BIOMEDICAL ENGINEERING (BMEG)

Faculty

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Mission Statement

The biomedical engineering department is dedicated to providing the best possible undergraduate biomedical curricula to meet the full range of needs of a highly selective undergraduate student body. The program is designed to ensure that our students are qualified to enter and succeed in the biomedical engineering profession through direct entry to the industrial workplace or further professional study. The department strives to achieve a process of continuous improvement of the curricula, provide a faculty that is professionally current in their field, and to maintain state-of-the-art facilities.

To do this, the department offers the following:

- A Bachelor of Science in biomedical engineering degree for students seeking a comprehensive education in biomedical engineering.
- A minor in biomedical engineering for students in other engineering disciplines seeking a basic competency in the discipline and enhanced background in the life sciences.
- Elective courses to support the needs of students outside of the major and minor programs.

Program Educational Objectives

The following Program Educational Objectives of the Department of Biomedical Engineering at Bucknell University are broad statements that describe what graduates are expected to attain within a few years of graduation. As graduates will pursue diverse career paths, these objectives are intended to apply to those who pursue technical and professional careers.

- Alumni will experience success in a variety of biomedical engineering-related postgraduate environments or other diverse areas that require technical and/or professional skills.
- Alumni will contribute to their fields or professions.
- Alumni will pursue professional development, including continuing or advanced education, relevant to their career path.

Bachelor of Science in Biomedical Engineering

The **Bachelor of Science** in biomedical engineering requirements are:

First Year

First Semester	Credits	Second Semester	Credits
ENGR 100	1	BMEG 210	1
MATH 201	1	BMEG 226	.5
PHYS 211	1	MATH 202	1
Elective	1	PHYS 212	1
		Elective	1
	4		4.5

Sophomore

First Semester	Credits	Second Semester	Credits
BMEG 250	1	BMEG 205	1
BMEG 409	.5	BMEG 220	.5
CHEM 205	1	CHEM 211	1
MATH 211	1	MATH 212	1
Elective	1	ENGR 240	1
	4.5		4.5

Junior

First Semester	Credits	Second Semester	Credits
BMEG 350	1	BMEG 300	1

BIOL 205	1	BMEG 408	.5
Two Electives	2	CHEM 230	1
		BIOL 221	1
		Elective	1
	4		4.5

Senior

First Semester	Credits	Second Semester	Credits
BMEG 400	1	BMEG 402	1
BMEG 401	1	Three electives	3
Two Electives	2		
	4		4

Total Credits: 34

The nine electives courses are distributed as follows:

- Five courses selected from any of the following: social science courses, arts and humanities courses, university courses, residential college courses, or foundation seminars. These five courses must include one course in arts and humanities and one course in social sciences.
- Two approved 200+ level engineering, math, or science courses from the list published by the department.
- One approved 300+ level engineering course from the list published by the department.
- One BMEG engineering elective course from the list published by the department.
- Two courses in any department or program of the University provided that the prerequisites are satisfied.

Of all courses in the student's degree program (required and elective courses):

- Three courses must fulfill the University writing requirement.
- One course must fulfill the college global perspectives requirement.

Minor in Biomedical Engineering

Engineering students not pursuing the Bachelor of Science in biomedical engineering may choose to pursue a **minor** in biomedical engineering. This minor is attained through a judicious use of electives that combine the study of the basic biological sciences with their area of technological interest. To complete the biomedical engineering minor, engineering students must successfully complete at least five credits from approved courses as follows. Additional courses may be approved by the Biomedical Engineering Department on a case-by-case basis.

At least two credits from the following list with at least one having a [1] designation:

BMEG 431	Biomimetic Materials [1]	1
BMEG 441/ECEG 411	Neural Signals and Systems [1]	1
BMEG 451	Biomechanics and Injury Prevention [1]	1
BMEG 452	Human Factors [1]	1
BMEG/MECH 457	Accident Analysis	1
BMEG 461	Brain, Mind and Culture [1]	1
BMEG 465	Biomedical Modeling [1]	1
BMEG 471/472	Advanced Topics in Biomedical Engineering [1]	1
BMEG 480/481	Biomedical Engineering Project	.5
BMEG 490/491	Biomedical Engineering Research	1
CHEG 452	Bioprocess Engineering	1
CHEG 454	Pharmaceutical Engineering	1
CHEG 460	Biomaterials: Materials in Medicine	1
MECH 476	Biomechanics	1
Select remaining credits from the above list or the following:		
BIOL 205	Introduction to Molecules and Cells	1
BIOL 206	Organismal Biology	1
BIOL 207	Genetics	1
BIOL 221	Human Physiology	1
BIOL 312	Comparative Vertebrate Anatomy	1
BIOL 318	Principles of Physiology	1

BIOL 324	Neurophysiology	1
BIOL 326	Cytogenetics	1
BIOL 327	Molecular Biology	1
BIOL 328	Endocrinology	1
BIOL 340/CHEM 358	Biochemical Methods	1
BIOL 348	Immunology	1
BIOL 352	Cell Biology	1
BIOL 365	Introduction to Microscopy	1
CHEM 340	Biological Physical Chemistry	1
CHEM 351	Biochemistry I	1
CHEM 352	Biochemistry II	1
CHEM 358/BIOL 340	Biochemical Methods	1

Graduates of the program shall demonstrate the following learning outcomes which reflect ABET accreditation requirements:

a. An ability to apply knowledge of mathematics, science, and engineering.

b. An ability to design and conduct experiments, as well as analyze and interpret data.

c. 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.

d. An ability to function on multidisciplinary teams.

e An ability to identify, formulate, and solve engineering problems.

f. An understanding of professional and ethical responsibility.

g. An ability to communicate effectively.

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

i. A recognition of the need for, and an ability to engage in life-long learning.

j. A knowledge of contemporary issues.

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Courses

BMEG 205. Bioinstrumentation I. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:2
Introduction to analog and digital circuits with applications to medicine and biology. Corequisite: MATH 212. Prerequisite: MATH 202. Open to biomedical engineering majors only.

BMEG 210. Fundamentals of Biomedical Engineering. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Other:2
Introduction to the application of fluid mechanics, mass transfer, instrumentation, mechanics, and societal issues to biomedical problems. Hands-on laboratory experiences integrated with lecture. Prerequisites: MATH 201 and PHYS 211. Open to biomedical engineering majors only.

BMEG 220. Introduction to Engineering Computing. .5 Credits.
Offered Spring Semester Only; Lecture hours:2,Other:1
Introduction to numerical methods and programming fundamentals. Problems drawn from mathematics, engineering, and biomedical engineering. Corequisite: MATH 212. Not open to students who have taken ENGR 211, ENGR 212, ENGR 214. Open to biomedical engineering majors only.

BMEG 226. Statistical Methods in Biomedical Engineering. .5 Credits.
Offered Spring Semester Only; Lecture hours:2,Other:1
Introduction to concepts in experimental design and data analysis with application to biomedical engineering, medicine, and biology. Prerequisite: MATH 201. Not open to students who have taken ENGR 215, MATH 216 or MATH 226. Open to biomedical engineering majors only.

BMEG 250. Fundamentals of Biomechanics. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Lab:2
Application of mechanical analyses to solve biomechanical problems including: equilibrium of rigid bodies, anthropometric analysis, link segment analysis, internal loads, combined loading, failure theory. Prerequisites: PHYS 211 and MATH 201. Not open to students who have taken ENGR 220, ENGR 221 or MECH 220. Open to biomedical engineering majors only.

BMEG 300. Biotransport I. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:2
First biotransport course. Fluid mechanics principles applied to biological systems and medical devices. Properties of biological fluids, energy and momentum balances, computational modeling. Prerequisite: MATH 212. Not open to students who have taken CHEG 300, ENGR 222, or ENGR 233. Open to biomedical engineering majors only.

BMEG 350. Fundamental of Biomedical Signals and Systems. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Lab:2
Time and frequency analysis, filter design and feedback control as applied to biomedical signals and systems. Prerequisites: BMEG 205 and MATH 212. Open to biomedical engineering majors only.

BMEG 400. Biotransport II. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Lab:2
Second biotransport course focusing on the advanced application of fundamental heat and mass transport concepts to biological systems and medical devices. Conduction, convection, thermal properties of materials, mass diffusion, compartmental modeling. Prerequisite: BMEG 300. Open to biomedical engineering majors only.

BMEG 401. Biomedical Engineering Capstone I. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Lab:2
Senior design course emphasizing the biomedical engineering design process including problem identification and medical motivation, background research, medical regulations and ethics, design and project proposal presentation. Prerequisite: BMEG 408. Open to biomedical engineering majors only.

BMEG 402. Biomedical Engineering Capstone II. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Lab:2
Second semester of the biomedical engineering design sequence emphasizing fabrication, instrumentation, testing and evaluation, and final presentation of projects. Prerequisites: BMEG 401. Open to biomedical engineering majors only.

BMEG 408. Medical Device Assessment and Development. .5 Credits.
Offered Spring Semester Only; Lecture hours:2,Other:1
An examination of medical device design including benchmarking, intellectual property, regulatory pathways, industry standards, project planning, project management, and individual and team professionalism. Topics will be applied to currently marketed medical devices. Prerequisites: BMEG 205. Open to biomedical engineering majors only.

BMEG 409. Fabrication and Experimental Design. .5 Credits.
Offered Fall Semester Only; Lecture hours:2,Other:1
A hands-on course focusing on skills relevant to biomedical engineers, such as computer-aided design and documentation, fabrication, materials, selection and biocompatibility. Cell culture and experimental design. Class will be a mixture of lectures and hands-on activities. Prerequisite: BMEG 226. Open to biomedical engineering majors only.

BMEG 431. Biomimetic Materials. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Recitation:1
Introduction to topics in biomimetics, studying nature as an inspiration for engineering design. Topics include relationships between microstructure and physical properties of natural materials and tissue engineering approaches to biomaterials design. Prerequisite: permission of the instructor.

BMEG 441. Neural Signals and Systems. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Recitation:1
Introduction to neural systems and signaling. Topics include neural physiology, models of action potential generation and synapse dynamics, neural networks and techniques of neural waveform analysis. Prerequisite: permission of the instructor. Crosslisted as ECEG 411 and ECEG 611.

BMEG 451. Biomechanics and Injury Prevention. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Recitation:1
Survey course for field of biomechanics and research for injury prevention (lowering risk and/or severity). Mixture of lectures, labs, and projects. Prerequisite: permission of the instructor.

BMEG 452. Human Factors. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Recitation:1
Introduction to human factors and occupational biomechanics. Topics include: work-related musculoskeletal disorders, hand tool design, anthropometry, low back biomechanics. Prerequisite: permission of the instructor.

BMEG 457. Accident Analysis. 1 Credit.
Offered Either Fall or Spring; Lecture hours:4
Vehicle crash dynamics and crashworthiness. Non motor-vehicle accidents. Mechanics of injuries. Evaluation of designs intended to reduce risk of injury. Prerequisite: permission of the instructor. Crosslisted as MECH 457.

BMEG 461. Brain, Mind and Culture. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Recitation:1
The goal of this course is to use the tools of biomedical technologies, network and game theory to address enduring cultural questions. Prerequisite: permission of the instructor.

BMEG 465. Biomedical Modeling. 1 Credit.
Offered Either Fall or Spring; Lecture hours:3,Recitation:1
Application of computational models to understanding normal and pathological biological function and to the design of diagnostic tools and therapeutic interventions. Prerequisite: permission of the instructor.

BMEG 471. Advanced Topics in Biomedical Engineering. 1 Credit.
Offered Fall Semester Only; Lecture hours:3,Recitation:1; Repeatable
Advanced, in-depth course developed from areas of biomedical engineering. Topics will vary. Prerequisite: permission of the instructor.

BMEG 472. Advanced Topics in Biomedical Engineering. 1 Credit.
Offered Spring Semester Only; Lecture hours:3,Recitation:1; Repeatable
Advanced, in-depth course developed from areas of biomedical engineering. Topics will vary. Prerequisite: permission of the instructor.

BMEG 480. Biomedical Engineering Project. .5 Credits.
Offered Fall Semester Only; Lecture hours:1,Other:5; Repeatable
Individual work with a faculty adviser on development, design, or research project beginning with a written plan and culminating with a written or oral presentation. Prerequisite: permission of the instructor.

BMEG 481. Biomedical Engineering Project. .5 Credits.
Offered Spring Semester Only; Lecture hours:1,Other:5; Repeatable
Individual work with a faculty adviser on development, design, or research project beginning with a written plan and culminating with a written or oral presentation. Prerequisite: permission of the instructor.

BMEG 490. Biomedical Engineering Research. 1 Credit.
Offered Fall Semester Only; Lecture hours:1,Other:10; Repeatable
Independent study with a faculty adviser on a research or design project. Submit a proposal for group review, conduct the work, and culminate with a written report and an oral presentation before a faculty group. Prerequisite: permission of the instructor.

BMEG 491. Biomedical Engineering Research. 1 Credit.
Offered Spring Semester Only; Lecture hours:1,Other:10; Repeatable
Independent study with a faculty adviser on a research or design project. Submit a project proposal for group review, conduct the work, and culminate with a written report and an oral presentation before a faculty group. Prerequisite: permission of the instructor.