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. Detailed instructions for the proposal should be followed. A <u>checklist</u> is available to assist in the preparation of a proposal. For more information, call the Faculty Senate Office at 831-2921.

Submitted by: _Dawn M Elliott	phone number_x1295
Department: Biomedical Engineering Program	email address_delliott@udel.edu
Date: _11/1/2014	
Action: _Request for Permanent Status	inor/concentration, revise permanent status, policy change, etc.)
Effective term_15F(use format 04F, 05W)	
Current degreeBBE – Bachelor in Biomedical Engine (Example: BA, BACH, BACJ, HBA, EDD, MA	, MBA, etc.)
Proposed change leads to the degree of:BBE – Bachel (Example: BA, BAC	or in Biomedical Engineering CH, BACJ, HBA, EDD, MA, MBA, etc.)
Proposed name:not applicable Proposed new name for revised or new major / mino (if applicable)	or / concentration / academic unit
Revising or Deleting:	
Undergraduate major / Concentration:(Example: Applied M	Music – Instrumental degree BMAS)
Undergraduate minor: (Example: African Studies, Business A	dministration, English, Leadership, etc.)
Graduate Program Policy statement change:(Must attach	your Graduate Program Policy Statement)
Graduate Program of Study:	your Graduate Program Poncy Statement)
(Example: Animal Science: MS Animal Science:]	PHD Economics: MA Economics: PHD)
Graduate minor / concentration:	
Note: all graduate studies proposals must include an electrogram Policy Document, either describing the new pr made to the original policy document.	ctronic copy of the Graduate ogram or highlighting the changes

List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)? (Be aware that approval of the curriculum is dependent upon these courses successfully passing through

the **Course Challenge** list. If there are no new courses enter "None")

No new or revised curriculum is part of this Request for Permanent Status. The current curriculum in this document is approved and independently stands for this review. Note, however, as part of the Program assessment and continuous improvement, we will be submitting a <u>separate</u> Form for Revising the current curriculum this academic year.

Supply support letter from the Library, Dean, and/or Department Chair if needed (all new majors/minors will need a support letter from the appropriate administrator.)

Dean and Department Chair letter are provided in the pages immediately after this Form.

Supply a resolution for all new majors/programs; name changes of colleges, departments, degrees; transfer of departments from one college to another; creation of new departments; requests for permanent status. See example of resolutions.

Attached.

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

The BME program's curriculum supports the 10 general education goals of the University. Specifically, students are required to learn how to write reports effectively (GOAL 1), think critically and solve problems (GOAL 2), as that is an important part of engineering, and work independently and work in teams (GOAL 3). They are taught ethical behavior as part of BMEG101 and PHIL444 (GOAL 4), understand diverse thinking throughout their breadth requirements (GOAL 5), and are encouraged to expand their intellectual curiosity to other fields through open-ended projects (GOAL 6). The senior design capstone experience integrates the student knowledge with experiences that extend the boundaries of the classroom and expands understanding and appreciation for human creativity (GOAL 7 and 8). The field of biomedical engineering and our educational approach, which applies engineering principles to the study of biology, medicine, and health, requires an understanding of the US society and the global society, as it is within these diverse cultures and societies that different health issues arise (GOAL 9 and 10).

Identify other units affected by the proposed changes:

(This would include other departments/units whose courses are a required part of the proposed curriculum. Attach permission from the affected units. If no other unit is affected, enter "None")

Support letters from the following units are included in Appendices Section G-6.

Deans	
College of Agriculture and Natural Resources	Mark Rieger
College of Arts and Sciences	George Watson
Alfred Lerner College of Business and Economics	Bruce Webber
College of Earth, Ocean, and Environment	Nancy Targett
College of Education and Human Development	Lynn Okagaki
College of Health Sciences	Kathy Matt
Department Chairs – College of Engineering	
Chemical & Biomolecular Engineering	Abraham Lenhoff
Civil & Environmental Engineering	Tripp Shenton
Computer & Information Sciences	Errol Lloyd
Electrical & Computer Engineering	Ken Barner
Materials Science & Engineering	Darrin Pochan
Mechanical Engineering	Suresh Advani

Department Chairs – Outside College of Engineering

Applied Economics and Statistics Titus Awokuse **Biological Sciences** Robin Morgan Chemistry & Biochemistry Murray Johnston Kinesiology & Applied Physiology William Farquhar Mathematical Sciences John Pelesko Medical Laboratory Sciences Michele Parent Philosophy Kai Draper Physics & Astronomy Edmund Nowak Psychology Robert Simons

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

(Explain your reasons for creating, revising, or deleting the curriculum or program.)

No program changes are proposed with this Request for Permanent Status. As described in the initial provisional program proposal, and as held true through the experiences of the last four years, there is tremendous student interest in the bachelor's degree in biomedical engineering. These are detailed within the self-study.

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.) See example of side by side.

The curriculum as it currently appears in the Course Catalog is provided in the self study section F-1-d.

ROUTING AND AUTHORIZATIO	ON: (Please do not remove supp	orting documentation.)
Department Chairperson	Ethy	Date 11/1/2014
Dean of College tynck og	maule	_Date_ 11/15/2014.
(By signing above, the Dean confirms that their co	llege policies and bylaws have been for	ollowed correctly during
The approval actions that were taken at the college	level were (check all that apply)	
college faculty vote;	college curriculum approval	college senate approval
Chairperson, College Curriculum Committee_//	angluf Suther	Date_ 11/14/2014
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
RegistrarI	Program Code	_Date
Vice Provost for Academic Affairs & International	Programs	_Date
Board of Trustee Notification		_Date

Revised 10/27/2014/khs



College of Engineering OFFICE OF THE DEAN 102 du Pont Hall Newark, DE 19716-3101 Phone: 302-831-2401 Fax: 302-831-8179

TO: University of Delaware Faculty Senate

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FROM: Babatunde Ogunnaike, Dean, College of Engineering

DATE: November 17, 2014

RE: Creation of a Permanent Academic Program: Bachelor of Biomedical Engineering (BBE)

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

For several years before our proposed and approved provisional BBE program started, our college's External Advisory Council recommended that we establish a new program in biomedical engineering. From its inception, our provisionally approved program has enjoyed strong demand and remarkable success, thereby confirming the viability of this program offering. Furthermore, we recently hosted an evaluation team from the Accreditation Board for Engineering and Technology (ABET); and even though the final official report is not due until later next year, the initial report was very favorable and our overall program was well received. In step with national and global trends, our college research enterprise also continues to be increasingly biological in content. In the departments of Chemical & Bimolecular Engineering, Electrical Engineering, Mechanical Engineering and Materials Science & Engineering, roughly 40% of the aggregated funded research portfolio involves bioengineering in one form or another.

Virtually all nationally recognized engineering colleges offer degrees in bioengineering or biomedical engineering. This major has recently become one of the most popular among students interested in engineering, being especially popular with those interested in biomedical research-based and allied health graduate degrees, or those bound for medical school. Locally, at our UD recruiting events, we continue to see an increasing number of high school students (especially women) who show great interest in biomedical engineering, many of whom have the strongest credentials in the prospective student population. We believe that the absence of a permanent undergraduate degree program in biomedical engineering will affect our ability to recruit the best students to the University of Delaware in Engineering. Given the ever growing list of new initiatives in health sciences at the University of Delaware, a permanent degree offering of this type is critical for our College and Campus as a whole. It is my opinion that approval of this permanent program proposal will be an important factor in our College's national recognition, and in our success in forging new relationships with partners in the Delaware Health Sciences Alliance and beyond.

The faculty of the college discussed this proposed permanent program at a regular college faculty meeting. We had a subsequent vote and it was strongly approved by the faculty via mail ballot on November 13, 2014. I support this proposed permanent program: it is well-conceived and the original plans have been executed excellently to date. I am convinced that it has all the attributes needed to make it a success and to become another spire of excellence in the College. I therefore give this program my strongest possible recommendation for approval by the faulty senate.



102 du Pont Hall Newark, DE 19716-3101 Phone: 302-831-2401 Fax: 302-831-8179

TO:	Engineering Faculty
FROM:	Michael L. Vaughan, Associate Dean, Academic Affairs College of Engineering

DATE: November 17, 2014

SUBJECT: Results of Voting Ballot BBE Major Proposals

On November 10, 2014, the discussion information (slides presented at the 2014 Fall Faculty Meeting) for a proposed permanent status for Bachelor of Biomedical Engineering (BBE) and departmental formation of Biomedical Engineering along with a ballot were sent to the voting faculty of the College by Dean Tunde Ogunnaike. The votes were collected on the close date of November 13, 2014 by Crystal Maccari, Administrative Specialist to the Dean, and the results are as follows:

- 1. Be it resolved that the College of Engineering supports the permanent status proposal of the Bachelor of Biomedical Engineering Program (BBE)
 - For:79Against:0Abstain:1Non Votes:50
- 2. Be it resolved that the College of Engineering supports the departmental formation proposal of the Biomedical Engineering Program

For:	77
Against:	0
Abstain:	3
Non Votes:	50

Therefore, the resolutions have passed by a majority vote of the Engineering Faculty (consistent with the College By-laws).



College of Engineering DEPARTMENT OF BIOMEDICAL ENGINEERING 161 Colburn Lab Newark, DE 19716 Phone: 302-831-6234 Email: bmeg-info@udel.edu

November 7, 2014

Dear Dr. Ogunnaike:

The biomedical engineering faculty and I strongly support granting permanent status to the **Bachelor in Biomedical Engineering** major. Our faculty vote was unanimous with 12 out of 12 in support of permanent status.

BME enrollment has quickly grown to full capacity, now at 220 total students, since the major was provisionally launched in fall of 2010. The BME program consistently attracts some of the top students to the University: the matriculating students in Fall 2014 had an incoming average 2032 SAT, 3.91 GPA, and 93rd percentile in their high school ranking. Of these students, 49% are female and 33% are in the Honors Program.

The first five graduates were in January 2014 and the inaugural class graduated in May 2014 for a total 44 BME alumni. We have successfully identified post-graduation activities for 32 of these graduates: 61% are employed and the remaining 39% are equally divided between masters programs, doctoral programs, and medical school. Indeed, both our experience and the national trends for the BME major confirm that it is extremely popular, likely due to a combination of the excellent job outlook (CNN Money has ranked biomedical engineering first in Best Jobs for the last two years) and the personal satisfaction of a career that applies engineering to improve human health.

Biomedical Engineering also contributes to the University's emphasis on interdisciplinary programs. In addition to 7 primary faculty, over 55 affiliated, secondary, or joint faculty from 13 departments, 3 UD colleges, and 3 external hospitals or institutes participate in the program. Interdisciplinary opportunities are strong and growing across the university and region. For example, during the winter session Clinical Immersion course, over 40 BME undergraduates have identified unmet clinical needs at multiple sites in the Delaware Health Science Alliance; and, during 2014 Summer Scholars program, the 21 BME student Scholars were engaged with faculty from nine departments across three colleges.

In sum, the outstanding students and strong educational program leading to the Biomedical Engineering bachelor's degree has produced a successful program over the five-year probationary period. The program has met or exceeded our milestones, including being on-track for ABET accreditation. I strongly support granting permanent status to the Bachelor in Biomedical Engineering major.

Best regards,

Dawn Elliott, PhD Professor and Director Biomedical Engineering

B. Copy of the Faculty Senate resolution granting provisional status

Recommendation from the Faculty Senate Committee on Undergraduate Studies (Beth Morling, Chair) with the concurrence of the Coordinating Committee on Education (John Madsen, Chair) and the Executive Committee (Cihan Cobanoglu, Chair) for the request to add a new degree Bachelor of Biomedical Engineering (BBE) with a major in Biomedical Engineering (attachment) (revised email attachment) (resolution doc 3-5-10) <u>APPROVED</u>

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," and

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,", and

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, and

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, and

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, and

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, and

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 Allience, be it therefore

Resolved, that the Faculty Senate approves provisionally, for five years, the establishment of a new Bachelor of Biomedical Engineering (BBE) degree with a major in Biomedical Engineering, effective September 1, 2010.

F. Self Study Report For Permanent Approval of the Provisional Bachelor's Degree in Biomedical Engineering

1. General information about the program

Executive Summary

The Biomedical Engineering (BME) program at the University of Delaware was launched in fall 2010. Enrollment quickly grew to full capacity, now 55 students per class and 220 total students. Applications to BME have risen each year, with 763 applicants in 2014, of which 224 were admitted and 46 matriculated. The program consistently attracts some of the most highly qualified freshmen to the University: the matriculating students in Fall 2014 had an incoming average 2032 SAT, 3.91 GPA, and 93rd percentile in their high school ranking. Of these 2014 matriculating students, 49% are female, 33% are enrolled in the Honors Program, and 44% are Delaware residents. Since 2011, 20% of matriculants have transferred out of BME, most moved into other programs in engineering, arts and sciences, or health sciences; only 4% have left the university. When these seats open, students who wish to change major into BME immediately fill the seat, keeping BME enrollment at capacity. This popularity of the BME major is likely a combination of the excellent job outlook (CNN Money has ranked biomedical engineering first in Best Jobs for the last two years) and the personal satisfaction of a career that applies engineering to improve human health.

Now in its fifth year, the BME faculty consists of 7 primary faculty and 5 joint faculty who have significant documented BME workload. Additionally, over 50 affiliated, secondary, or joint faculty from 13 departments, 3 UD colleges, and 3 external hospitals or institutes participate in the program. Interdisciplinary opportunities are strong and growing across the university and region. For example, over 40 BME undergraduates have identified unmet clinical needs at multiple sites in the Delaware Health Science Alliance during a winter session immersion course, and the 21 BME students in the 2014 Summer Scholars were engaged with faculty from nine departments across three colleges. The first five graduates were in January 2014 and the inaugural class graduated in May 2014 for a total 44 BME alumni. We have successfully identified post-graduation activities for 31 of these graduates: 61% are employed and the remaining 39% are equally divided between masters programs, doctoral programs, and medical school. In sum, the outstanding students and strong educational program leading to the Biomedical Engineering bachelor's degree has produced a successful program over the five-year probationary period.

1-a. Brief introduction and history of the program - include dates *History*

A Biomedical Engineering concentration was first introduced by the Mechanical Engineering department in 2002. Because of growing interest, the Biomedical Engineering concentration became a Minor and was opened to other majors across the campus in 2007. With the increasing demand, the Biomedical Engineering (BME) program was created by a BME Task Force

Committee consisting of faculty from five departments (Chemical, Civil, Electrical, Materials Science, and Mechanical Engineering) in the College of Engineering. During the two planning years 2008-2009, the committee spent the first year evaluating the need for such a program and exploring if the University of Delaware had the resources to establish an undergraduate degree program in biomedical engineering. Demand for a program in biomedical engineering at the University of Delaware was evident through (a) increased enrollment in the biomedical engineering minor (maintained through Mechanical Engineering), (b) longstanding expertise of biomechanics, biomaterials and biochemical engineering faculty, which carried over to content in courses offered, (c) requests from parents of prospective students at recruitment events, and (d) a survey conducted in EGGG 101 Introduction to Engineering (required of all engineering freshmen). The second year was spent planning the curriculum by examining the curricula at the top ten ranked biomedical engineering programs according to *US News & World Report*.

In December 2009 the Engineering faculty voted to approve the creation of a bachelor's degree in Biomedical Engineering and the Academic Program Approval Form and proposal was submitted to the faculty senate. The faculty senate provisionally approved the new Bachelors in Biomedical Engineering (BBE) in January 2010.

The Biomedical Engineering program at the University of Delaware was officially launched in Fall 2010. During new student orientation, 18 students declared BME as a major. The enrollment grew to full capacity (50) within the first year through the change of major process. BME has maintained its status as a restricted major with capacity now set at 55 students per class.

Date	Milestone
2008–2009	BME Task Force committee meetings; College of Engineering vote in favor of Biomedical Engineering undergraduate program; Proposal submitted to faculty senate
January 2010	Proposal approved by faculty senate
Spring 2010	University of Delaware Board of Trustees approves BME program
Fall 2010	BME Program began with 18 students enrolled. Increased to 50 students by end of year.
Fall 2011	104 students enrolled – BME program at full capacity; Dawn Elliott hired as Program Director.
Spring 2012	BME Graduate program approved; BMEG 101 "Introduction to Biomedical Engineering" offered as optional course
Fall 2012	151 undergraduate students enrolled – BME program remains at full capacity. BME seminar series begins; first External Advisory Council meeting; 6 doctoral graduate students admitted. Anita Singh hired as temporary teaching faculty.
Winter 2013	Clinical immersion course offered as a technical elective that continues each Winter terms since.
Spring 2013	Capacity increased to 55 students per class

Timeline of BME Program Development

Fall 2013	206 undergraduate students and 15 doctoral graduate students enrolled – BME program remains at full capacity. BMEG 101 required as FYE course for majors; Three new full-time Tenure-Track Assistant Professors hired: Christopher Price, Emily Day, John Slater; Jean Stephens hired as temporary teaching faculty. Annual External Advisory Council meeting; First 5 seniors graduated (ahead of the inaugural class in May 2014 due to transfer into BME after completing one to two years in another major).
Spring 2014	First 44 bachelor degrees in BME (39 graduates in May 2014 plus 5 from Fall 2013)
Fall 2014	ABET evaluation visit. One new tenure-track Assistant Professor hired: Jason Gleghorn. One new Assistant Professor of Instruction hired: Jean Stephens.

1-b. Explain how the program is compatible with the academic priorities of the University.

The BME 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 University of Delaware 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." When compared to the national landscape of engineering colleges as ranked by US News and World Reports, all but two of the top 35 undergraduate engineering colleges have a Biomedical Engineering undergraduate program (Princeton and University of California Santa Barbara do not). It is expected for a world-class engineering college to offer a biomedical engineering degree.

1-c. Explain how the program will help students meet the general education requirements of the University, specifically the ten (10) general education goals for undergraduate education (please note that this section applies only to undergraduate programs).

The BME program is undergoing external accreditation by ABET (Accreditation Board for Engineering and Technology) during which we assess 11 "Student Outcomes" a-k (see assessment section). These Student Outcomes map onto the 10 general education goals of the University. Specifically, students are required to learn how to write reports effectively (GOAL 1), think critically and solve problems (GOAL 2), as that is an important part of engineering, and work independently and work in teams (GOAL 3). They are taught ethical behavior as part of BMEG101 and PHIL444 (GOAL 4), understand diverse thinking throughout their breadth requirements (GOAL 5), and are encouraged to expand their intellectual curiosity to other fields through open-ended projects (GOAL 6). The senior design capstone experience integrates the student knowledge with experiences that extend the boundaries of the classroom and expands understanding and appreciation for human creativity (GOAL 7 and 8). The field of biomedical engineering and our educational approach, which applies engineering principles to the study of biology, medicine, and health, requires an understanding of the US society and the global society, as it is within these diverse cultures and societies that different health issues arise (GOAL 9 and 10).

1-d. Curricular requirements, including fulfillment of University, college and departmental requirements.

The Bachelor of Biomedical Engineering degree program requires 126 credit hours. The student plan of study is provided in Table below.

Freshman – Fall			Freshman – Spring		
Course	Description	Credits	Course	Description	Credits
MATH 241	Analytical Geom & Calc A	4	MATH 242	Analytical Geom & Calc B	4
CHEM 103	General Chemistry I	4	CHEM 104	General Chemistry II	4
CISC 106	Computer Science for Eng	3	BISC 207	Introductory Biology I	4
BMEG 101	Introduction to Biomedical Eng	2	ENGL 110	Critical Reading & Writing	3
	Breadth 1	3			
		16			15
Sophomore	- Fall		Sophomore	– Spring	
MATH 243	Analytical Geom & Calc C	4	MATH 305	Applied Math for BME and CBE	3
CHEM 321	Organic Chemistry I	4	CHEM 322	Organic Chemistry II	4
BISC 208	Introductory Biology II	4	ELEG 305	Signals & Systems	3
PHYS 207	Fundamentals of Physics I	4	PHYS208	Fundamentals of Physics II	4
				Breadth 2	3
		16			17
Junior - Fal	I		Junior - Spring		
MSEG 302	Materials Science for Engineers	3	BMEG 320	Biological Transport Phenomena	3
BMEG 310	Bioengineering Mechanics I	4	BMEG 311	Bioengineering Mechanics II	3
CHEM 527	Introduction to Biochemistry	3	CHEG 404	Engineering Prob & Statistics	3
BMEG 401	Systems Physiology I	3	BMEG 402	Systems Physiology II	3
	Technical Elective 1	3	BMEG 330	Biomedical Instrumentation	4
		16			16
Senior - Fall			Senior - Spri	ng	
BMEG 450	Biomedical Engineering Design	6	PHIL 444	Medical Ethics	3
MSEG 460	Biomaterials & Tissue Engr	3	BMEG 479	Intro to Medical Imaging	3
	Breadth 3	3		Technical Elective 2	3
	Breadth 4	3		Technical Elective 3	3
				Breadth 5	3
		15			15
			Total Credit	s: 126	

BME Curriculum, course catalog effective 2014-15 Academic Year

Math and Basic Science

The first year establishes fundamental background in basic science and mathematics. The second year continues building a biology, chemistry and physics foundation plus applied mathematics. In the third year students take biochemistry.

Engineering

The first year engineering course is an introduction to biomedical engineering (BMEG 101). BMEG 101 satisfies First Year Experience (FYE) requirements to prepare students to succeed at the University. BMEG 101 enables the students in biomedical engineering to establish a sense of community among their peers and better understand the diverse nature of biomedical engineering and be initiated in the design process, teamwork, and oral presentation. Another first year engineering topic course is computer science for engineers (CISC 106, taken by all freshmen in the College of Engineering). The second year includes the engineering course ELEG 305, which is the study of electrical signals and systems, with an emphasis on time and frequency characterization of linear, time-invariant systems.

With a solid background in basic sciences and engineering, in the third and fourth year the students are exposed to the technical engineering content relevant to biomedical applications. In the third year, students take materials science and engineering, bioengineering mechanics (including fundamentals of statics, dynamics and solid mechanics), systems physiology, biomedical instrumentation, biotransport and statistics. As part of the bioengineering mechanics sequence, student teams complete a common design project culminating in a formal presentation. During the fourth year, students participate in the capstone senior design experience. Courses in tissue engineering and medical imaging are also required in senior year.

The capstone senior design course in BME is BMEG 450 Biomedical Engineering Design, a six credit senior-level course in the fall. BMEG 450 is jointly offered with the senior design program in mechanical engineering (MEEG 401). There are numerous benefits to this combined senior design experience. Students have benefited from the history and network opportunities provided by the successful mechanical engineering program that recruits multiple industry sponsored projects. Building on prior experience, teams of 4-5 students are expected to complete functional prototypes and professional presentations for their project sponsors during the semester. Teams are multidisciplinary and mostly involve students from biomedical and mechanical engineering. In some instances, we have added electrical engineering students to the teams as appropriate for the project.

Technical electives are taken during the third and fourth year to provide the students with an opportunity to pursue areas of particular interest. In addition, the students are encouraged to work directly with faculty through research and independent study. Because of the wide range of technical areas in which biomedical engineers work, the approved list of technical electives includes upper level courses across departments. The approved technical electives from the 2014-15 UD Catalog are:

Students must take 9 credits of technical electives from the approved list in the course catalog.

Within the College of Engineering (must include 6 credits):

BMEG 350, BMEG 400-699. except BMEG 401, BMEG 402, BMEG 450 and BMEG 479 CHEG 325, CHEG 326, CHEG 400-699. except CHEG 404 and CHEG 595 CIEG 301, CIEG 302, CIEG 305, CIEG 311, CIEG 331, CIEG 351, CIEG 400-699 CISC 181, CISC 220, CISC 260, CISC 275, CISC 280, CISC 303, CISC 304, CISC 310, CISC 320, CISC 360, CISC 361, CISC 400-699 CPEG 202, CPEG 222, CPEG 400-699 ELEG 306, ELEG 320, ELEG 400-699, except ELEG 479 MSEG 400-699. except MSEG 420, MSEG 425, MSEG 443 MEEG 300-699. except MEEG 483

Outside the College of Engineering:

BISC 400-699 CHEM 400-699. except CHEM 527 KAAP 220, KAAP 309, KAAP 428, KAAP 430 MATH 351, MATH352, MATH 353, MATH 389, MATH 400-699 MEDT 360, MEDT 390, MEDT 401, MEDT 403, MEDT 406 NSCI 320 PHYS 309, PHYS 310, PHYS 313, PHYS 400-699 STAT 400-699 UNIV 401, UNIV 402 (Thesis topic must be approved by academic advisor)

General Education

General education is achieved through ENGL 110: Critical Reading and Writing in the first year and PHIL 444: Medical Ethics in the fourth year (which also fulfills an upper level breadth requirement). Additionally, students take their breadth requirements to achieve breadth of knowledge across diverse fields and perspectives. The Biomedical Engineering Program does not add additional requirements above those stipulated by the University and the College of Engineering.

1-e. Results of assessments or evaluations regarding the quality of the program - must indicate policies and procedures, how the assessment was used, and how the program changed because of it. What has the program accomplished in order to enhance assessment, particularly focusing on student learning outcomes?

Summary of Assessment Process

The Biomedical Engineering Program at the University of Delaware has a comprehensive assessment, evaluation, and continuous improvement process that was developed and implemented as part of the ABET accreditation process. The aim of this process is to satisfy the program educational objectives and meet and improve performance of student outcomes. To achieve this goal, we have determined the following **Program Educational Objectives (PEOs)** to prepare our graduating students for the following professional and career accomplishments:

- 1. Professional employment in biomedical industries such as medical devices, imaging, biotechnology, biopharma, and other health and life science related industries.
- 2. Entry and completion of advanced studies, including graduate programs in biomedical engineering or related engineering and life sciences, medicine, law, business, or other professional programs.
- 3. Careers where they can make positive and ethical contributions to the biomedical field while actively seeking to provide technical, educational, public sector and/or business services and leadership.

We established these PEOs based on multiple inputs from the institutional mission and goals, our external constituency, and our internal constituency (Figure 1). We assess and modify our PEOs through the Program Improvement and Student Outcomes Improvement Loops (Figure 1). Our Student Outcomes help meet our PEOs. We assess and evaluate Student Outcomes using several direct and indirect assessment tools. The data obtained from the assessment tools are used to measure the level of performance achieved. Outcomes below the expected level are evaluated for improvement. The improvements



Figure 1: Continuous Improvement process in the UD BME program

are integrated and reassessed using the same process.

In brief, our assessments demonstrate that we not only meet, but also exceed our student outcome expectations. Moreover, as part of our continuous improvement process, we have implemented changes each year, formally, through the course approval process, and informally, through course content and delivery improvements. An abbreviated version of the Assessment Process, Results from the Assessment Process, and Continuous Improvement Process, taken from the ABET report, are provided in the sections below. The full document and extensive supporting materials are available upon request.

Assessment Processes and Results of Assessment

The BME program employs both direct and indirect assessment tools to assess student outcomes. Student Performance from course elements (e.g., quizzes, exams, reports, homeworks) are direct assessments that serve as learning indicators. We employ surveys as indirect assessments. The graduate exit survey relates to plans after graduation and satisfaction with student outcomes.

Student Performance

All the Biomedical Engineering Student Outcomes (ABET a through k, see Table) are met by at least three required courses and are assessed and evaluated every three years upon the completion of each course. Faculty instructors for these BME courses submit a Course Initiation form at the beginning of the semester and a Course Completion and Assessment form at the end of the semester. The faculty also submitted summary evidence for specific outcomes assigned to that course at the end of the semester. Student evidence is collected to support the specific course element used for the outcome assessment. Additionally, the instructor presents the course goals and outcomes in a regularly scheduled faculty meeting after the term that the course was offered. Successful achievement for a particular student outcome should be an average ≥ 3 (in the 1–5 scale) in at least 80% of students.

Student Outcomes	Course 1	Course 2	Course 3
a: Math & Science: an ability to apply knowledge of mathematics, science, and engineering	BMEG 320	BMEG 402	BMEG 479
b: Experiment: an ability to design and conduct experiments, as well as to analyze and interpret data	BMEG 310	BMEG 330	BMEG 367
c: Design: an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	BMEG 311	BMEG 450	BMEG 101
d: Teams: an ability to function on multidisciplinary teams	BMEG 311	BMEG 367	MSEG 460
e: Formulate & Solve: an ability to identify, formulate, and solve engineering problems	BMEG 320	BMEG 479	MSEG 460
f: Ethics & Professional Responsibility: an understanding of professional and ethical responsibility	BMEG 367	BMEG 402	BMEG 101
g: Communication: an ability to communicate effectively	BMEG 310	MSEG 460	BMEG 450
h: Broad Education: the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	BMEG 401	BMEG 402	BMEG 101

Courses and Student Outcomes (a-k)

i: Life Long Learning: a recognition of the need for, and an ability to engage in life long learning	BMEG 330	BMEG 401	BMEG 450
j: Contemporary Issues: a knowledge of contemporary issues	BMEG 320	BMEG 401	BMEG 311
k: Modern Tools: an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	BMEG 310	BMEG 330	BMEG 479

Examples of direct student evidence for a course for Student Outcomes a, b, and c are shown below. Similar elements for all a-k Student Outcomes were measured for three courses per Outcome.

Outcome a: An ability to apply knowledge of mathematics, science and engineering. Course
used was BMEG 402 (System Physiology II). Specific element used was Final exam Problem 2.

Course	Element	Outcome (1–5 Scale)	% of Students with ≥3
BMEG 402	Final Exam: Problem 2	Ave =3.35, Max = 5, Min = 0	90%

Outcome b: An ability to design and conduct experiments, as well as to analyze and interpret data. Course used was BMEG 310 (Bioengineering Mechanics I). Specific elements used were four lab experiments.

Course	Element	Outcome (1–5 Scale)	% of Students with ≥3
BMEG 310	Labs 1, 2, 3 and 4	Ave = 4.8, Max = 5, Min = 4	100%

Outcome c: An ability to design a system, component or process to meet desired needs. Course used was BMEG 450 (Biomedical Engineering Design). Specific element used was design synthesis portion of the Phase 3 detailed design report			
Course	Element Outcome (1–5 Scale) % of Students v		% of Students with ≥3
BMEG 450	Phase 3, Written Report	Ave = 4.5, Max = 5, Min = 3	97%

The results of the student outcome data demonstrated that all courses offered during 2013-2014 academic year had an average level of attainment >3 (Figure 2A), thereby meeting our satisfactory requirement. Our second satisfactory requirement, an expected level of attainment of >3 by \geq 80 percent of students, was observed for all student outcomes except Outcome e (an ability to formulate and solve engineering problems) and Outcome i (a recognition of the need for and an ability to engage in life long learning). The data were assessed and evaluated by the

BME Undergraduate Education Committee. The proposed actions to meet the expected level of outcome for Outcomes e and i included:

- 1. Incorporating in-class activities, projects and assignments that help students develop an ability to formulate and solve engineering problems, while also helping them to develop an ability to engage in life long learning.
- 2. Developing new courses that help students' ability to formulate and solve engineering problems, while recognizing the need and develop an ability to engage in life long learning.
- 3. Monitoring and assessing these outcomes at the mid-semester in order to make changes, as needed, to help students attain these outcomes.





Figure 2: Student Outcome Data from all courses during 2013-2014 academic year. A: summary of student outcome data, B: % of students having performed above the acceptable level (>3).

Graduating Student Survey

The College of Engineering conducts an exit survey for graduating students using Educational Benchmarking Inc. (EBI). The survey includes a detailed questionnaire about their experience at the university, including faculty interactions, facilities, work-load and grade satisfaction. An important aspect of the survey is student perception of student outcomes. Graduate exit survey data from the Spring 2014 graduating class are presented in Figures 3A and B. Blue represents data from the BME students (44 percent of students responded) and yellow represents the entire College of Engineering (46 percent responded).

The newly formed BME Program was comparable in its graduating student survey results to the overall College of Engineering across all of the student outcomes and other student feedback regarding faculty and facilities. All students responded with >5 (on a 7 point scale) in attaining BME student outcomes (Figure 3A). BME students also rated faculty accessibility, faculty responsiveness, grade satisfaction and facilities and labs available to students >5.





Figure 3: Graduating student survey data. A: Student Outcomes a - k, B: Faculty and facilities, for BME (blue) and all College of Engineering (yellow), where 1: Not at All, 4: Moderately, 7: Extremely.

Continuous Improvement

The continuous improvement process has evolved since the inception of the program in 2010 through the three phases described below (Figure 4).

Student Outcomes for graduating class (up to academic year 2013–2014):

The Course Evaluations and Instructor recommendations are discussed during BME Undergraduate Education Committee **Phase 1**: Participate in College of Engineering Educational Activities Committee; Form Undergraduate Educational Committee; Collect course syllabi and review the student outcomes (a-k) to meet Program Educational Objectives

> **Phase 2**: Define student learning objectives; Set expected levels of achievement; Review and discuss the BME junior and senior courses in faculty meetings following their offering

> > **Phase 3**: Assess Student Performance, Course Evaluations, and Surveys, and recommned changes for continous improvement; Implement curriculum changes through the Engineering Educational Activities Committee and University Faculty Senate; Review PEOs with faculty and External Advisory Council

Figure 4: Continuous Improvement Phases (2010-2014)

meetings to suggest changes for course improvements. Integrated changes are again monitored through the same process for continuous improvement.

While the Undergraduate Education Committee closely monitors continuous improvement, other mechanisms are also used for program improvement. A mechanism that has proven successful in assessing and reviewing the UD BME Program student outcomes for courses is to dedicate a component of regular departmental faculty meetings (held monthly during the academic year) to discuss the course. Typically 20 minutes is spent discussing a single course. During this time, one course is given particular attention and the faculty member who has recently taught the course discusses particulars of the most recent offering. This includes a presentation of the syllabus, discussion of the textbook used, course requirements, student outcomes, future scope of improvement, and any other pertinent information. This is a particularly useful time to describe the impact of any changes in the course that have recently been implemented, and allows for feedback from others who may have taught that course or similar courses in the past. The results of these discussions are recorded in the minutes of the faculty meetings. Any action that requires a vote, such as curriculum changes, are revisited and voted upon by the Undergraduate Education Committee and changes are implemented, as appropriate, through the faculty senate process.

Curriculum Development and Course Improvement (up to academic year 2013–2014):

Although many changes in the Biomedical Engineering program are data-driven via assessment and evaluation procedures inherent to the BME program, our curriculum also takes advantage of other source of input for improvement. Since the UD BME undergraduate curriculum utilizes courses from a variety of other academic units, primarily the College of Engineering and the College of Arts and Sciences, we continually benefit from the quality improvement process of these units. An example is the recently developed Integrated Chemistry and Biology courses and laboratories that are now offered in the new Integrated Science and Engineering (ISE) building. The integrated courses include CHEM 103 + BISC 207 and CHEM 104 + BISC 208 and these courses allow students to experience an integrated chemistry and biology education. Pending approval through the normal university process, the BME students will begin taking the integrated courses in the Fall of 2015.

The Undergraduate Educational Committee also meets with instructors from other departments and colleges who are involved in teaching BME courses to discuss ways to improve problemsolving skills for BME students taking these courses. These meetings have led to improvements in how the relevant courses were taught, which increased student satisfaction. Examples of recent meetings have included those with faculty from the Chemistry department (to discuss the number and content of courses taken by BME students) and the Math department (to discuss the content, class examples, and homework problems for MATH 305).

Continuous Improvement Strategies Planned (academic years 2014–2015 and after):

This section presents the new continuous improvement strategy that will be implemented beginning the Fall term of the 2014–15 academic year. These new strategies were proposed based on our assessments of student outcomes over the last four years and are thus a key element of closing the loop on our program's continuous improvement process.

Senior design judge assessment: During the Fall 2013 BMEG 450 Senior Design Course we invited external judges (5 or more people from industry and academia) to assess our seniors. They evaluated each design team in these three categories: Design Process, Resource Management, and Communications. The initial assessment showed attainment of the student outcomes to the expected level (Average: 4.2, Max 4.5 and Min 4.0, 5-Point scale). We plan to further develop the assessment rubric to capture our student outcomes and assess the attainment of program educational objectives in future offerings of BMEG 450. These industry experts are an important constituency of the program, they can make a direct assessment of outcome achievement, and the Undergraduate Committee can evaluate the judges' feedback to make improvements and/or close the loop to determine whether we have achieved desired improvements across the program.

Alumni Survey: We had a small group of five students graduate in January 2014 and a cohort of 39 students graduate in Spring 2014. These first graduates will form the base of future Alumni from which to evaluate our program. We will employ an online Alumni Survey to collect data that will assess program effectiveness. A survey request will be sent out to our graduates one year after graduation (Spring 2015). Additionally, using social media networks, specifically LinkedIn, we will acquire information on alumni activities. The alumni data will form another methodology to close the loop and ensure we are meeting the PEOs.

Employer Survey: Once the program matures and a group of employers of our graduates are identified, we intend to develop and deploy a survey to assess the effectiveness of our program from this key stakeholder. We will develop the online survey through The Office of Educational Assessment. We are currently utilizing our External Advisory Council for this capacity; however, it will be of tremendous value in closing the loop for program improvements to utilize the constituents who employ our students.

Continuous Improvement: Curriculum Development

In our review of student outcomes, course evaluations, and graduating student survey from the first graduating class, we found that our student outcomes were satisfied, but that we could make improvements. Specifically, we need more engineering content and the engineering content should be deployed earlier. In response to these assessments, the faculty held a curriculum retreat in August 2014. Curriculum changes suggested from the faculty curriculum retreat to improve the already strong program will be submitted through the regular university and faculty senate process under a separate Academic Approval process from this request for Permanent Status.

1-f. What are the department/unit's strategies for student advisement?

The Engineering Advisement Office is the primary source of advisement for matters that are concerned with requirements common to all students in the college or the University, such as changing major, adding minors, general education or breadth requirements, and rules for transferring courses from other institutions. This office uses an online process to review the academic progress of all engineering seniors, providing advice as necessary, and finally clears for graduation those engineering students who have completed all requirements for their

respective programs. The assistant dean of undergraduate studies also monitors students on academic probation.

When students are admitted to the Biomedical Engineering Program, they are assigned one faculty member as their faculty advisor that will remain so through the student's tenure at the University of Delaware. The faculty advisors are not changed unless the faculty member goes on sabbatical leave, takes on administrative duties, or a request is made by the student. The faculty advisors are responsible for guiding the student in curricular and career matters, helping with nominations for awards, and recommendation letters. The faculty advisors also help students seeking independent research opportunities and assist students applying to graduate school.

Students are expected to meet with their advisors to review their academic progress at the time of pre-registration. Students get further advice through student-faculty contact in the BME courses. Instructors of core and elective courses have 'office hours', which is normally used for questions related to course topics. Students also use these times to seek advice on curricular or academic matters and professional development in general.

Within the Biomedical Engineering program, the undergraduate academic advisor is responsible for helping students with general curricular questions, registration, university procedures and general academic advice. This staff member also acts as the liaison for the University and College of Engineering by serving as the point of contact for the Career Services Center, Registrar's Office, the Scheduling Office, the Engineering Advisement Office, and other academic departments.

The BME program faculty and staff academic advisor work closely with the University of Delaware Career Services and help arrange for seminar events, inviting recruiters for campus and program visits, preparing and distributing resume books of Juniors and Senior students to potential employers and other events that help students reach their career goals. The Undergraduate committee also arranges seminars about applying to graduate school and recommends students who are interested in pursuing higher degrees. Finally, professional student organizations, such as the Biomedical Engineering Society Student Chapter, are each advised by a faculty member. These advisors work with the student officers to help develop necessary leadership and organizational skills as well as provide advice on academic and professional issues to all members of the organizations as needed.

To ensure that all students are advised regarding curriculum and career matters, the following summarizes the processes within the University, College of Engineering and/or Biomedical Engineering Program:

- All students new to the University (Freshman and transfer) meet, in person, with an academic advisor during New Student Orientation before their first semester.
- Freshman and transfer students have a <u>mid-term</u> grading period during the Fall and Spring semesters. The College of Engineering Office of Undergraduate Advisement sends an email to all students who have earned two Ds, or an F, or a Z (unofficial withdrawal) at this stage of the semester that states it is "imperative that [they] make an appointment with their academic advisor" prior to the Change of Registration Deadline.

The BME academic advisor is then responsible to meet with all students who contact them for an appointment and complete the Freshman/Transfer Mid-Term Grade Advisement Checklist. Using this Checklist, they discuss causes of the grade problems and provide information on assistive strategies and resources. Corrective course actions are also noted.

- A few weeks prior to the Winter/Spring or Summer/Fall Course Registration period, the Registrar's Office provides a list of students who are on Academic Probation. The College of Engineering Office of Undergraduate Advisement sends all of these students a letter (hard copy and email) informing them that they will need to meet with their academic advisor to discuss strategies for improving their academic performance. Once this meeting is held and documented, the Registration Hold is removed from their record, and they are able to register for classes for the Winter/Spring or Summer/Fall terms.
- In the Fall prior to graduation, the College of Engineering Office of Undergraduate Advisement sends all seniors a letter with instructions regarding Senior Checkout informing them to 1) verify the expected graduation term is correct on UDSIS, and 2) make an appointment with the BME academic advisor prior to the end of the Drop/Add period for a Degree Audit meeting to ensure the student's coursework will fulfill all degree requirements.
- The BME undergraduate associate director provides faculty advisement training to BME faculty advisors each Fall.
- The BME academic advisor sends an email request to meet with each BME student once per semester.

In order to improve the advising process, based on feedback from students and faculty, the following processes were put in place within the Biomedical Engineering Program in Fall 2014.

- Faculty advisement is discussed annualy in a fall BME faculty meeting.
- During advisement meetings, the academic advisor recommends that the student also meet with his or her faculty advisor for guidance.
- Faculty advisors are encouraged to contact their advisees at least once per semester to request a meeting.
- Three fall BME courses include a meeting with the student's faculty advisor as a class assignment: BMEG 101 (Freshman), BMEG 401 (Junior), MSEG 460 (Senior).
- Student advisor meetings logged in Advisor Notes will be monitored by the academic advisor once per year in the summer or early fall. If a student has not met with both the academic and faculty advisor over the course of one year, an email notification requesting a meeting will be sent to the student with copies sent to both of the advisors and to the BME undergraduate associate director. The undergraduate associate director will report to the program director regarding each faculty advisor and his or her student advisement meetings.

1-g. If applicable, specify if the program meets all accreditation requirements (e.g., ABET, AACSB, APA, CADE etc.).

The biomedical engineering program is currently in the process of ABET accreditation. The current cycle, immediately after our first graduating class in May 2014, was the first time we were eligible for ABET review. In June 2014 we submitted our ABET self-study. In October 2014 the university hosted the ABET evaluation team. Following standard procedures, the onsite evaluation is reviewed by the ABET commission, with a final decision by August 31, 2015.

1-h. Report any changes in the program admission criteria, degree requirements, or subject areas since the program was initiated.

Admission Standards History

Program admissions and criteria are described below. There have been no changes in subject areas since the program was initiated. A history of BME admission statistics is offered in the table below, beginning with the program's inception in academic year 2010. Average composite SAT scores (1947-1981) and high school GPA (3.79-3.94) have been consistently strong and among the best at the University.

Academic Year	AVG (NEW) Math/Verbal /Writing	High School Percentile Rank	High School GPA	Based on following count of admission deposits as of 7/31
2010-11	1932	87	3.98	19
2011-12	1947	91	3.93	53
2012-13	1965	91	3.94	51
2013-14	1985	89	3.91	50
2014-15	2032	93	3.91	49

Profile of BME Students by Year of Admission

Data Source: Admissions Data Mart, University of Delaware Enterprise Warehouse; High school percentile rank is only available for roughly half of students reported. GPAs outside of standard range have been excluded from average GPA calculation (3 in 2010; 2 in 2011).

Admission of Transfer Students from Within the Institution

Since its inception, Biomedical Engineering has been a restricted major (originally limited to 50 students, with capacity increased to 55 in Spring 2013) due to physical space limitations in laboratory courses. As such, students must meet the minimum stated requirements as listed on

the Registrar's site, www.udel.edu/registrar/students/restmajorsinfo.html. Currently the site conveys the following:

Biomedical Engineering: Restricted for all students due to program capacity limitations. Prospective student applicants must have a minimum cumulative GPA of 3.0 and a grade of Bor better in both CHEM 103 and MATH 241.

The change of major period for College of Engineering restricted majors for spring semester is from the time all fall final grades are posted through the middle of January, and for fall semester from the time all spring grades are posted through the middle of August. Departments will notify students of their decisions before the start of the next semester.

Internal Process

BME was initially limited to 50 students per graduating class, but increased to 55 in the spring of 2013. Students cannot be admitted unless the enrollment for their particular class falls below the registration cap. Students are permitted to apply after fall or spring final grades are posted.

Applications are submitted via web form and are directed to the BME Academic Advisor. At the end of the stated application time period applications are printed, student records are verified and ranked by GPA. The BME academic advisor and the BME undergraduate director meet to review the submitted applications.

Applicants are ranked for each class as follows:

- 1. Met stated criteria of a minimum GPA of 3.0 and B- or better in CHEM 103 and MATH 241
- 2. GPA
- 3. Courses required for BME

Effective Fall 2013, a college-wide policy established the prioritization of change of major requests as follows: freshman engineering undeclared (FR EGU) students who submit their Change of Major/Minor/Concentration form by November 15 will be given the first priority for slots available in each major. Beginning Fall 2014, these students must be in good academic standing. The second priority would be for those students already in College of Engineering majors who meet established Change of Major guidelines. The third priority would be those students in majors outside the College of Engineering who meet established Change of Major guidelines.

Transfer Student History

A history of engineering transfer student statistics is shown in Table. Since the inception of the program we have admitted students to fill seats left by students who transferred out of BME. Students that meet eligibility criteria are declined when there are no seats available.

Transfer student statistics				
# Students	Class of 2014	Class of 2015	Class of 2016	Class of 2017
Admitted	1	1	3	5
Declined	0	2	9	1
Notes	Admitted from ENEG (1)	<i>Admitted</i> from BISC (1) GPA 3.67	Admitted from EGU (2), BISC (1), GPA 3.29 – 3.96	Admitted from EGU (4), BISC (1), GPA 3.00 – 3.91
	GPA 3.60	<i>Declined</i> from CHEG (2) GPA 3.15 – 3.25	Declined BISC (5), CHEG (1), EGU (2), UNIV (1) GPA from 3.25 – 3.79	Declined UST (1) GPA 2.16

Represents total number of students admitted and declined based on graduation year

Changes to Degree Requirements

Changes to the degree requirements have been made through the Faculty Senate Academic Program Approval process. These are summarized, by year, below.

Submitted December 2011, Effective September 2012:

• Update technical electives.

Submitted December 2012, Effective September 2013:

- Replace EGGG101 with BMEG101 (FYE course)
- Update BMEG 450 (senior design) from 4 to 6 credits and delete 1 technical elective
- Replace MEEG 483 by BMEG 311 in core curriculum

Submitted December 2013, Effective September 2014:

- Revise BMEG 330 to become a 4-credit course
- Revise catalog to list BMEG 479 instead of ELEG 479
- Update technical electives

1-i. General description of recruiting procedures - include any information for underrepresented populations.

The BME program fully participates in all recruitment events that are organized by the Admission's Office and coordinated and communicated to BME through the College of Engineering Advisement Office. Examples of these events are the Blue and Golden Saturdays in

the Fall, Decision Days in the Spring, and Discovery Days in the Summer. We also participate in the Distinguished Scholar weekend and interview candidates for Distinguished Scholarships during that visit. The College participates in Destination Delaware, a program run by the Admissions Office for admitted underrepresented group members in conjunction with one of the Decision Day programs.

2. Student Information

2-a Application and enrollment history – provide a tabular summary or graphical representation by year showing numbers of applicants, offers, matriculated, graduated, and dropped out (this data must be confirmed by the Admission's office, the Registrar's Office, the Office of Graduate Studies, or the Office of Institutional Research and Planning, as appropriate.)

Year	Sum of Applied	Sum of Admitted	Sum of Matriculated	Sum of Graduated	Sum of WD/changed program
2010	19	19	19	10	8
2011	429	193	49	1	16
2012	600	174	48	0	12
2013	653	214	50	0	11
2014	763	224	46	0	0

TABLE 7: Application and enrollment history

Applied: indicated BME on application at any stage. Admitted: offered admission to BME. Matriculated: enrolled in program. Graduated: awarded BBE. WD/changed program: Not currently active in or on leave from BMEG-BBE program; not graduated. This covers formal withdrawals, administrative withdrawals, and changes of major.

Note that not all BME students enter the program through the admissions process: some transfer in from other programs, so the current enrollment total is greater than the sum of matriculated minus graduated minus withdrawn from the table above. This is particularly true for the first matriculation year in 2010, where only 19 were admitted through admissions, but the class size grew to 50 in that academic year, and a total of 44 BBE degrees were awarded from that cohort to date. Note also that upon opening seats from the withdrawn or change of program, students who wish to change major into BME immediately fill the seat.

Analysis of 39 (20%) of these students who left the major from the 193 matriculated BME students beginning in 2011 show that only 7 (4%) of these either left or were dismissed from the university. The remaining 32 students moved into another major (see Figure). The new majors for these students include:

• College of Engineering (12 students): Computer Science (3), Chemical Engineering (2), Civil Engineering (2), Environmental Engineering (2), Mechanical Engineering (2), and Information Systems

- College of Arts & Sciences (11 students): Biology (4), Neuroscience (4), Criminal Justice, International Relations, and Psychology
- College of Health Science (5 students): Medical Laboratory Science (2), Actuarial Science, Dietetics, and Nursing
- College of Business & Economics (2 students): Finance and Marketing
- Collage of Agriculture & Natural Resources (1 student): Natural Resource Management



2-b Annotated evidence of placement for students who have graduated. Indicate how the department facilitates placement.

The first 44 bachelor's degrees in Biomedical Engineering were awarded in 2014, with 5

graduates in January and 39 in May. While there is no official source of post-graduation placement, we have collected information directly from the students via email or identified their placement via their LinkedIn or Facebook pages. Of the 44 graduates, we know the placement for 31 (71%). Of these 31 graduates, 61% are employed, 13% each are in masters degree programs, doctoral degree programs, and medical school (Figure).

Some of the employers of our graduates include: Agilent, Ahnolt Industries, Bank of America, BrainLab, Danico Medical, EPIC, Food and Drug Administration (FDA), Goldman Sachs, Hamilton Robotics, the Hospital for Special Surgery, Johns Hopkins, Millstone Medical Outsources, Seiberlich Trane, Terumo, Trenton Hospital, Zimmer.



Representative job titles include: consultant, consumer product strategy analyst, lead engineering reviewer, operations analyst, product development engineer, product engineer, quality engineer, research engineer, sales engineer, and technical service analyst.

Of the graduates continuing their education, the master's degree students are pursing a degree in engineering at Columbia University (BME), University of Delaware (ME), Drexel University (BME), and San Diego State (BME). The doctoral degree students are pursuing degrees at Colorado State (BME), University of Delaware (Physical Therapy), University of Florida (Rehabilitation Science), and University of Michigan (Pharmaceutical Science). The graduates pursuing medical degrees are attending Jefferson Medical College, two at Philadelphia College of Osteopathic Medicine, and State University of New York Upstate.

We put considerable efforts into facilitating placement of our graduates in collaboration with UD Career Services. Faculty advisement and co-sponsored events with the student chapter of the Biomedical Engineering Society (BMES) have provided direct career mentoring to students. The BME program sponsored and attended a bus trip to the BMES Career Fair in Washington DC in October 2013. The program staff and faculty network at multiple regional events and with multiple companies to provide information and resume books to potential employers, including Delaware Bioscience events, career fairs, Agilent, and Terumo. We have established a BME LinkedIn page for networking and post job opportunities on that page. The BME program staff frequently connect with seniors and unemployed graduates and coordinates with UD Career Services to create and distribute a resume book.

3. Identify demand and competitive factors in the region, nationally, or internationally for attracting students – explain how this benefits and/or challenges the program.

The demand for admission to the BME program is very high, as noted above. The reason for the high demand is the popularity for a degree in Biomedical Engineering across the nation. Recent media has called biomedical engineering the top of all majors in terms of employment outlook and job satisfaction. Forbes described biomedical engineering as number one among the most valuable college major based on starting pay, growth in pay, and opportunities, noting *"Biomedical Engineering is the major that is most worth your tuition, time and effort"* (http://www.forbes.com; 5/15/2012). U.S. News and World Report cited biomedical engineering first among the College Majors that Lead to Jobs and notes that *"The Bureau of Labor Statistics estimates the field will see a 62 percent growth in jobs between 2010 and 2020"* (http://www.usnews.com/education/best-colleges/articles/2013/09/10/discover-11-hot-college-majors-that-lead-to-jobs; 9/10/2013). Finally, CNN Money ranks biomedical engineering as first in Best Jobs in America in 2013 and 2012, noting, *"For those with a technical aptitude, it's an opportunity to make the world a better place. Every day, there's the potential to create something groundbreaking"* (http://money.cnn.com/pf/best-jobs/2013/full_list/; 11/12/2013)

The UD BME program competes regionally with three highly ranked BME programs at University of Pennsylvania, Johns Hopkins University, and Columbia University. These programs are highly selective and also very expensive private schools. Thus, there is likely not a large impact on the UD BME program's student demand. We do compete regionally with strong and long-established BME programs at Drexel University, Penn State University, University of

Maryland, and Rutgers University. Since 44% of our current BME enrollment is Delawareans, one of our advantages seems to be that all of these out of state programs are more expensive for Delaware Residents to attend than UD. Importantly, even though UD BME competes regionally, we attract a number of students from Pennsylvania, New Jersey, New York, and Maryland, with 42% of our current BME enrollment from these 4 states (Figure). Thus, even though UD BME is a young program, the strength of the curriculum and program and the strength of the College of Engineering and the overall



University have attracted a large number of outstanding applicants. Notably the quality of these students is very high and the demand for the BME major at UD remains exceptionally high. Indeed a large number of highly qualified applicants are declined due to our current restricted enrollment. We expect the demand to not only continue, but to grow with the BME program in the coming years.

4. Identify factors that make this program unique or distinctive compared to similar programs at other institutions.

The UD BME program, while based on the curriculum of the top BME programs in the nation, has several distinctive features. The engineering content of the curriculum is a balance of breadth (it covers bio-related topics across mechanical, electrical, and chemical engineering) with depth (it applies advanced mathematics and science foundations to two or more course sequences within each topic area). The laboratory and design features within the UD BME curriculum are also strengths of the program. In particular the 6-credit capstone senior design is interdisciplinary by being offered with mechanical engineering and having student teams that can include BME, mechanical, and electrical engineering students. It is primarily comprised of industry or clinician initiated projects that have immediate transferability to real-world problems. While UD does not have a medical school, which may first appear to be a disadvantage, we find that the breadth of the Delaware Health Science Alliance provides an extended opportunity for clinical input into our curriculum. For example, a distinctive feature of our program is our Clinical Immersion technical elective course that is offered each Winter session. In this class students are immersed in a clinical setting, primarily within the DHSA, and identify clinical problems that can be addressed by an engineer. The final poster sessions, where the students present the problems and potential solutions to an interdisciplinary audience, have been quite impressive. The extended interdisciplinary affiliated faculty, with participation from outstanding faculty across the University and region, provides a wealth of knowledge and student research

opportunities for the BME undergraduates. Finally, the young and growing BME primary faculty are a unique set of outstanding individuals with world-class training and a very bright future in research and education.

5. Overview of interdisciplinary relationships (if any) – include trends on what students choose for electives.

Biomedical engineering is, by definition, highly interdisciplinary: it applies math, science, and engineering principles to problems in medicine and biology. Thus the courses, the faculty, and the affiliated faculty span nearly all fields of engineering and science. One clear piece of evidence for this is the more than 50 extended joint, affiliated, and secondary faculty in the UD BME program, which span 13 departments, 3 UD colleges, and 3 hospitals or institutes outside of UD. Many of our undergraduate students perform research in faculty laboratories across these interdisciplinary areas. For example, the twenty-one undergraduates presenting in the 2014 Summer Scholars symposium were from faculty labs in biomedical engineering (6), mechanical engineering (6), materials science and engineering (2), kinesiology & applied physiology (2), psychology (1), electrical and computer engineering (1), chemical and biomolecular engineering (1), medical laboratory sciences (1), and physical therapy (1).

The 44 BME graduates from 2014 had minors across four colleges: engineering, arts and sciences, health sciences, and business. Specifically, the following twelve minors were fulfilled for BME graduates in 2014: bioelectrical engineering (29), biological sciences (4), chemistry (4), electrical & computer engineering (3), mathematics (3), economics (2), and one student each for anthropology, biochemical engineering, exercise science, materials science and engineering, public health, and Spanish. Additionally, one student completed a double major with computer science.

Required science and engineering courses span multiple disciplines, including math, biology, chemistry, physics, electrical and computer engineering, computer science, materials science and engineering. The technical electives taken by BME students are interdisciplinary and include courses from the above departments and also mechanical engineering, chemical & biomolecular engineering, civil & environmental engineering, kinesiology & applied physiology, medical laboratory sciences, and statistics.

6. Characterize whether the facilities available for this program are adequate to support student, faculty, and staff needs.

Offices

The Biomedical Engineering Program occupies a total of 1589 sq. ft. of office space in two suites located in 161 Colburn and 301 Spencer Labs. The Colburn suite houses the program director along with the administrative staff. The Spencer Lab suite houses the Undergraduate and Graduate Academic Advisors, Professors for Instruction, and a conference room. Offices for recent tenure-track faculty hires are located adjacent to their research laboratories at the Delaware Technology Park #5 (DTP5). BME graduate students, who work with faculty

throughout the College of Engineering, occupy offices in the location of their research advisor, with the majority of BME graduate students residing at DTP5.

Laboratories

The Biomedical Engineering program has some primary teaching laboratories and shares some teaching laboratories with the mechanical engineering and electrical engineering departments. Each department takes responsibility for various rooms, but all departments share laboratories for efficient use of educational laboratory equipment and space. Regardless of the department responsible for the room, each program purchases and maintains specialized laboratory equipment and supplies as needed. The BME laboratory courses are described below, with the room number and the responsible department noted.

BMEG 310 – Bioengineering Mechanics I. Biomechanics I Laboratory is taught in Spencer room 131B (969 sq. ft.), which is under the responsibility of the BME program. Spencer room 122 is also used for some portions of BMEG 310 experiments as this room houses the material testing instruments (maintained by the mechanical engineering department).

BMEG 330 – Biomedical Instrumentation. The instrumentation laboratory is taught in Evans room 334 (550 sq. ft.), which is under the responsibility of the electrical engineering department. BME purchased and maintains equipment and supplies for these laboratory experiments.

BMEG 450 – Biomedical Engineering Design. Senior design is co-taught with MEEG 401 offered by mechanical engineering department and BME faculty and staff in the Design Studio (described below) located in Spencer Laboratory that is under the responsibility of the mechanical engineering department. In addition, student teams utilize Spencer room 131B and ISE room 322 (1024 sq. ft.), both of which are under the responsibility of the BME program. The undergraduate space in ISE room 322 is designated classroom space that is also used for senior design team meetings and for BME seminars. The Design Studio in the mechanical engineering department creates a unique interdisciplinary learning environment where students and educators collaborate in hands-on learning experiences. The Design Studio is a 3,500 square foot "hacker space" on the first floor of Spencer Laboratory that includes space for group projects, computer-aided design, prototyping, and design validation.

7. Provide information on other budgetary requirements of the program beyond the typical unit expenses.

The biomedical program currently consists of 7 primary faculty, 5 joint faculty with documented teaching and advising workload, administrative staff, and an operational budget. The college recently renovated and equipped teaching laboratory space for the undergraduate program and there are additional investment funds earmarked to support to expand the faculty to 9 tenure-track and 2 non-tenure track faculty, and 5 staff. There are no additional budgetary requirements to continue to deliver the bachelors degree in biomedical engineering and BME faculty teach our courses. Investment in biomedical engineering, however, within the strategic plan of the college of engineering and the university, is likely in the coming years.

G. Appendices for supporting documentation, as appropriate

- G-1. Original application for provisional approval
- G-2. Transcripts of any open hearings required by the Faculty Senate Coordinating Committee on Education: None
- G-3. List of any concerns raised by Faculty Senate Committees at the provisional approval stage: None
- G-4. Letters of support for the permanent status approval of the program from the department Chair and the Dean of the corresponding college
- G-5. Program review report: None

G-6 Letters of Approval from Contributing or Affected Departments

Deans

College of Agriculture and Natural Resources	Mark Rieger
College of Arts and Sciences	George Watson
Alfred Lerner College of Business and Economics	Bruce Webber
College of Earth, Ocean, and Environment	Nancy Targett
College of Education and Human Development	Lynn Okagaki
College of Health Sciences	Kathy Matt

Department Chairs – College of Engineering

Chemical & Biomolecular Engineering	Abraham Lenhoff
Civil & Environmental Engineering	Tripp Shenton
Computer & Information Sciences	Errol Lloyd
Electrical & Computer Engineering	Ken Barner
Materials Science & Engineering	Darrin Pochan
Mechanical Engineering	Suresh Advani

Department Chairs – Outside College of Engineering

Titus Awokuse
Robin Morgan
Murray Johnston
William Farquhar
John Pelesko
Michele Parent
Kai Draper
Edmund Nowak
Robert Simons



College of Engineering

OFFICE OF THE DEAN

G-1 Original Application

University of Delaware Newark, Delaware 19716-3101 Ph: 302/831-8017 Fax: 302/831-6751 Email: chajes@udel edu http://www engr udel edu/

Date: December 21, 2009

To: UD Faculty Senate

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

That Chu

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

то:	Engineering Faculty
FROM:	Michael L. Vaughan, Serior 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 <u>831-2401</u>
Department: <u>C</u>	ollege of Engineering	email address <u>buchanan@udel.edu</u>
Action: <u>Approve</u> (E academic un	New Major Bachelor of Biomedical Eng kample: add major/minor/concentration, do it name change, request for permanent stat	incering (BBE) elete major/minor/concentration, revise major/minor/concentration us, policy change, etc.)
Effective term_1	<u>0F</u> (use format 04F, 05W)	
Current degree_	(Example: BA, BACH, BACJ, HB	A, EDD, MA, MBA, etc)
Proposed chang	e leads to the degree of:(Exam	ple: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)
Proposed name:	Proposed new name for revised or new (if applicable)	/ major / minor / concentration / academic unit
Revising or Dele	ting:	
Undergra	duate major / Concentration (Exampl	e: Applied Music – Instrumental degree BMAS)
Undergra	duate minor:(Example: African Studie:	s, Business Administration, English, Leadership, etc)
Graduate	Program Policy statement ch	ange: (Must attach your Graduate Program Policy Statement)
Graduate	Program of Study: (Example: Animal Science: MS Animatics)	al 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 effect 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 activity 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 biorelated 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 loosing 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

3-cr CISC 106---General Computer Science for Engineers

Spring

- 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

- 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

- 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
- 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

Notes:

- 1) items in italics will be new courses
- 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 need

 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
 16-cr

 Junior
 3-cr

 Senior
 MSEG 302—Materials Science for Engineers

 3-cr
 BMEG 310—Bioengineering Mechanics

 3-cr
 BMEG 301—Systems Physiology I

 3-cr
 Tech Elec 1

 16-cr
 Senior

Freshmal 4-cr MATH 241-Analytic Geometry & Calculus A

4-cr CHEM 103-General Chemistry I

2-cr EGGG 101—Introduction to Engineering 3-cr ENGL 110—Critical reading & Writing

- 3-cr MSEG 460—Biomaterials & Tissue Engineering 3-cr Tech Elec 2 3-cr GenEd 3 3-cr GenEd 4
 - 16-cr

16-cr

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

ROUTING AND AUTHORIZATION:	(Please do not remove supporting documentation.)	
Department Chairperson Director The	2 file Date12/22/09	
Dean of CollegeMul Chr	Date 12/22/09	_
Chairperson, College Curriculum Committee	Tur 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_	
RegistratProgram	CodeDate	
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 Allience,

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

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 breath 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 REOUI	REMENTS	
FNGI 110	Critical Reading and Writing (minimum grade (-)	3
First Year Experience (i		0-4
Discovery Learning Exp	rence (DLF)	2
Multi-cultural Courses		3
main calcular courses		5
MAJOR REQUIREM	ENTS	
Breadth Requirements		18
See: College Breadth R	equirements. One of the breadth requirement courses m	av fulfill the University
multicultural requirem	ent (See List). A list of current breadth requirement cours	ses can be obtained at:
http://www.engr.udel.e	edu/adsup/advise/gen-ed-reg.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 Linear Systems 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 <u>Honors Degree</u>. Graduate courses approved for this purpose by the department may be counted as Honors courses.

BIOMEDICAL ENGINEERING 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, řěhal, 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. Frerequisite: 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

3

3

3

3

3

4

BIOMEDICAL ENGINEERING FACULTY

Suresh G. Advani Sunil Kumar Agrawal Maciek R. Antoniewicz Kenneth Barner Thomas S. Buchanan Takashi Buma David L. Burris Daniel K. Cha Pei C. Chiu Sylvain G. Cloutier Steven K. Dentel Dominic M. Di Toro Eric M. Furst Jill S. Higginson Chin-Pao (C.P.) Huang Paul T. Imhoff <u>Xinqiao Jia</u> Kristi L. Kiick Kelvin H. Lee Abraham M. Lenhoff Kurt Manal **David Martin** Mark Mirotznik Darrin J. Pochan Ajay K. Prasad John F. Rabolt **Christopher J. Roberts** Anne S. Robinson Michael H. Santare Kausik Sarkar Millicent O. Sullivan Herbert Tanner Lian-Ping Wang Liyun Wang Ryan Zurakowski

George W. Laird Professor of Mechanical Engineering **Professor of Mechanical Engineering** Assistant Professor of Chemical Engineering Professor and Chairman of Electrical & Computer Engineering George W. Laird Professor of Mechanical Engineering Assistant Professor of Electrical & Computer Engineering Assistant Professor of Mechanical Engineering **Professor of Civil & Environmental Engineering** Professor of Civil & Environmental Engineering Assistant Professor of Electrical & Computer Engineering Professor of Civil & Environmental Engineering Edward C. Davis Professor of Civil & Environmental Engineering Associate Professor of Chemical Engineering Assistant Professor of Mechanical Engineering Donald C. Philips Professor of Civil & Environmental Engineering Associate Professor of Civil & Environmental Engineering Assistant Professor of Materials Science & Engineering Associate Professor of Materials Science & Engineering Gore Professor of Chemical Engineering Gore Professor of Chemical Engineering **Research Assistant Professor of Mechanical Engineering** Karl W. & Renate Böer Professor & Chair of Materials Science & Engineering Associate Professor of Electrical & Computer Engineering Babatunde A. Ogunnaike William L. Friend Chaired Professor of Chemical Engineering Eleftherios T. Papoutsakis Eugene DuPont Chaired Professor of Chemical Engineering **Professor of Materials Science & Engineering Professor of Mechanical Engineering** Karl W. and Renate Böer Professor of Materials Science & Engineering Associate Professor of Chemical Engineering **Professor of Chemical Engineering Professor of Mechanical Engineering** Associate Professor of Mechanical Engineering Assistant Professor of Chemical Engineering Assistant Professor of Mechanical Engineering Professor of Mechanical Engineering Assistant Professor of Mechanical Engineering Assistant Professor of Electrical & Computer Engineering

Biomedical Engineering Program

Fall

3-cr CISC 106-General Computer Science for Engineers

Freshmal 4-cr MATH 241—Analytic Geometry & Calculus A

4-cr CHEM 103-General Chemistry I

4-cr CHEM 321-Organic Chemistry I

4-cr BISC 208-Introductory Biology II

4-cr PHYS 207--Fundamentals of Physics I

2-cr EGGG 101-Introduction to Engineering

4-cr MATH 243—Analytic Geometry & Calculus C

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 ENGL 110---Critical reading & Writing

Spring

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

15-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

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

15-cr

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

126 credits total

Notes:

1) items in italics will be new courses

The following substitutions may be made for students 2) 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 need

- 3-cr Tech Elec 1 16-cr 4-cr BMEG 450-Biomedical Engineering Design Senior 3-cr MSEG 460-Biomaterials & Tissue Engineering 3-cr Tech Elec 2
 - 3-cr GenEd 3
 - 3-cr GenEd 4 16-cr

16-cr

16-cr

Soph

Junior /

- **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

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 breath 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 *Greate 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 BCE-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.

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

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

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

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 ELEG 478 Introduction to Nano and 3-cr Biophotonics
- 3-cr ELEG 680 Immunology for Engineers
- 3-cr MEEG 482 Clinical Biomechanics
- 3-cr MEEG 485 Control of Human Movement MEEG 612 Biomechanics of Human
- 3-cr 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

ELEG 479—Intro to Medical Imāğing 3-cr 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

Notes:

- 1) items in italics will be new courses

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

DEGREE: BACHELOR OF BIOMEDICAL ENGINEERING MAJOR: BIOMEDICAL ENGINEERING

CURRICULUM		CREDITS
UNIVERSITY RI	EQUIREMENTS	
ENGL 110	Critical Reading and Writing (minimum grade C-)	3
First Year Experie	0-4	
Discovery Learnin	g Experience (DLE)	3
Multi-cultural Cou	urses	3
MAJOR REQUI	REMENTS	
Breadth Requiren	nents	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

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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 Linear Systems I)	3
ELEG 479	Intro to Medical Imaging Systems	ġ.
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
5156 270		· ·
BIMSC 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	Senor Thesis	2-4
UNIV 402	Senor 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
Sunil Kumar Agrawal	Professor of Mechanical Engineering
Maciek R. Antoniewicz	Assistant Professor of Chemical Engineering
Kenneth Barner	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
Daniel K. Cha	Professor of Civil & Environmental Engineering
<u>Pei C. Chiu</u>	Professor of Civil & Environmental Engineering
Sylvain G. Cloutier	Assistant Professor of Electrical & Computer Engineering
<u>Steven K. Dentel</u>	Professor of Civil & Environmental Engineering
Dominic M. Di Toro	Edward C. Davis Professor of Civil & Environmental Engineering
Eric M. Furst	Associate Professor of Chemical Engineering
Jill S. Higginson	Assistant Professor of Mechanical Engineering
<u> Chin-Pao (C.P.) Huang</u>	Donald C. Philips Professor of Civil & Environmental Engineering
Paul T. Imhoff	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
Babatunde A. Ogunnaike	William L. Friend Chaired Professor of Chemical Engineering

Eleftherios T. Papoutsakis	Eugene DuPont Chaired Professor of Chemical Engineering
<u>Darrin J. Pochan</u>	Professor of Materials Science & Engineering
Ajay K. Prasad	Professor of Mechanical Engineering
<u>John F. Rabolt</u>	Karl W. and Renate Böer Professor of Materials Science & Engineering
Christopher J. Roberts	Associate Professor of Chemical Engineering
Anne S. Robinson	Professor of Chemical Engineering
Michael H. Santare	Professor of Mechanical Engineering
<u>Kausik Sarkar</u>	Associate Professor of Mechanical Engineering
Millicent O. Sullivan	Assistant Professor of Chemical Engineering
<u>Herbert Tanner</u>	Assistant Professor of Mechanical Engineering
Lian-Ping Wang	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 capistone course (BMEG 450) provides a unique opportunity to evaluate students' competitive 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 pregraduate 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,

George Water

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

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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.
Subject: Proposed Biomedical Engineering Major

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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: 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: <u>ksmatt@udel.edu</u>

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

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.

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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



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

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.

Anette M. Karlsson, PhD

Anette M. Karisson, PhD Chairperson Department of Mechanical Engineering



DEPARIMENT 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 campüs, 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.

Congratuations 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

AN EQUAL OPPORTUNITY UNIVERSITY

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,

.

DMat

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: Sent: To: Subject: Randall Duncan [rlduncan@UDel.Edu] Tuesday, December 22, 2009 12.45 PM Buchanan, Thomas S. 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*: 302/831-1543 *Fax*: 302/831-4234

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.

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Sincerely,

mie Relell

Katherine Rudolph, PhD, PT Associate Professor, Physical Therapy Director, Interdisciplinary Program in Biomechanics & Movement Science 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

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.
- >

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.

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: Sent: To: Subject: Peter Monk [monk@math udel.edu] Friday, December 18, 2009 5.05 PM Buchanan, Thomas S. 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" <<u>monk@math.udel.edu</u>> 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" <<u>monk@math.udel.edu</u>> 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 of concerns?

Regards,

Tom

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

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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

G-6 Letters of Support from Contributing Colleges/Depts

"Rieger, Mark" <mrieger@udel.edu> To: "Ogunnaike, Babatunde A." <ogunnaik@udel.edu> Cc: "Matt, Kathleen S." <ksmatt@udel.edu>, "Okagaki, Lynn" <okagaki@udel.edu>, "Targett, Nancy M." <ntargett@udel.edu>, "Watson, George H" <ghw@udel.edu>, "Weber, Bruce" <bweber@udel.edu>, "Vaughan, Michael L." <vaughan@udel.edu>, "Elliott, Dawn" <delliott@udel.edu> Re: Biomedical Engineering Permanent Status

Fully supportive, Tunde

Sent from my iPad

On Nov 3, 2014, at 11:05 AM, Ogunnaike, Babatunde A. <<u>ogunnaik@udel.edu</u>> wrote:

Colleagues,

I trust that this note finds you all well.

As you all know, about 5 years ago, our college proposed a new undergraduate major in biomedical engineering. With the support of those of you who were here at the time, especially George (whose college provided instruction for most of the required courses outside of engineering), the major was granted the usual provisional status. I am writing to inform you that we are now preparing to approach the faculty senate to seek approval for a "Permanent Academic Program: Bachelor of Biomedical Engineering (BBE)", and, as we did the first time around, I also write to seek your support. While this program does not affect all of your colleges directly (again, 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 for permanent status. I already have George's support.

From its inception, the provisionally approved program has enjoyed strong demand and remarkable success. It has become one of the most popular among students interested in engineering, being especially popular with those interested in biomedical research-based and allied health graduate degrees, as well as with those bound for medical school. Locally at our UD recruiting events, we continue to see an increasing number of high school students (especially women) who show great interest in biomedical engineering, many of whom have the strongest credentials in the prospective student population. Furthermore, this past month, we hosted an evaluation team from the Accreditation Board for Engineering and Technology (ABET); and even though the final official report is not due until later next year, the initial report was very favorable and our overall program was well received. The original plans have been executed very well to date and the program has confirmed its viability both financially and programmatically. I am convinced that it has all the attributes needed to make it a success and for it to become another spire of excellence in the college. I will be grateful to receive your support. Please don't hesitate to ask if you require any further clarification.

A simple response to this email indicating your support of the proposed permanent program in Biomedical Engineering is all I will need; it would be greatly appreciated.

Best regards, Tunde

Babatunde A. Ogunnaike William L. Friend Chaired Professor of Chemical Engineering Dean, College of Engineering 102 DuPont Hall, Newark, DE 19716



College of Arts & Sciences OFFICE OF THE DEAN 4 Kent Way Newark, DE 19716 Phone: 302-831-2793 Fax: 302-831-6398

13 November 2014

RE: Proposed Permanent Status for Bachelor's Degree Program in Biomedical Engineering

Dear Tunde,

The College of Arts & Sciences supports your proposal for permanent status for the Bachelors in Biomedical Engineering (BBE). This will have a significant impact on several departments in Arts & Sciences, including Chemistry and Biochemistry, Biological Sciences, Mathematical Sciences, and Philosophy. As we have discussed, there are important issues that we must continue to discuss and resolve to accommodate your students. I am committed to working with you and Provost Grasso to resolve them.

It is my understanding that in the next few years, undergraduate enrollment in the College of Engineering is projected to be stable. There will nevertheless be an impact on our College if the number of BBE students grows, since they take a different set of courses than most Engineering majors. The greatest challenges will be instruction in Biology and Chemistry, where BBE majors must take several classes. This will increase demands on our capacity in terms of both faculty and learning laboratory space. Specifically, we expect to see greater enrollments in Chemistry, primarily CHEM 104, CHEM 321 and 322, and CHEM 527. Each of these courses will require greater teaching capacity and the first three will continue to add to the demand for laboratory space and the associated operating costs. Even with our recent renovations in the organic chemistry laboratories (CHEM 321 and 322), we are already close to the limits of our capacity.

The fact that BBE majors include a large proportion of Honors-level students adds to the complexity of staffing these introductory science courses. Chemistry and Biology courses have higher than average costs, and Honors courses are especially costly to offer. We can manage these issues only if the tuition revenue distribution provides adequate funding to the College for the additional students.

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.

George Water

George Watson Dean

"Weber, Bruce" < bweber@udel.edu>

To: "Matt, Kathleen S." <ksmatt@udel.edu>

Cc: "Targett, Nancy M." <ntargett@udel.edu>, "Ogunnaike, Babatunde A." <ogunnaik@udel.edu>, "Matt, Kathleen S." <ksmatt@udel.edu>, "Okagaki, Lynn" <okagaki@udel.edu>, "Rieger, Mark" <mrieger@udel.edu>, "Watson, George H" <ghw@udel.edu>, "Vaughan, Michael L." <vaughan@udel.edu>, "Elliott, Dawn" <delliott@udel.edu> Re: Biomedical Engineering Permanent Status

We are supportive of permanent status for the BBE program.

Multidisciplinary programs are increasingly critical to the future of the university.

Sent from my iPhone

On Nov 3, 2014, at 11:25 AM, "Matt, Kathleen S." <<u>ksmatt@udel.edu</u>> wrote:

We support as well. We enjoy working closely with students in this great program. All the best, Kathy

Kathleen S Matt, PhD Dean, College of Health Sciences, UD Executive Director, DHSA

On Nov 3, 2014, at 11:10 AM, "Targett, Nancy M." <<u>ntargett@udel.edu</u>> wrote:

Tunde, I think this is a terrific program. It has my support. Best, nancy

From: Ogunnaike, Babatunde A.
Sent: Monday, November 3, 2014 11:06 AM
To: Matt, Kathleen S.; Okagaki, Lynn; Rieger, Mark; Targett, Nancy M.; Watson, George H; Weber, Bruce
Cc: Vaughan, Michael L.; Elliott, Dawn
Subject: Biomedical Engineering Permanent Status

Colleagues,

I trust that this note finds you all well.

As you all know, about 5 years ago, our college proposed a new undergraduate major in biomedical engineering. With the support of those of you who were here at the time, especially George (whose college provided instruction for most of the required courses outside of engineering), the major was granted the usual provisional status. I am writing to inform you that we are now preparing to approach the faculty senate to seek approval for a "Permanent Academic Program: Bachelor of Biomedical Engineering (BBE)", and, as we did the first time around, I also write to seek your support. While this program does not affect all of your colleges directly (again, 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 for permanent status. I already have George's support.

From its inception, the provisionally approved program has enjoyed strong demand and remarkable success. It has become one of the most popular among students interested in engineering, being especially popular with those

"Targett, Nancy M." <ntargett@UDel.Edu> November 3, 2014 11:10 AM To: "Ogunnaike, Babatunde A." <ogunnaik@udel.edu>, "Matt, Kathleen S." <ksmatt@udel.edu>, "Okagaki, Lynn" <okagaki@udel.edu>, "Rieger, Mark" <mrieger@udel.edu>, "Watson, George H" <ghw@udel.edu>, "Weber, Bruce" <bweber@udel.edu> Cc: "Vaughan, Michael L." <vaughan@udel.edu>, "Elliott, Dawn" <delliott@udel.edu> RE: Biomedical Engineering Permanent Status

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A simple response to this email indicating your support of the proposed permanent program in Biomedical Engineering is all I will need; it would be greatly appreciated.

Best regards, Tunde "Ogunnaike, Babatunde A." <ogunnaik@UDel.Edu> To: "Elliott, Dawn" <delliott@udel.edu>, "Vaughan, Michael L." <vaughan@udel.edu> Fwd: Biomedical Engineering Permanent Status

We have every dean.

Sent from my iPhone

Begin forwarded message:

From: "Okagaki, Lynn" <<u>okagaki@udel.edu</u>> Date: November 6, 2014 at 2:22:20 PM EST To: "Ogunnaike, Babatunde A." <<u>ogunnaik@udel.edu</u>> Subject: Re: Biomedical Engineering Permanent Status

I support your program.

From: <Ogunnaike>, "Babatunde A." <<u>ogunnaik@udel.edu</u>>

Date: Monday, November 3, 2014 11:05 AM

To: "Matt, Kathleen S." <<u>ksmatt@udel.edu</u>>, "Okagaki, Lynn" <<u>okagaki@udel.edu</u>>, "Rieger, Mark" <<u>mrieger@udel.edu</u>>, "Targett, Nancy M." <<u>ntargett@udel.edu</u>>, "Watson, George H" <<u>ghw@udel.edu</u>>, "Weber, Bruce" <<u>bweber@udel.edu</u>>
 Cc: "Vaughan, Michael L." <<u>vaughan@udel.edu</u>>, "Elliott, Dawn" <<u>delliott@udel.edu</u>>
 Subject: Biomedical Engineering Permanent Status

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"Matt. Kathleen S." <ksmatt@UDel.Edu> To: "Targett, Nancy M." <ntargett@udel.edu> Cc: "Ogunnaike, Babatunde A." <ogunnaik@udel.edu>, "Matt, Kathleen S." <ksmatt@udel.edu>, "Okagaki, Lynn" <okagaki@udel.edu>, "Rieger, Mark" <mrieger@udel.edu>, "Watson, George H" <ghw@udel.edu>, "Weber, Bruce" <bweber@udel.edu>, "Vaughan, Michael L." <vaughan@udel.edu>, "Elliott, Dawn" <delliott@udel.edu> **Re: Biomedical Engineering Permanent Status**

We support as well. We enjoy working closely with students in this great program. All the best, Kathy

Kathleen S Matt, PhD Dean. College of Health Sciences, UD Executive Director, DHSA

On Nov 3, 2014, at 11:10 AM, "Targett, Nancy M." <ntargett@udel.edu> wrote:

I think this is a terrific program. It has my support. Best. nancy

From: Ogunnaike, Babatunde A. Sent: Monday, November 3, 2014 11:06 AM To: Matt, Kathleen S.; Okagaki, Lynn; Rieger, Mark; Targett, Nancy M.; Watson, George H; Weber, Bruce Cc: Vaughan, Michael L.; Elliott, Dawn Subject: Biomedical Engineering Permanent Status

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Tunde.



Department of Chemical & Biomolecular Engineering OFFICE OF THE CHAIR

Newark, DE 19716-3110 Phone: 302-831-8079/8155 Fax: 302-831-8201

October 14, 2014

Professor Dawn Elliott Director, Biomedical Engineering Program University of Delaware CAMPUS

Dear Dawn:

I am pleased to write in strong support of the application of the Biomedical Engineering major for permanent status. Since its inception the major has attracted outstanding students and added an important new thrust to the directions open to engineering majors at the University of Delaware. The subsequent hiring of a group of excellent faculty and the establishment of a vigorous research effort in Biomedical Engineering has also provided the undergraduates in the major with extensive new research opportunities.

Within the undergraduate major we have been pleased to support the initial efforts by having some of our faculty teaching courses and having Biomedical Engineering majors enroll in some relevant courses in our department, including one that was a required course in the original curriculum. We are happy to continue to support your major in ways such as these, the most prevalent of which is likely to be via the continued inclusion of some of our courses as technical electives.

I wish you good luck with your application.

Best regards,

ychen

Abraham M. Lenhoff Allan P. Colburn Professor and Chair



College of Engineering

DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

301 DuPont Hall University of Delaware Newark, DE 19716-3120 Phone: 302-831-2442 Fax: 302-831-3640

October 9, 2014

To: Faculty Senate

From: Tripp Shenton, Chair Department of Civil and Environmental Engineering

Subject: Permanent status of Biomedical Engineering degree program

The Department of Civil and Environmental Engineering fully supports the application of the Biomedical Engineering (BBE) major for permanent status. This was the first new engineering degree to be created at UD in over a decade and represents a major step forward in providing well trained, highly capable graduates to this exciting and ever advancing field of engineering. The program was built with strong support of all of the departments in the college of engineering. The popularity of the major and quality of the students has been outstanding so far - we look forward to its continued success for many years to come.

Many of our courses are in the BME curriculum and we will continue to welcome these students in our courses, including elective courses CIEG 301, 302, 305, 311, 331, 351, and 400-699.



College of Engineering DEPARTMENT OF COMPUTER AND INFORMATION SCIENCES

October 7, 2014

Professor Dawn Elliott Director, Biomedical Engineering Program

Dear Professor Elliott,

It is with pleasure that I write on behalf of the Department of Computer and Information Sciences in strong support of the application of the Biomedical Engineering (BME) major for permanent status. The CIS faculty recognize that this is an important major that benefits the UD undergraduate students and as well as the research initiative on campus.

Many of our courses are in the BME curriculum and we will continue to welcome BME students in our courses, including required course CISC 106, and elective courses CISC 181, 220, 260, 275, 280, 303, 304, 310, 320, 360, 361, and 400-699. Our expectation is that there will be a full complement of BME students in CISC106 each year, while typically there will be a handful of BME students in each offering of the courses numbered 181 and higher. Our current class sizes and available resources are sufficient to handle those students in our courses.

We in CIS strongly support the granting of permanent status to your program.

vol Lof

Errol L. Lloyd Professor and Chair



Department of Electrical & Computer Engineering

Newark, DE 19716-3130 Phone: 302-831-2405 Fax: 302-831-4375

October 21, 2014

Dawn Elliott, PhD Director Biomedical Engineering Program

Dear Dr. Elliott:

The Department of Electrical and Computer Engineering supports the application of the Biomedical Engineering (BBE) major for permanent status. The faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

Many of our courses are in the BME curriculum and we will continue to welcome these students in our courses, including required course ELEG305, and elective courses ELEG306, ELEG320, ELEG 400-699.

We have multiple faculty members with joint and affiliated ECE/BME appointments and anticipate expanding such appointments and collaboration between the departments.

Kenneth E. Barner

Professor and Chair



College of Engineering

DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING 201 Dupont Hall Newark, DE 19716-3106 Phone: 302.831.2062 Fax: 302.831.4545 Email: matsci@udel.edu

October 9, 2014

Dear Prof. Elliott,

The Department of Materials Science and Engineering supports the application of the Biomedical Engineering (BBE) major for permanent status. The faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

Many of our MSEG courses are in the BME curriculum, and we will continue to welcome these students in our courses, including required course MSEG302 and MSEG460, and elective courses MSEG400-699.

Prof. Darrin Pochan Chair, Materials Science and Engineering 201 DuPont Hall University of Delaware Newark, DE 19716 pochan@udel.edu http://www.mseg.udel.edu



Suresh G. Advani Chair and G. W. Laird Professor of Mechanical Engineering and Associate Director, Center For Composite Materials University of Delaware Newark, Delaware 19716-3119 Ph: 302/831-8975 Fax: 302/831-3619

To whom it may concern

October 12th, 2014

Mechanical Engineering Department has played a critical role in the establishment of the BME program. Several ME faculty have partnered with BME and have been appointed affiliated faculty in BME. ME faculty taught some of the courses in the biomechanics course sequence during their early growth phase and the integrated senior design course established is a model of synergy and interdisciplinary educational experience for both ME and BME students. This is a unique experience of a capstone course in the college of engineering which has benefited both the departments. Many of our courses are in the BME curriculum and we will continue to welcome these students in our classes, including elective courses MEEG300-699.

The faculty recognizes this is an important major that benefits the undergraduate students and strengthens the interdisciplinary research initiative on campus. Hence I support the application of the Biomedical Engineering (BBE) major for permanent status at the University of Delaware.

Advani

Suresh G. Advani



College of Agriculture & Natural Resources

DEPARTMENT OF APPLIED ECONOMICS & STATISTICS

Titus O. Awokuse Department Chair 213 Townsend Hall Newark, Delaware 19716 Phone: 302-831-1323 Fax: 302-831-6243 Email: kuse@udel.edu

October 14, 2014

Dr. Dawn Elliot Professor and Director Biomedical Engineering University of Delaware Newark, DE 19716

Dear Dr. Morgan:

Re: Letter of Support for the degree program in Biomedical Engineering

As the Chair of the Department of Applied Economics and Statistics (APEC), I write in support of the application for permanent status for the degree program in Biomedical Engineering (BME) offered since 2010. Our department will continue to support this program by allowing BME students to take relevant courses offered by APEC. We are in support of your plan to continue to use several of our courses (STAT XXX) as part of the courses for the degree. My department is excited to be a part of this initiative and looks forward to having more of your students in the classroom. Please contact me if I can be of additional assistance in this process.

VOKuse

Titus O. Awokuse Professor and Chair

"Morgan, Robin W" <morgan@udel.edu> To: "Elliott, Dawn" <delliott@udel.edu> Cc: "Fontana, Tina M" <tfontana@udel.edu>, "Morgan, Robin W" <morgan@udel.edu> Support for permanent status for Biomedical Engineering

Dear Dawn,

The Biology Department sent you a letter on October 8th indicating that the Department of Biological Sciences would support the application of Biomedical Engineering major for permanent status. While I don't see a problem with getting support from Biology, at our faculty meeting today, it was pointed out to me that because this is an application for permanent status, I am required to get a vote of the faculty at a duly scheduled faculty meeting. Therefore, I need to rescind that letter of support. I will send the request immediately to the Biology Undergraduate Studies Committee for their review, and we will process this in accordance with our department by-laws at our next department meeting. In your application, you can attach this email to the previous letter I sent and indicate that formal review by the Biology Department is pending. I don't think anyone anticipates a problem with supporting your request for permanent status, but it is important for me to act in accordance with the department by-laws.

Could you resend the information about the program and the biology requirements? I think the letter of support was drafted by my assistant Tina Fontana, and I now need to forward the request to the Undergraduate Studies Committee in this department. We will get this done as quickly as possible.

Thanks, Robin

Robin W. Morgan, PhD Interim Department Chair - Biological Sciences Professor - Departments of Biological Sciences and Animal & Food Sciences Office: 118 C Wolf Hall University of Delaware Newark, DE 19716 Lab: Room 229 Delaware Biotechnology Institute 15 Innovation Way Newark, DE 19711 E-mail: morgan@udel.edu



DEPARTMENT OF BIOLOGY OFFICE OF THE CHAIR

University of Delaware Newark, Delaware 19716-2590 *Ph*: 302/831-6977 *Fax*: 302/831-2281

Robin W. Morgan, Ph.D. Professor and Chair Department of Biological Sciences 118C Wolf Hall Telephone (302) 831-4296 Fax No. (302) 831-1033 E-mail: morgan@udel.edu

October 8, 2014

Dr. Dawn Marie Elliott, Director Biomedical Engineering Program College of Engineering 125 E. Delaware Avenue Newark, Delaware

Dear Dr. Elliott:

The Department of Biological Sciences supports the application of the Biomedical Engineering (BBE) major for permanent status. The faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

Many of our courses are in the BME curriculum and we will continue to welcome these students in our courses, including required courses BISC207 and BISC208, and elective courses BISC400-699.

Best regards,

Om W.

Professor and Chair


Department of Chemistry & Biochemistry OFFICE OF THE CHAIR 102 Brown Laboratory Newark, DE 19716-2522 Phone: 302-831-1247 Fax: 302-831-6335

October 8, 2014

Professor Dawn Elliott Biomedical Engineering

Dear Dawn,

This letter is to confirm that the Department of Chemistry and Biochemistry supports the application of the Biomedical Engineering (BBE) major for permanent status. Our faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

Many of our courses are in the BME curriculum and we will continue to welcome these students in our courses, including required courses CHEM103, CHEM104, CHEM321, CHEM322, CHEM527, and elective courses CHEM400-699.

Please contact me if you have any questions.

Whenen te

Murray V. Johnston Professor and Chair Department of Chemistry and Biochemistry



DEPARTMENT OF KINESIOLOGY AND APPLIED PHYSIOLOGY COLLEGE OF HEALTH SCIENCES 540 South College Avenue 201T Health Sciences Complex Newark, Delaware 19713 Office: (302) 831-2937

October 13, 2014

Dawn Elliott, PhD Professor and Director Biomedical Engineering

Dear Dawn,

The Department of Kinesiology and Applied Physiology supports the application of the Biomedical Engineering (BBE) major for permanent status. The faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

Many of our courses are in the BME curriculum and we will continue to welcome these students in our courses, including elective courses KAAP 220, 309, 428, and 430.

Which B fg/L

William B. Farquhar, PhD, FACSM Professor and Chair, Dept. of Kinesiology and Applied Physiology College of Health Sciences



Department of Mathematical Sciences University of Delaware 501 Ewing Hall Newark, DE 19716-2553 Phone: 302-831-2653 Fax: 302-831-4511

October 9, 2014

Dear Professor Elliott:

The Department of Mathematical Sciences is pleased to support your application of the Biomedical Engineering (BME) major for permanent status. The faculty of our department recognize this as an important and successful major that benefits both our undergraduate students and many research initiatives on campus.

It is worth noting that this degree program routinely attracts the highly mathematically talented applicants to our campus and that we fully welcome these students into our courses. Many of our courses are part of the required BME curriculum, including Math 241, 242, 243, and 305, and students in this program often choose elective courses from our department, especially Math 351, 352, 353, 389, and 400-699. We are very happy to continue to welcome your students into our courses and wish you continued success with this excellent program.

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John A. Pelesko, Professor and Chair Department of Mathematical Sciences

Dear Professor Elliott,

The Department of Philosophy supports the application of the Biomedical Engineering (BBE) major for permanent status. The faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

We will continue to support PHIL444 Medical Ethics as a required course for the biomedical engineering students.

Best, Kai Draper



College of Health Sciences DEPARTMENT OF MEDICAL LABORATORY SCIENCES 305 Willard Hall Education Building Newark, DE 19716-3720 Phone: 302-831-2849 Fax: 302-831-4180 Email: mls-dept@udel.edu

October 13, 2014

Dawn Elliott, PhD Professor and Director Biomedical Engineering University of Delaware <u>delliott@udel.edu</u>

Dear Dr. Elliott,

I just wanted to inform you of our support for the Biomedical Engineering program as it applies for permanent status for the Bachelor of Biomedical Engineering degree. The Department of Medical Laboratory Sciences supports the application of the Biomedical Engineering (BME) as the faculty recognizes this as an important major benefiting the undergraduate students and as well as the research initiative on campus.

Many of our courses are in the BME curriculum and we will continue to welcome these students in our courses, including elective courses MEDT360, 390, 401, 403, 406.

Please feel free to contact me with any questions or concerns regarding our support of your program. We wish you the best as you move forward with this important offering to our undergraduate community.

Sincerely,

Michelle A. Parent, Ph.D. Associate Professor & Interim Chairperson Department Medical Laboratory Sciences College of Health Sciences University of Delaware



Department of Physics & Astronomy 104 The Green 217 Sharp Lab Newark, DE 19716-2570 Phone: 302-831-2661 Fax: 302-831-1637

October 13, 2014

Re: Biomedical Engineering (BME) major for permanent status

To Whom It May Concern:

I am pleased to declare my support for the application of the Biomedical Engineering (BME) major for permanent status. I recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

The Department of Physics and Astronomy will continue to welcome these students in our courses, several of which are already in the BME curriculum, including required courses PHYS 207 and PHYS 208, and elective courses PHYS 309, 310, 313, and 400-699.

If you require further information or would like to continue this discussion, please do not hesitate to contact me.

Cordially,

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Dr. Edmund R. Nowak Professor and Chair Department of Physics and Astronomy

October 11, 2014

Dawn:

The Department of Psychological and Brain Sciences enthusiastically supports the application of the Biomedical Engineering (BBE) major for permanent status. Our faculty recognize this is an important major that benefits the undergraduate students and as well as the research initiative on campus.

We will continue to welcome the BME students in our courses, including elective course NSCI 320 and we look forward to working with BBE as we craft a neuroscience minor that I think will be of interest to a number of your students.

Robert Simus

Robert F. Simons, Ph.D. Professor and Chair