barner, Kenneth E.
Subject: Biomedical Engineering major--approval requested

Dear Ken,

As you know, we are proposing a new undergraduate major in biomedical engineering and I am writing to seek your support in the form of a brief note of approval that we could show to the faculty senate.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research.

We would like all students in this program to take **ELEG 305** (Signals & Systems) and **ELEG 479** (Intro to Medical Imaging Systems).

We would like to be able to list **ELEG 418, 471, and 680** (Digital Control Systems, Mathematical Physiology, and Introduction to Nano & Biophotonics) as Technical Electives.

Initially, the total number of engineering students is not likely to increase due to the new major, but rather the freshman we have in our college will be distributed into 7, as opposed to 6, majors. Over time, we do expect an increase in engineering majors, and at steady state, the biomedical engineering program will have between 50 and 100 students per year.

Documentation about this program (probably more than you might be interested in seeing!) is attached. If you have any questions or concerns, please let me know.

We hope you will support this effort with a positive note before the Christmas break so we can move it to the faculty senate before January 1.

Regards,

Tom

--

Thomas S. Buchanan, PhD
George W. Laird Professor and Deputy Dean of Engineering
University of Delaware
102 DuPont Hall
Newark, DE 19716
302-831-2401

Maccari, Crystal B.

From: Randall Duncan [rduncan@UDel.Edu]
Sent: Tuesday, December 22, 2009 12:45 PM
To: Buchanan, Thomas S.
Subject: RE: Biomedical Engineering major--approval requested

Tom,

I have examined the curriculum of the proposed undergraduate major in Biomedical Engineering. I am excited about the possibilities of such a major and the potential that could result from interactions between our Department and your College. I realize that Biological Sciences is central to the success of this program. The main point of impact for us is in the heavily populated introductory classes, BISC 207/208. This is a concern since we are constrained by time and space available for teaching the class as it is now. However, by extending the days that the lab courses are taught, we should be able to meet the needs of this new program. I am willing to work with our faculty and staff, as well as the administration of the Colleges of Arts and Sciences and Engineering to facilitate these changes. I believe that this program will not only benefit the College of Engineering, but my Department and College as well.

Best regards,
Randy

Randall L. Duncan, Ph.D.
Professor and Chairman
Department of Biological Sciences
University of Delaware
Newark, DE 19716
(Tel) 302.831.4296
(Fax) 302.831.1033

From: Buchanan, Thomas S. [mailto:buchanan@UDel.Edu]
Sent: Thursday, December 10, 2009 11:49 PM
To: Randy Duncan
Subject: Biomedical Engineering major--approval requested

Dear Randy,

We are proposing a new undergraduate major in biomedical engineering and I am writing to inform you of our intention and to seek your support in the form of a brief note of approval that we could show to the faculty senate.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research.

We would like all students in this program to take **BISC 207 and 208**.
We would also like to be able to list **BISC 276** as one of the Technical Electives.

Initially, the total number of engineering students is not likely to increase due to the new major, but rather the freshman we have in our college will be distributed into 7, as opposed to 6, majors. Many of those would have been in the biomedical engineering minor or biochemical engineering minors and would already have planned to take those courses. Over time, we do expect an increase in engineering majors, and at steady state, the biomedical engineering program will have between 50 and 100 students per year.

Documentation about this program (probably more than you might be interested in seeing!) is attached. If you have any

questions or concerns, please let me know.

We have been encouraged to pursue this from our college's external advisory board as well as from President Harker (and our own faculty). We hope you will support this effort with a positive note before the Christmas break so we can move it to the faculty senate before January 1.

Regards,

Tom

--

Thomas S. Buchanan, PhD
George W. Laird Professor and Deputy Dean of Engineering
University of Delaware
102 DuPont Hall
Newark, DE 19716
302-831-2401



BIOMECHANICS AND
MOVEMENT SCIENCE

301 McKinly Lab
University of Delaware
Newark, Delaware 19716-3140
Ph: 302.831.1544
Fax: 302.831.4244

December 22, 2009

Dear Tom,

I am writing to express my support of the undergraduate program in Biomedical Engineering that is being proposed in the College of Engineering. As Director of the Interdisciplinary Program in Biomechanics and Movement Science (BIOMS) I see the development of this undergraduate degree as very positive and I look forward to continued collaboration in educating our students in areas that will enhance the excellence in biomedical research at the University of Delaware.

As you know, the BIOMS program includes many faculty members from the College of Engineering and BIOMS students regularly attend courses offered through Departments in your college. However, relatively few BIOMS PhD students are enrolled in the BIOMS - Rehabilitation Engineering track. The proposed undergraduate program in BME will provide a solid foundation in engineering principles and the biological sciences that will better prepare the engineering students to pursue graduate study in interdisciplinary programs including the PhD in BIOMS.

I am hopeful that the proposed BME courses, along with the development of new BIOMS courses that I plan to initiate, will benefit both engineering and BIOMS students and I look forward to continuing the many collaborations between faculty and Programs in the College of Engineering with the Interdisciplinary Program in Biomechanics and Movement Science as the BME Program grows.

Sincerely,

A handwritten signature in black ink that reads "Katherine Rudolph".

Katherine Rudolph, PhD, PT

Associate Professor, Physical Therapy

Director, Interdisciplinary Program in Biomechanics & Movement Science

Friday, December 18, 2009 3:16 PM

Subject: Re: Biomedical Engineering major--approval requested
Date: Friday, December 18, 2009 12:43 PM
From: David Saunders <saunders@UDel.Edu>
To: Thomas Buchanan <buchanan@admin.udel.edu>
Cc: "Doren, Douglas J." <doren@UDel.Edu>

Dear Tom,

Computer and Information Sciences is pleased to support this initiative for a major in biomedical engineering. We concur that CISC 106 is an appropriate and essential component of this major.

As you observe, the new major per se will not change resource needs for CISC106. Overall growth in engineering freshmen (and science and math students taking CISC106) will. Resource issues can be dealt with in the context of admissions planning.

With best wishes for the new biomedical engineering major, an important and valuable program for UD to offer,

-dave

PS. I remark that the scheduling of CISC 106 for fall of freshman year for all engineers creates a significant imbalance in CIS course needs between spring and fall semesters. It would be helpful if some students could be encouraged to take it in the spring term. This could apply to science and math students and/or some engineering majors.

B. David Saunders, Professor and Chair
Department of Computer and Information Sciences
University of Delaware
302-831-6238

Buchanan, Thomas S. wrote:

> Dear Dave,

>

> We are proposing a new undergraduate major in biomedical engineering and

> I am writing to inform you of our intention and to seek your support in

> the form of a brief note of approval that we could show to the faculty
> senate.
>
> Biomedical engineering is a growing discipline and the aims of this
> program are to provide students with the training necessary to pursue a
> career in medicine, engineering or biomedical research.
>
> We would like all students in this program to take *CISC 106*.
>
> Initially, the total number of engineering students is not likely to
> increase due to the new major, but rather the freshman we have in our
> college will be distributed into 7, as opposed to 6, majors. Since CISC
> 106 is required of all engineering majors, this will not constitute a
> change for your department. Over time, we do expect an increase in
> engineering majors, and at steady state, the biomedical engineering
> program will have between 50 and 100 students per year.
>
> Documentation about this program (probably more than you might be
> interested in seeing!) is attached. If you have any questions or
> concerns, please let me know.
>
> We have been encouraged to pursue this from our college's external
> advisory board as well as from President Harker (and our own faculty).
> We hope you will support this effort with a positive note before the
> Christmas break so we can move it to the faculty senate before January 1.
>
> Regards,
>
> Tom
>
> --
> Thomas S. Buchanan, PhD
> George W. Laird Professor and Deputy Dean of Engineering
> University of Delaware
> 102 DuPont Hall
> Newark, DE 19716
> 302-831-2401

Tuesday, December 15, 2009 12:45 PM

Subject: Re: Biomedical Engineering major--approval requested
Date: Friday, December 11, 2009 2:43 PM
From: schueler@UDel.Edu
To: Thomas Buchanan <buchanan@admin.udel.edu>, <schueler@UDel.Edu>
Cc: Doug Doren <doren@UDel.Edu>

Dear Tom,

I am of course happy to endorse the proposed new biomedical engineering major.

I am also happy to see that Phil 444 will be required. The only possible issue I see is that I doubt that the Philosophy Department will be able to offer that course more than once a year, at least for awhile, given our current faculty and the demand for other courses.

Best wishes,

Fred

G. F. Schueler
Email: schueler@udel.edu
Web Site: <http://udel.edu/~schueler/>

----- Original message -----

>Date: Fri, 11 Dec 2009 00:19:56 -0500
>From: "Buchanan, Thomas S." <buchanan@UDel.Edu>
>Subject: Biomedical Engineering major--approval requested
>To: "schueler@udel.edu" <schueler@UDel.Edu>
>Cc: Doug Doren <doren@UDel.Edu>

>

> Dear Fred,

>

> We are proposing a new undergraduate major in
> biomedical engineering and I am writing to inform
> you of our intention and to seek your support in the
> form of a brief note of approval that we could show
> to the faculty senate.

>

Tuesday, December 15, 2009 12:44 PM

Subject: Re: Biomedical Engineering major--approval requested
Date: Friday, December 11, 2009 10:31 AM
From: Klaus Theopold <theopold@UDel.Edu>
To: Thomas Buchanan <buchanan@admin.udel.edu>
Cc: Doug Doren <doren@UDel.Edu>, John Burmeister <jlburm@UDel.Edu>

Dear Tom,

While I wholeheartedly support the creation of this new major in the abstract, I need to point out some concerns I have about the availability of space in some of the CHEM classes you list. The enrollment in CHEM 321 & 322 is constrained by the organic teaching laboratories available to us. We are currently at capacity, and the addition of 50 - 100 students per year, starting in 2011, will be impossible without the addition of commensurate capacity.

The College of Arts and Sciences is currently exploring options for the renovation of our organic teaching labs (including the addition of much needed fume hoods). Under favorable outcomes of this exercise, we may be able to accommodate your proposed scheme. However, at this point I cannot guarantee the latter, nor do I know whether any renovations will be completed in time for your current plans to work.

I regret having to be circumspect - given the necessary facilities we would of course welcome the Biomedical Engineering majors.

Regards, Klaus

On Dec 10, 2009, at 11:57 PM, Buchanan, Thomas S. wrote:

Dear Klaus,

We are proposing a new undergraduate major in biomedical engineering and I am writing to inform you of our intention and to seek your support in the form of a brief note of approval that we could show to the faculty senate.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research.

We would like all students in this program to take **CHEM 103, 104, 321, 322 and 527.**

We would also like to be able to list **CHEM 443** as one of the Technical Electives.

Monday, December 21, 2009 1:42 PM

Subject: RE: Biomedical Engineering major--approval requested
Date: Tuesday, December 15, 2009 1:37 PM
From: Kinservik, Matthew <matthewk@english.udel.edu>
To: Thomas Buchanan <buchanan@admin.udel.edu>

Dear Tom,

Thanks for the note. I will be happy to write a note of support for this. Who should I address that note to? And should I send it to you?

All good wishes,
Matt

Matthew J. Kinservik
Professor and Chair
Department of English
University of Delaware
Newark, DE 19716
302-831-3351

From: Buchanan, Thomas S. [mailto:buchanan@UDel.Edu]
Sent: Friday, December 11, 2009 12:19 AM
To: matthewk@udel.edu
Cc: Doug Doren
Subject: Biomedical Engineering major--approval requested

Dear Matt,

We are proposing a new undergraduate major in biomedical engineering and I am writing to inform you of our intention and to seek your support in the form of a brief note of approval that we could show to the faculty senate.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research.

We would like all students in this program to take **ENGL 110** (Critical Reading and Writing).

Initially, the total number of engineering students is not likely to increase due to the new

major, but rather the freshman we have in our college will be distributed into 7, as opposed to 6, majors. Over time, we do expect an increase in engineering majors, and at steady state, the biomedical engineering program will have between 50 and 100 students per year.

Documentation about this program (probably more than you might be interested in seeing!) is attached. If you have any questions or concerns, please let me know.

We have been encouraged to pursue this from our college's external advisory board as well as from President Harker (and our own faculty). We hope you will support this effort with a positive note before the Christmas break so we can move it to the faculty senate before January 1.

Regards,

Tom

--

Thomas S. Buchanan, PhD
George W. Laird Professor and Deputy Dean of Engineering
University of Delaware
102 DuPont Hall
Newark, DE 19716
302-831-2401

Maccari, Crystal B.

From: Peter Monk [monk@math.udel.edu]
Sent: Friday, December 18, 2009 5:05 PM
To: Buchanan, Thomas S
Subject: Re: Biomedical Engineering major--approval requested

Hi Tom

Thats great about MATH35X and will make your life easier. CE majors take MATH 351 + MATH353 and ME take MATH351/2/3 so this way majors from either program will be able to transfer in.

I am waiting for word from Doug. I sent him an e-mail and I presumed he would respond in time. I'll pulse him and answer on Monday.

Do you think the following is a problem: MATH305 is for ChE only at present so the lab portion is heavily ChE (the math part is pretty generic) and is taught by one of their faculty. I think that your going with MATH305 will need an extra lecture and so someone (your program? ChE?) will need to provide a person to teach the lab (we will, of course, teach the math lecture part for both). Who would provide the teacher? Would we modify the course to have some sort of material relevant to your program for one lecture and for ChE for the other, or would you be happy with ChE content? In any case we will have (ultimately) to involve ChE if there are to be changes. I don't view any of this as difficult to solve, but it might be worth clarifying expectations?

Peter

On Dec 18, 2009, at 3:36 PM, Buchanan, Thomas S. wrote:

Peter,

I have chatted with folks here and think we could go with MATH351 + either MATH352 or MATH352 .

Have you had a chance to chat about staffing? We would like to move forward on this and need to put together the proposal before break.

Tom

On 12/16/09 10:21 AM, "Peter Monk" <monk@math.udel.edu> wrote:

Tom

Why not require MATH351 and MATH353 (i.e. not MATH352) or perhaps still MATH351 and either MATH352 or MATH353. The closest match to MATH351+MATH353 so if you want transfers to be similarly trained as students in the major, this offers the best hope. Note that typical students take MATH351 in the fall of their sophomore year, and MATH352/353 in the spring, so with choice is a sequence.

I am talking to Doug about staffing and will get back to you today.

Peter

On Dec 15, 2009, at 2:30 PM, Buchanan, Thomas S. wrote:

Peter,

Thanks for getting back to me. I know Mechanical Engineering students take the 351/352/353 sequence, but the committee felt that a two semester sequence more like what Civil or Electrical Engineering students take (i.e., 351/352) might be an adequate (optional) upgrade from the Chemical Engineering orientated single course (305). I could be wrong, but I don't think the folks here will be excited about a 3-course sequence.

Tom

On 12/15/09 1:33 PM, "Peter Monk" <monk@math.udel.edu> wrote:

Tom

Sorry about this. I will try to get you a response tomorrow. Would you consider adding MATH353 to the advanced options (math305 has a matlab component and this is not covered in 351/352).

Peter

On Dec 15, 2009, at 12:58 PM, Buchanan, Thomas S. wrote:

Dear Peter,

We haven't heard back from you on this. Do you have any questions or concerns?

Regards,

Tom

On 12/11/09 12:20 AM, "Tom Buchanan" <buchanan@udel.edu> wrote:

Dear Peter,

We are proposing a new undergraduate major in biomedical engineering and I am writing to inform you of our intention and to seek your support in the form of a brief note of approval that we could show to the faculty senate.

Biomedical engineering is a growing discipline and the aims of this program are to provide students with the training necessary to pursue a career in medicine, engineering or biomedical research.

We would like all students in this program to take **MATH 241, 242, 243, and 305**.

We would also like to be able to list **MATH 351 and 352** as advanced options instead of MATH 305

Initially, the total number of engineering students is not likely to increase due to the new major, but rather the freshman we have in our college will be distributed into 7, as opposed to 6, majors. Since math is required of all engineering majors, this will not constitute a major change for your department. Over time, we do expect an increase in engineering majors, and at steady state, the biomedical engineering program will have between 50 and 100 students per year.

Documentation about this program (probably more than you might be interested in seeing!) is attached. If you have any questions or concerns, please let me know.

We have been encouraged to pursue this from our college's external advisory board as well as from President Harker (and our own faculty). We hope you will support this effort with a positive note before the Christmas break so we can move it to the faculty senate before January 1.

Regards,

Tom

Tuesday, December 22, 2009 1:11 PM

Subject: Biomedical Engineering Major

Date: Monday, December 14, 2009 4:08 PM

From: hadji <hadji@UDel.Edu>

To: Thomas Buchanan <buchanan@admin.udel.edu>

Cc: Norbert Mulders <mulders@UDel.Edu>

Dear Thomas,

Physics and Astronomy approves and supports the new undergraduate major in biomedical engineering and the use of PHYS207 and PHYS208 in the BMEG sophomore year curriculum. The Physics UG Program Director will make adjustments upward to course limits to accommodate the approximately 20 biomedical engineering students per year who will need to take both of these courses. We have noted the increase in PHYS207 course demand over the past five years, from 411 in 06-07 to 568 registrations last year 08-09. It is necessary that we appropriately spread out the semester demand, so having PHYS207 as a fall curriculum choice is beneficial for us in use of space and lab times. Spring semester PHYS207 lab time slots are quite full throughout the week at this point.

Again, Physics will provide the PHYS207, PHYS208 course support necessary for this new UG major, and I wish the College much success with the growth of the new biomedical engineering major beginning in AY2010-2011.

Best regards,

George