Biomedical Engineering (BME)

Major in Biomedical Engineering

Department of Biomedical Engineering, College of Engineering and Applied Sciences

CHAIRPERSON: Clinton Rubin  UNDERGRADUATE PROGRAM DIRECTOR: Mary Frame McMahon
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Minors of particular interest to students majoring in Biomedical Engineering: Biochemistry (BCH), Biology (BIO) Chemistry (CHE), Optics (OPT)

Faculty

Danny Bluestein, Associate Professor, Ph.D., Tel Aviv University: Cardiovascular flow mechanics and pathologies; prosthetic devices.

Weiliam Chen, Assistant Professor, Ph.D., University of Michigan: Gene therapy and drug delivery.

Ki Chon, Associate Professor, Ph.D., University of Southern California: Cardiac autonomic nervous system in normal and diseased states; renal autoregulatory dynamics; neuro-respiratory control; medical devices; clinical diagnostic and prognostic applications.

Richard Clark, Professor, M.D., University of Rochester: Tissue engineering; skin cell activation; tissue formation of healing cutaneous wounds.

Anil Dhundale, Assistant Professor, Ph.D., Stony Brook University: Development of diagnostic and research products in biotechnology, pharmaceutical, and medical devices; DNA microarray.

Shmuel Einav, Professor, Ph.D., Stony Brook University: Blood-tissue interaction; vascular prosthetic devices.

Emilia Entcheva, Assistant Professor, Ph.D., University of Memphis: Cardiac cellular electromechanics; cardiac tissue engineering; fluorescence imaging; computer simulations of cellular function.

Michael Hadjiargyrou, Associate Professor, Ph.D., City University of New York: Molecular mechanisms of bone development and regeneration.

Stefan Judex, Assistant Professor, Ph.D., University of Calgary: Adaptation response to mechanical stimuli at the organ, tissue, cellular and molecular levels.

Partap Khalsa, Associate Professor, Ph.D., Worcester Polytechnic Institute: Robotics; haptic interfaces in robotics; neural encoding.

Wei Lin, Research Assistant Professor, Ph.D., Stony Brook University: Noninvasive assessment of bone quality; confocal acoustic scanning technology.

Mary Frame McMahon, Associate Professor, Ph.D., University of Missouri: Microvascular network flow control; nanobiotechnology; tissue engineering of vascular structures.

Lilanne Mujica-Parodi, Assistant Professor, Ph.D., Columbia University: Limbic dysregulation in schizophrenia; physiological/cognitive components of human arousal response; complex systems analysis.

Yingtian Pan, Associate Professor, Ph.D., Huazhong University of Science and Technology: Optical imaging of biological tissue at the cellular level; diagnosis and assessment of tissue growth.

Yi-Xian Qin, Associate Professor, Ph.D., Stony Brook University: Fluid flow of porous structures; ultrasonic-based diagnostics.

Clinton Rubin, Professor, Ph.D., University of Bristol: Adaptation of the skeletal system; therapeutic medical devices.

Helmut Strey, Assistant Professor, Ph.D., Technical University, Munich: Characterization of nanostructured materials for bioseparation; controlled drug delivery; biosensors; DNA sequencing applications.

Adjunct Faculty

Estimated number: 8

Teaching Assistants

Estimated number: 16

The Department of Biomedical Engineering offers the major in Biomedical Engineering, leading to the Bachelor of Engineering (B.E.) degree. The Department also offers a minor in Bioengineering designed for non-engineering students. (See the entry in the alphabetical listings of Approved Majors, Minors, and Programs for the requirements for the minor in Bioengineering.) In a rigorous, cross-disciplinary training and research environment, the major program provides an engineering education along with a strong background in the biological and physical sciences. It is designed to enhance the development of creativity and collaboration through study of a specialization within the field of biomedical engineering. Teamwork, communication skills, and hands-on laboratory and research experience are emphasized. The curriculum provides students with the underlying engineering principles required to understand how biological organisms are formed and how they respond to their environment.

Core courses provide depth within the broad field of biomedical engineering. These are integrated with, and rely upon, course offerings from both the College of Engineering and Applied Sciences and the College of Arts and Sciences. To achieve the breadth of engineering experience expected of Biomedical Engineering graduates, additional elective courses from the College of Engineering and Applied Sciences are required of all Biomedical Engineering students.

The Department also offers a five-year combined B.E./M.S. degree, which can be completed within one additional year of studies beyond the Bachelor's degree.

The combined B.E./M.S. is intended to prepare high-achieving and highly-motivated undergraduate BME students for either doctoral studies or a variety of advanced professional positions. The program is highly selective with admission based on academic performance as well as undergraduate research. Juniors can be admitted into the combined degree program if they satisfy the requirements outlined in the Graduate Bulletin. The requirements for the combined program are the same as the requirements for the B.E. and M.S. degree, except that two graduate 500-level courses replace two 300-level electives, so that six graduate credits are counted towards the undergraduate degree.

Graduates are prepared for entry into professions in biomedical engineering, biotechnology, pharmaceuticals, and medical technology, as well as careers in academia and government. Potential employers include colleges and universities, hospitals, government, research institutes and laboratories, and private industry.
Program Educational Objectives
The undergraduate program in biomedical engineering has the following five specific program educational objectives:

1. Career Preparation: Our graduates will be prepared to excel in bioengineering, bioscience, or medical disciplines in basic and applied research, design, or technology development, representing the fields of academics, government, medicine, law, or industry.

2. Professional Development: Our graduates will emerge as recognized experts in the field of biomedical engineering, and serve in positions of leadership in academics, government, medicine, or industry. Further, our alumni will function successfully as principal members of integrative and interdisciplinary teams.

3. Professional Conduct: Our graduates will hold paramount the health, safety, and welfare of the public, and conduct themselves in a professional and ethical manner at all times. Further, our alumni will communicate effectively to a variety of target audiences through both written and oral media.

4. Societal Contribution: Our graduates will respond and adapt to the scientific and engineering needs of society both nationally and internationally, seek out new opportunities, and contribute to the development of a healthy and globally competitive economy.

5. Life-long Learning: Our graduates will continually build on their undergraduate foundation of science, engineering, and societal understanding, and continue to develop their knowledge, skills, and contributions throughout their professional careers and private lives. This will include active participation in professional societies, attending and making presentations at conferences, and participating in outreach activities within their areas of expertise.

Program Outcomes
To prepare students to meet the above program educational objectives, a set of program outcomes that describes what students should know and be able to do when they graduate, have been adopted. We expect students to gain:

a. the ability to apply knowledge of advanced mathematics, science, biology, physiology, biotechnology, and engineering;

b. the ability to design and conduct experiments from living and non-living systems, as well as to analyze and interpret data;

c. the 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. the ability to function on multidisciplinary teams;

e. the ability to identify, formulate, and solve problems at the interface of engineering and biology;

f. the understanding of professional and ethical responsibility;

g. the ability to communicate effectively;

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

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

j. a knowledge of contemporary issues; and

k. the ability to use the techniques, skills, and modern engineering tools necessary for addressing the problems associated with the interaction between living and/or non-living materials and systems.

More details about program educational objectives and outcomes can be found at http://bme.sunysb.edu/bme/ugrad/index.html#abet.
Courses Offered in Biomedical Engineering

See the Course Descriptions listing in this Bulletin for complete information.
BME 100 Introduction to Biomedical Engineering
BME 201-H Biomedical Engineering and Society
BME 212 Biomedical Engineering Research Fundamentals
BME 300 Writing in Biomedical Engineering
BME 301 Bioelectricity
BME 303 Biomechanics
BME 304 Genetic Engineering
BME 305 Biofluids
BME 313 Biomonitoring
BME 353 Biomaterials: Manufacture, Properties, and Applications
BME 381 Nanofabrication in Biomedical Applications
BME 404 Essentials of Tissue Engineering
BME 420 Computational Biomechanics
BME 430 Engineering Approaches to Drug and Gene Delivery
BME 440 Biomedical Engineering Design
BME 441 Senior Design Project in Biomedical Engineering
BME 461 Biomedical Statistics
BME 475 Undergraduate Teaching Practicum
BME 481 Biosensors
BME 488 Biomedical Engineering Internship
BME 499 Research in Biomedical Engineering

Acceptance into the Major in Biomedical Engineering

Freshman applicants who have specified their interest in the major in Biomedical Engineering may be accepted directly into the major upon admission to the University. Freshman and transfer applicants admitted to the University but not immediately accepted into the Biomedical Engineering major may apply for acceptance to the major at any time during the academic year by contacting the director of the undergraduate program. Students in good academic standing may apply in any semester, but priority for admission to the Biomedical Engineering major is given to those students who have:

1. completed MAT 132 and PHY 132/134 or their equivalents;
2. earned a g.p.a. of 3.20 in all mathematics and physics courses with no more than one grade in the C range; and
3. received completed course evaluations for all transferred courses that are to be used to meet requirements of the major.

Requirements for the Major in Biomedical Engineering (BME)

The curriculum begins with a focus on basic mathematics and the natural sciences followed by courses that emphasize engineering science and bridging courses that combine engineering science and design. The sequence of courses culminates with a one-year design experience that integrates the science, engineering, and communication knowledge acquired. The technical electives and additional courses are chosen in consultation with a faculty advisor, taking into consideration the particular interest of the student. Completion of the major requires approximately 130 credits.

1. Mathematics
   a. AMS 151, 161 Calculus I, II
   b. AMS 261 or MAT 203 or MAT 205 Calculus III
   c. AMS 361 or MAT 303 or MAT 305 Calculus IV
   d. AMS 210 Matrix Methods and Models
   e. AMS 310 Survey of Probability and Statistics

   Note: The following alternate calculus course sequences may be substituted for AMS 151, 161:
   - MAT 125, 126, 127
   - MAT 131, 132
   - MAT 141, 142
   - MAT 171

2. Natural Sciences
   a. BIO 202 Fundamentals of Biology: Molecular and Cellular Biology or RIO 203 Fundamentals of Biology: Cellular and Organ Physiology
   b. CHE 131, 132 General Chemistry I, II
   c. PHY 131/133, 132/134 Classical Physics I, II with labs

   Note: The following alternate science sequences may be substituted:
   - PHY 125, 126, 127, or PHY 141, 142 in lieu of PHY 131/133, 132/134
   - CHE 141, 142, in lieu of CHE 131, 132

3. Computers and Programming
   a. ESG 111 C Programming for Engineers
   b. MEC 112 Practical C/C++ for Scientists and Engineers
   c. ESE 124 Computer Techniques for Electronic Design
   d. CSE 130 Introduction to Programming in C

4. Engineering
   a. MEC 250 Engineering Statics
   b. MEC 262 Engineering Dynamics
   c. ESE 271 Electrical Circuit Analysis I

5. Biomedical Engineering
   a. BME 100 Introduction to Biomedical Engineering
   b. BME 212 Laboratory Methods in Biomedical Engineering
   c. BME 301 Bioelectricity
   d. BME 304 Genetic Engineering
   e. BME 305 Biofluids
   f. BME 440 Biomedical Engineering Design
   g. BME 441 Senior Design Project in Bioengineering

6. Biomedical Engineering Specializations and Technical Electives

Biomedical engineering students must complete a specialization, composed of at least 30 credits in one of four areas, including at least two 3- to 4-credit design technical elective courses. (See below for the four specializations with course options.) The specialization must be declared in writing by the end of the sophomore year and is selected in consultation with the faculty advisor to ensure a cohesive curriculum with depth at the upper level.

7. Upper-Division Writing Requirement: BME 300 Writing in Biomedical Engineering

All degree candidates must demonstrate skill in written English at a level acceptable for engineering majors. All Biomedical Engineering students must complete the writing course BME 300 concurrently with a selected BME 300-level course. The quality of writing in technical reports submitted for the course is evaluated, and students whose writing does not meet the

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Grading
All courses taken to satisfy 1–6 above must be taken for a letter grade. A grade of C or higher is required in the following courses: AMS 151, 161 or equivalent; BIO 202 or 203; CHE 131, 132 or equivalent; PHY 131/133, 132/134 or equivalent; all BME courses.

Specializations
To complete the specialization, students choose from the technical elective course list for one of the four specializations. Other courses may be used towards this requirement with the permission of the undergraduate program director.

a. Biomechanics
Courses that focus on developing an understanding of mechanical structures and dynamics of biological systems. This specialization is appropriate for students interested in the areas of biofluid mechanics, hard and soft tissue biomechanics, biomaterials, medical prosthetics, or bioinstrumentation.

Recommended courses:
BME 303 Biomechanics
BME 313 Bioinstrumentation
BME 381 Nanofabrication in Biomedical Applications
BME 404 Essentials of Tissue Engineering
BME 420 Computational Biomechanics
BME 430 Engineering Approaches to Drug and Gene Delivery
BME 481 Biosensors
ESG 302 Thermodynamics of Materials
ESM 353 Biomaterials
MEC 363 Mechanics of Solids

Alternative courses:
AMS 331 Mathematical Modeling
CSE 326 Digital Image Processing
CSE 332 Introduction to Scientific Visualization
ESE 315 Control System Design
ESM 359 Polymers
ESM 450 Phase Changes and Mechanical Properties of Materials
MEC 320 Engineering Design Methodology and Optimization

b. Biomaterials
Courses focusing on the development of understanding of various material sciences issues pertinent to biomedical problems, specifically issues of biocompatibility of materials used in the design of biomedical devices and implants. Students study the basics of biology, organic chemistry, and material science to understand how to apply knowledge acquired to the design of prosthetic devices and materials that will be in contact with living tissues and organs.

Recommended courses:
BME 303 Biomechanics
BME 313 Bioinstrumentation
BME 381 Nanofabrication in Biomedical Applications or BME 481 Biosensors
BME 404 Essentials of Tissue Engineering
BME 420 Computational Biomechanics
BME 430 Engineering Approaches to Drug and Gene Delivery
ESE 332 Materials Science I
ESM 335 Strength of Materials
ESM 353 Biomaterials
ESM 369 Polymers

Alternative courses:
ESG 281 Engineering Intro to Solid State
ESG 302 Thermodynamics of Materials
ESG 316 Engineering Science Design II
ESM 321 Introduction to the Chemistry of Solids
ESM 309 Thermodynamics of Solids
ESM 325 Diffraction Techniques and Structure of Solids
ESM 334 Materials Engineering
ESM 335 Strength of Materials
ESM 355 Materials and Processes in Manufacturing Design
ESM 450 Phase Changes and Mechanical Properties of Materials

MEC 402 Mechanical Vibrations
MEC 410 Design of Machine Elements
MEC 411 Control System Analysis and Design
MEC 455 Applied Stress Analysis

MEC 310 Introduction to Machine Design
MEC 320 Engineering Design Methodology and Optimization
MEC 410 Design of Machine Elements
MEC 455 Applied Stress Analysis

Spring 2007: updates since Fall 2006 are in red
**Recommended courses:**

(Students should take both BIO 202 and BIO 203.)

BIO 202 Fundamentals of Biology: Molecular and Cellular Biology
BIO 203 Fundamentals of Biology: Cellular and Organ Physiology
BIO 317 Principles of Cellular Signaling
BME 313 Bi instrumentation
BME 381 Nanofabrication in Biomedical Applications
BME 404 Essentials of Tissue Engineering
BME 461 Biosystems Analysis
BME 481 Biosensors
CHE 321 Organic Chemistry I
CHE 322 Organic Chemistry II
CHE 327 Organic Chemistry Laboratory

**Alternative courses:**

BIO 302 Human Genetics
BIO 310 Cell Biology
BIO 311 Techniques in Molecular and Cellular Biology
BIO 320 General Genetics
BIO 325 Animal Development
BIO 328 Mammalian Physiology
BIO 361 Biochemistry I
BIO 362 Biochemistry II
BIO 365 Biochemistry Laboratory
BME 303 Biomechanics
BME 430 Engineering Approaches to Drug and Gene Delivery
CHE 312 Physical Chemistry
CHE 346 Biomolecular Structure and Reactivity
CHE 353 Chemical Thermodynamics
ESG 332 Materials Science I
BME/ESM 353 Biomaterials: Manufacture, Properties and Applications
ESM 369 Polymers