Biomedical Engineering (BME)

Major in Biomedical Engineering
Department of Biomedical Engineering, College of Engineering and Applied Sciences

CHAIRPERSON: Clinton Rubin  UNDERGRADUATE DIRECTOR: Danny Bluestein  UNDERGRADUATE PROGRAM ASSISTANT: Marilynn Cute
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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-vascular 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 Ertecheva, Assistant Professor, Ph.D., University of Memphis: Cardiac cellular electromechanics; cardiac tissue engineering; fluorescence imaging; computer simulations of cellular function.
Mary D. Frame, Associate Professor, Ph.D., University of Missouri: Microvascular network flow control; nanobiotechnology, tissue engineering of vascular structures.
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.
Lilianne 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.

Affiliated Faculty
Christopher Berndt, Materials Science and Engineering

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 Biomedical Engineering.) 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.

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.

The current Program Educational Objectives for the Biomedical Engineering program are available at http://bme.sunysb.edu/bme/ugrad/overview.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  Laboratory Methods in Biomedical Engineering
BME 300  Writing in Biomedical Engineering
BME 301  Bioelectricity
BME 303  Engineering Methods in Biomechanics
BME 304  Genetic Engineering
BME 305  Biofluids
BME 313  Virtual Bioinstrumentation
BME 353  Biomaterials: Manufacture, Properties, and Applications
BME 381  Nanofabrication in Biomedical Engineering
BME 404  Essentials of Tissue Engineering

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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  Linear Systems Analysis with Biomedical Applications
BME 475  Undergraduate Teaching Practicum
BME 481  Biosensors
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 110 credits.

Sample Course Sequence for the Major in Biomedical Engineering

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<tr>
<th>Freshman Fall Credits</th>
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<tr>
<td>D.E.C. A 3</td>
<td>AMS 161 3</td>
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<tr>
<td>First Year Seminar 101</td>
<td>CHE 131 4</td>
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<td>CHE 262 3</td>
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<td>D.E.C. 3</td>
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<td>BIO 202 or 203 4</td>
<td>MEC 212 3</td>
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<td>D.E.C. 3</td>
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<td>BME 305 3</td>
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<td>Specialization elective 3</td>
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<td>D.E.C. 3</td>
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<td>Total 16</td>
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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 310 Survey of Probability and Statistics

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

2. Natural Sciences
a. BIO 150 The Living World
b. BIO 202 Fundamentals of Biology: Molecular and Cellular Biology or BIO 203 Fundamentals of Biology: Cellular and Organ Physiology
c. CHE 131, 132 General Chemistry I, II
d. 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
   or MEC 112 Practical C/C++ for Scientists and Engineers
   or ESE 124 Computer Techniques for Electronic Design
   b. MEC 203 Technical Drawing and Computer Aided Drafting

4. Engineering
   a. MEC 260 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 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 required standard are referred for remedial help. Satisfactory writing warrants an S grade for BME 300, thereby satisfying the requirement.

Grading
   All courses taken to satisfy requirements 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; B10 150 and B10 202 or 203; CHE 131, 132 or equivalent; and PHY 131/133, 132/134 or equivalent. The average g.p.a for all BME courses and technical elective courses must be at least 2.00.

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 focusing on developing an understanding of mechanical structures and dynamics. This specialization is appropriate for students interested in the areas of biofluid mechanics, biomaterials, mechanical prosthetics, or mechanical instrumentation.

Recommended courses:
   BME 303 Engineering Methods in Biomechanics
   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
   ESE 315 Control Systems Design
   MEC 363 Mechanics of Solids
   MEC 412 Computer Aided Design

Alternative courses:
   AMS 331 Mathematical Modeling
   BME/ESM 353 Biomaterials: Manufacture, Properties, and Applications
   CSE 326 Digital Image Processing
   CSE 332 Introduction to Scientific Visualization
   ESM 369 Polymers
   ESM 450 Phase Changes and Mechanical Properties of Materials
   MEC 320 Engineering Design Methodology and Optimization
   MEC 402 Mechanical Vibrations
   MEC 410 Design of Machine Elements
   MEC 411 Control System Analysis and Design
   MEC 455 Applied Stress Analysis

b. Biomaterials
   Courses focusing on developing an 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 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
   BME 461 Linear Systems Analysis with Biomedical Applications
   ESG 332 Materials Science I
   ESM 335 Mechanical Properties of Materials
   BME/ESM 353 Biomaterials: Manufacture, Properties, and Applications
   ESM 369 Polymers

Alternative courses:
   ESG 302 Thermodynamics of Materials
   ESG 316 Engineering Science Design II
   ESM 221 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 Mechanical Properties of Materials
   ESM 355 Materials and Processes in Manufacturing Design

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c. Bioelectricity
Courses focusing on the description of biological cells, tissues, and organisms as complex systems. This specialization is appropriate for students interested in the areas of bioinstrumentation, medical imaging, electrical prosthetics, electromagnetic compatibility, tissue engineering, or bioinformatics.

**Recommended courses:**
- AMS 210 Applied Linear Algebra
- BME 313 Virtual Bioinstrumentation
- BME 461 Linear Systems Analysis with Biomedical Applications
- BME 481 Biosensors
- CHE 321 Organic Chemistry
- ESE 211 Electronics Laboratory A
- ESE 218 Digital System Design
- ESE 306 Random Signals and Systems
- ESE 314 Electronics Laboratory B
- ESE 315 Control System Design
- ESE 372 Electronics

**Alternative courses:**
- AMS 311 Probability Theory
- ESE 305 Deterministic Signals and Systems
- ESE 324 Electronics Laboratory
- EST 421 Starting the High-Technology Venture

*Students should take both BIO 202 and BIO 203.*

**d. Molecular and Cellular Biomedical Engineering**
Courses focus on the application of biochemistry, cell biology, and molecular biology (i.e., recombinant DNA methodology) to the broad fields of genetic engineering, biotechnology, bionanotechnology, and biosensors. Includes the specific engineering principles that are applied to problems involving structure and function of molecules and cells in areas such as tissue engineering, gene therapy, microarray, drug design and delivery, structural biology computational methods, and bioinformatics.

**Recommended courses:**
- 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 Virtual Bioinstrumentation
- BME 381 Nanofabrication in Biomedical Applications
- BME 404 Essentials of Tissue Engineering
- BME 461 Linear Systems Analysis with Biomedical Applications
- 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 Engineering Methods in 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