

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: Takashi Buma and Robert Rogers Phone: 831-8447 and 831-8517

Department: Electrical & Computer Engineering Email: buma@ece.udel.edu and rrogers@ece.udel.edu

Action: Add minor in bioelectrical engineering

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

Effective term _____ 08F _____
(use format 04F, 05W)

Current degree _____ None _____
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

Proposed change leads to the degree of: _____ Minor in Bioelectrical Engineering _____
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

Proposed name: _____ Minor in Bioelectrical Engineering _____
Proposed new name for revised or new major / minor / concentration / academic unit
(if applicable)

Revising or Deleting: None

Undergraduate major / Concentration: _____
(Example: Applied Music – Instrumental degree BMAS)

Undergraduate minor: _____
(Example: African Studies, Business Administration, English, Leadership, etc.)

Graduate Program Policy statement change: _____
(Must attach your Graduate Program Policy Statement)

Graduate Program of Study: _____
(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

Graduate minor / concentration: _____

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

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

(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")

Two new courses are electives for the proposed minor.

ELEG 479 Introduction to Medical Imaging Systems - This course has been offered twice and is currently in the process of obtaining a permanent course number. Medical imaging systems encompass a wide range of electrical engineering concepts including device technology, signal processing, and computer hardware. This course provides engineering students with an important biomedical application of material covered in their previous coursework. Non-engineering students benefit from gaining a more quantitative understanding of the operating principles behind medical imaging technology. The Minor in Bioelectrical Engineering is strongly supported by the device physics, instrumentation, and signal and image processing covered in this course.

ELEG 680 Immunology for Engineers – This course has been offered once and is currently in the process of obtaining a permanent course number. Mathematical biology applies computational modeling to yield important and surprising insights to complex biological systems. This course emphasizes mathematical immunology to study the development and suppression of disease. Engineering students will benefit from the opportunity to apply their previous coursework to a medically significant problem. Non-engineering students benefit from learning how biological systems can be described in a mathematical framework. The Minor in Bioelectrical Engineering is strongly supported by the cell biology, mathematics, and computational modeling covered in this course.

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

2. Learn to think critically to solve problems.

The coursework challenges both non-engineering and engineering students to “think differently” about problems. Non-engineering students will apply more mathematics in problem solving. Engineering students will learn how to apply engineering concepts to less familiar biological scenarios.

5. Understand the diverse ways of thinking that underlie the search for knowledge in the arts, humanities, sciences and social sciences.

A deeper understanding of how signals are measured, processed, and displayed provides non-engineering students with a powerful tool for careers in academia or industry. Engineering students will gain more perspective by understanding the connection between their calculations with complex biological systems.

6. Develop the intellectual curiosity, confidence, and engagement that will lead to lifelong learning.

The proposed minor provides non-engineering students with the technical background necessary to communicate effectively with engineers. Likewise, engineering students will be able to relate with biologists, chemists, and even clinicians. These enhanced communication skills will foster not only teamwork but also curiosity and the ability to pursue creative ideas.

Identify other units affected by the proposed changes:

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

See attached support letters from the following departments:

Department of Biological Sciences – BISC 207 is required for the proposed minor. BISC 208 cannot be substituted for BISC 207.

Department of Human Movement and Exercise – HESC 688 is an elective course of the proposed minor that is open to any senior in the university who has completed the four required courses (see attachment).

Department of Mathematical Sciences – MATH 242 is required for the proposed minor.

Department of Physics – PHYS 202 or 208 are required for the proposed minor. It is understood that PHYS 201 or 207 are taken before PHYS 202 or 208.

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

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

Biomedical engineering is a rapidly growing field that is highly interdisciplinary. The lack of a dedicated biomedical engineering department at the University of Delaware forces biomedical engineering education to be distributed among existing departments. An undergraduate minor offers students the opportunity to merge biological sciences with a specific engineering discipline. Redundancy is avoided by ensuring the minor emphasizes the strengths of the particular engineering department while maintaining accessibility to any undergraduate student. For example, the Department of Mechanical Engineering offers a Biomedical Engineering Minor that emphasizes various aspects of biomechanics. The Department of Chemical Engineering offers a Biochemical Engineering Minor that emphasizes engineering approaches to pharmaceutical and biotechnology problems. Therefore, it is reasonable for the Department of Electrical and Computer Engineering to offer a minor in Bioelectrical Engineering. Instead of focusing on electronic instrumentation, the proposed minor takes a more general approach by emphasizing the acquisition, processing, and visualization of signals containing information regarding biological systems. In this manner we seek to create a formal minor in Bioelectrical Engineering that will serve the educational goals of the university at large. As a result, we expect that students who complete the minor will have an advantage when seeking either employment or advanced educational opportunities in this area.

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.)

Please see attached document for the proposed coursework.

Rationale for the proposed coursework:

The required courses are intended to provide students with sufficient background in both biology and engineering. BISC 207 covers the fundamentals of cell biology as well as laboratory techniques. MATH 242 further develops integration techniques and provides an introduction to computational work in symbolic, numerical, and graphical analysis. PHYS 202 and 208 cover the fundamentals of electricity and magnetism. ELEG 471 is an introduction to human physiology from an engineering perspective, while BISC 306 covers human physiology with a life sciences viewpoint. Undergraduates majoring in the life sciences benefit from taking courses with more mathematical content, which also prepares them for the technical electives. A comprehensive biology course challenges engineering students to extend beyond the boundaries of a “conventional” engineering curriculum.

The technical electives are open to any student who has completed successfully the required coursework. In the past, many of these courses have been taken by non-engineers as well as non-ELEG engineers. This strongly suggests that the technical electives are well within the capabilities of undergraduates who have not gone through the standard curriculum of the Electrical & Computer Engineering Department.

ROUTING AND AUTHORIZATION:

(Please do not remove supporting documentation.)

Department Chairperson g. [signature] Date 10/25/07
Dean of College _____ Date _____
Chairperson, College Curriculum Committee _____ Date _____
Chairperson, Senate Com. on UG or GR Studies _____ Date _____
Chairperson, Senate Coordinating Com. _____ Date _____
Secretary, Faculty Senate _____ Date _____
Date of Senate Resolution _____ Date to be Effective _____
Registrar _____ Program Code _____ Date _____
Vice Provost for Academic Programs & Planning _____ Date _____
Provost _____ Date _____
Board of Trustee Notification _____ Date _____

Attachment for Proposed Minor in Bioelectrical Engineering

MINOR IN BIOELECTRICAL ENGINEERING

A minor in Bioelectrical Engineering may be earned by a student in any University bachelor's degree program. This degree provides students with an opportunity to integrate physiology and biological sciences with engineering aspects in signal measurement and processing. To qualify for a Minor in Bioelectrical Engineering, students must complete a minimum of 21 credits as described below with a minimum grade of C- in each course.

CURRICULUM

CREDITS

Course requirements

(1) All students must take the following three courses:

BISC 207 ^(a)	Introductory Biology I	4
MATH 242	Analytic Geometry and Calculus B	4
PHYS 202 ^(b)	Introductory Physics II	4
or		
PHYS 208 ^(b)	Introductory Physics II	4

(2) And one of the following courses:

BISC 306	General Physiology	3
ELEG 471	Introduction to Biomedical Engineering	3

(3) And two of the following courses^(c):

ELEG 470	Biophysics of Excitable Membranes	3
ELEG 473	Signal Processing in Neural Systems	3
ELEG 475	Image Processing with Biomedical Applications	3
ELEG 478	Introduction to Nano and Biophotonics	3
ELEG 479	Introduction to Medical Imaging Systems	3
ELEG 676	Bioinformatics and Biosystems Analysis I	3
ELEG 680	Immunology for Engineers	3
BISC 627	Neuroscience II	3
HESC 688	Electromyographic Kinesiology	3

TOTAL CREDITS = 21

(a) BISC 208 cannot be substituted for BISC 207.

(b) It is understood that PHYS 201/207 is taken before PHYS 202/208.

(c) The listed 400 and 600-level courses are open to any student who has completed requirements (1) and (2) and the necessary prerequisites (or obtained permission of instructor).

Further inquiries about the Bioelectrical Engineering Minor can be made to Prof. Takashi Buma at 831-8447 (buma@ece.udel.edu).

PROPOSED COURSEWORK AND COMPARISON TO RELATED ENGINEERING MINORS

Bioelectrical Engineering Minor in ECE (21 credits)

Required courses (four)

BISC 207 Introductory Biology I
MATH 242 Calculus B
PHYS 202 or 208 Physics II

Choose ONE from:

BISC 306 General Physiology
ELEG 471 Intro to Biomedical Engineering

Elective courses (two)

ELEG 470 Biophysics of Excitable Membranes
ELEG 473 Signal Processing in Neural Systems
ELEG 475 Image Processing with Biomedical Applications
ELEG 478 Intro to Nano and Biophotonics
ELEG 479 Intro to Medical Imaging Systems
ELEG 676 Bioinformatics and Biosystems Analysis I
ELEG 680 Immunology for Engineers
BISC 627 Neuroscience II
HESC 688 Electromyographic Kinesiology

Biomedical Engineering Minor in MEEG (21 credits)

Required courses (four)

BISC 207 or 208 Introductory Biology I or II
MATH 243 Analytic Geometry and Calc C
PHYS 201 or 207 Physics I

Choose ONE from:

BISC 306 General Physiology
BISC 401 Mol. Biology of the Cell
HESC 220 Anatomy and Physiology

Elective courses (two)

MEEG 482 Clinical Biomechanics
MEEG 483 Orthopaedic Biomechanics
MEEG 484 Biomaterials and Tissue Engineering
MEEG 485 Control of Human Movement
MEEG 486 Cell and Tissue Transport
MEEG 612 Biomechanics of Human Movement
ELEG 471 Introduction to Biomedical Engineering

Biochemical Engineering Minor in CHEG (19 credits)

Required courses (four)

BISC 207 Introductory Biology I
BISC 401 Mol. Biology of the Cell
CHEM 527 Intro to Biochemistry
CHEG 620 Biochemical Engineering

Elective courses (two)

CHEG 621 Metabolic Engineering
CHEG 650 Biomedical Engineering
CHEM 643 Intermediary Metabolism
CHEM 644 Mechanisms of Enzyme Catalysis
CHEM 645 Protein Structure and Function
CHEM 646 DNA-Protein Interactions
CHEM 648 Membrane Biochemistry
CHEM 649 Molecular Biophysics

RELEVANT COURSEWORK FOR UNDERGRADUATES MAJORING IN ARTS & SCIENCES

<p><u>B.S. Biochemistry</u></p> <p><u>Required for Major</u> BISC 207, BISC 208, MATH 241, MATH 242 (very strongly recommended) PHYS 201, PHYS 202</p> <p><u>Typical technical elective for Major</u> BISC 306</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> Two elective courses</p>	<p><u>B.S. Chemistry</u></p> <p><u>Required for Major</u> MATH 241, MATH 242 PHYS 201, PHYS 202</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> BISC 207 ELEG 471 or BISC 306 Two elective courses</p>
<p><u>B.S. Biology (Cell & Molecular Biology and Genetics)</u></p> <p><u>Required for Major</u> BISC 207, BISC 208 MATH 241 PHYS 201, PHYS 202</p> <p><u>Typical technical elective for Major</u> BISC 306</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> MATH 242 Two elective courses</p>	<p><u>B.S. Biology (Biotechnology)</u></p> <p><u>Required for Major</u> BISC 207, BISC 208, MATH 241 PHYS 201, PHYS 202</p> <p><u>Typical technical elective for Major</u> BISC 306</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> MATH 242 Two elective courses</p>
<p><u>B.S. Quantitative Biology</u></p> <p><u>Required for Major</u> BISC 207, BISC 208 MATH 241, MATH 242, MATH 243 PHYS 207, PHYS 208</p> <p><u>Typical technical elective for Major</u> BISC 306</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> Two elective courses</p>	<p><u>B.S. Physics</u></p> <p><u>Required for Major</u> BISC 207 MATH 241, MATH 242, MATH 243 PHYS 207, PHYS 208</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> ELEG 471 or BISC 306 Two elective courses</p>
<p><u>B.S. Computer Science</u></p> <p><u>Required for Major</u> MATH 241, MATH 242 PHYS 207/208 or BISC 207/208</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> PHYS 208 or BISC 207 ELEG 471 or BISC 306 Two elective courses</p>	<p><u>B.S. in Exercise Science</u></p> <p><u>Required</u> MATH 242, PHYS 208 BISC 207, BISC 276 or 306</p> <p><u>Additional load for Bioelectrical Engineering Minor</u> Two elective courses</p>



COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF HEALTH,
NUTRITION, AND EXERCISE
SCIENCES

Carpenter Sports Building
University of Delaware
Newark, Delaware 19716-3750
Ph: 302/831-2265
Fax: 302/831-4261

October 24, 2007

Robert F. Rogers, Ph.D.
Assistant Professor
Dept. of Electrical & Computer Engineering
310 DuPont Hall
University of Delaware
Newark, DE 19716

Dear Professor Rogers:

Thank you for sharing your proposal for a minor in bioelectrical engineering. My department is in support of interdisciplinary programs in general, and this minor in particular, and we do not anticipate any problems associated with the inclusion of HESC688 as an elective course.

Regards,

A handwritten signature in cursive script that reads "Susan J. Hall".

Susan J. Hall, Ph.D.
Professor and Chair




DEPARTMENT OF BIOLOGY
OFFICE OF THE CHAIR

University of Delaware
Newark, Delaware 19716-2590
Ph: 302/831-6977
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Daniel D. Carson, Ph.D.
Trustees Distinguished Professor
and Chairman
Department of Biological Sciences
118C Wolf Hall
Telephone (302) 831-6977
Fax No. (302) 831-1033
E-mail: dcarson@udel.edu

October 23, 2007

MEMORANDUM

TO: Robert F. Rogers, Ph.D.
FROM: Dan Carson 
SUBJECT: Bioelectrical Engineering Minor

I and my Associate Chair, Dave Usher, have had a chance to review your proposed Bioelectrical Engineering Minor and support the concept of this interdisciplinary program. We don't anticipate any problems associated with the required or elective courses as they impact Biological Sciences.



DEPARTMENT OF
MATHEMATICAL SCIENCES

501 Ewing Hall
University of Delaware
Newark, Delaware 19716-2553
Ph: 302/831-2653
Fax: 302/831-4511/4456

Thursday, October 18, 2007

Professor Takashi Buma
Electrical and Computer Engineering
University of Delaware
Newark DE 19716

Dear Professor Buma:

I am writing to you to express the Department of Mathematical Sciences' support for your proposed undergraduate minor in Bioelectrical Engineering. You propose to add MATH242 as a required course, and we agree that this is highly desirable. We do not expect to need any more teaching resources to handle students in the Bioelectrical Engineering minor since most students in physical sciences already take MATH242.

We think that the minor will be of considerable interest to our Bachelor of Science students because of the great importance of applications in biology. We will certainly bring your minor to the attention of all our undergraduates.

Best wishes,

A handwritten signature in cursive script that reads "Peter Monk".

Peter Monk
Chair



DEPARTMENT OF PHYSICS
AND ASTRONOMY

University of Delaware
Newark, Delaware 19716
Phone: 302/831-3361
Fax: 302/831-1637

October 24, 2007

MEMORANDUM

TO: Prof. Takashi Buma, ECE

FROM: Norbert Mulders
Director Undergraduate Programs, DPA

SUBJECT: Bioelectrical Engineering Minor

The Department of Physics and Astronomy supports the introduction of a Minor in Bioelectrical Engineering. The physics courses proposed as part of the minor will not measurably increase the teaching load of the department.

We would hope that physics majors have access to this minor. Our only concern is that the proposed ELEG courses for this minor all have the restriction "only for seniors". It would be helpful if a statement could be made that this means that all seniors can register for these courses (provided they meet possible other prerequisites for the course), not just ECE majors.



UNIVERSITY OF
DELAWARE

DEPARTMENT OF ELECTRICAL
AND COMPUTER ENGINEERING

140 Evans Hall
University of Delaware
Newark, Delaware 19716-3130
Ph: 302/831-2405
Fax: 302/831-4316
<http://www.ece.udel.edu>

November 2, 2007

Norbert Mulders, Ph.D.
Director of Undergraduate Affairs
Department of Physics and Astronomy
262 Sharp Laboratory
University of Delaware
Newark, DE 19716

Dear Professor Mulders,

Thank you for your support of the proposed minor in Bioelectrical Engineering. We appreciate your concern about the accessibility of ELEG elective courses to undergraduates outside the ECE department. Yes, ELEG courses listed as "only for seniors" are indeed open to any senior, not just ECE majors, who has satisfied the necessary prerequisites or obtained permission of the instructor.

Thank you again for your support, and we look forward to collaborating with you in making the proposed minor in Bioelectrical Engineering a success.

Regards,

A handwritten signature in cursive script, appearing to read "Takashi Buma".

Takashi Buma
Assistant Professor
Department of Electrical & Computer Engineering