The interdisciplinary field of Biomedical Engineering combines elements of engineering (electronics, systems analysis, fluid mechanics) with the life sciences (biology, physiology, biochemistry) to define and solve problems in biology and medicine. Students choose this growing branch of engineering for the excitement of working with people and living systems, and for the opportunity to apply advanced technology to the complex problems of medical care.

The Biomedical Engineering program provides a special competence in and appreciation of the types of engineering applications relevant to biology and medicine. The program is excellent preparation for a career in the medical marketplace as well as for advanced studies in engineering.

BME is a popular pre-med major. In addition to advisement from the School of Engineering, pre-med BME’s have access to the University’s Pre-Health advisement office.

Biomedical Engineering students can participate in a variety of directed study courses or classroom projects at facilities such as the County-USC Medical Center, House Ear Institute, USC Biomechanics Lab, the Alfred Mann Institute and the Biomedical Simulations Resource Center.

### Programs Available

- Biomedical Engineering
  - Bachelor of Science
  - 128 units
- Biomedical Engineering (Biochemical)
  - Bachelor of Science
  - 132 units
- Biomedical/Electrical Engineering
  - Bachelor of Science
  - 133 units
- Biomedical/Mechanical Engineering
  - Bachelor of Science
  - 132 units

See pages 34-37 for the curricula of each of the B.S. programs listed above.

See page 82 for information on minor programs offered by the USC Viterbi School of Engineering.

### Courses of Instruction

- **B I O M E D I C A L  E N G I N E E R I N G  (  B M E )**

  101 Introduction to Biomedical Engineering (3, Fa) Historical development and survey of major areas comprising biomedical engineering: theoretical neurobiology and systems physiology, biomedical instrumentation, artificial organ and prosthetic devices, biomedical computer applications.

  Prerequisite: CSCI 101L; corequisite: MATH 245.

  302L Medical Electronics (4, Sp) 
  Electronic design and measurements for medical applications. Use of integrated circuits, biopotential measurements, static and dynamic calibration of physiological transducers. 
  Prerequisite: EE 202.

  350 Biomedical Engineering Industrial Project (3) Training in specific skills relevant to biomedical industry. Placement in summer internship following successful completion of the course. Junior standing. Prerequisite: BME 210.

  390 Special Problems (1-4) Supervised, individual studies. No more than one registration permitted. Enrollment by petition only.

  402 Control and Communication in the Nervous System (3, Sp) An introduction to the structural and functional elements common to nervous systems, with emphasis on cellular dynamics, interneuronal communication, sensory and effector systems. Prerequisite: BISC 220L, BME 210, MATH 245.

  403 Physiological Systems (3, Sp) A thorough bioengineering treatment of the physiological properties of various mammalian organ systems: e.g., cardiovascular, respiratory, renal, and musculoskeletal. Prerequisite: BISC 220L; MATH 245; corequisite: EE 202L.

  404 Biomechanics (3, Fa) Mechanical properties of biological tissues and fluid transport in physiological systems: blood rheology; bioviscoelastic solids and fluids; gas flow and mixing; prosthesis design. 
  Prerequisite: PHYS 151L; MATH 245; AME 201.

  405L Senior Projects: Measurements and Instrumentation (4, FaSp) Application of instrumentation and measurement techniques to biomedical engineering projects involving measurement, replacement or augmentation of biomedical systems. Prerequisite: BME 210, EE 202L.

  406L Senior Projects: Software Systems (4) Software projects employing engineering, mathematical, and computational principles; applications include sensory and motor processing. Prerequisite: BME 210.
410 Introduction to Biomaterials and Tissue Engineering (3, Fa) Application of principles of physical chemistry, biochemistry, and materials engineering to biomedical problems, e.g., materials selection and design for implants and tissue replacement. Prerequisite: CHEM 322AL.

414 Rehabilitation Engineering (3, Sp) An introduction to rehabilitation technology: limb and spinal orthoses; limb prostheses; functional electrical stimulation; sensory aids. Recommended preparation: AME 201.

416 Development and Regulation of Medical Products (3, Sp) An introduction to the process of medical product development with emphasis on the regulations that govern the design, fabrication, and maintenance of medical products. Junior standing. Departmental approval required.

423 Statistical Methods in Biomedical Engineering (3, Fa) Applications of parametric and non-parametric tests, analysis of variance, linear regression, time-series analysis, and autoregressive modeling, with biomedical applications to statistical analysis of biomedical data. Prerequisite: BME 210.

425 Basics of Biomedical Imaging (3, Fa) Basic scientific principles of various biomedical imaging modalities including nuclear magnetic resonance, X-ray computed tomography, single photon and positron emission tomography, ultrasonic imaging and biomagnetism. Prerequisite: PHYS 153L.

480 Senior Design for Biomedical Engineers (3) Engineering design principles applied to biomedical systems; design and implementation of a biomedical hardware and software project; presentation and demonstration. Prerequisite: BME 405L.

489 Biochemical Engineering (3, Sp) (Enroll in CHE 489)

490x Directed Research (2-8, max 8) Individual research and readings. Not available for graduate credit. Prerequisite: departmental approval.

499 Special Topics (2-4, max 8) Current trends and developments in the field of biomedical engineering.

GRADUATE COURSES

501 Advanced Topics in Biomedical Systems (4, Fa)

502 Advanced Studies of the Nervous System (4, Sp)

511 Physiological Control Systems (3, Sp)

513 Signal and Systems Analysis (3, Fa)

523 Measurement and Processing of Biological Signals (3, Fa)

525 Advanced Biomedical Imaging (4, Sp)

527 Integration of Medical Imaging Systems (3, Fa)

528 Medical Imaging Informatics (3, Sp)

533 Seminar in Bioengineering (1, max 3, FaSp)

535 Ultrasonic Imaging (3, Sp)

551 Introduction to Bio-MEMS and Nanotechnology (3, Fa)

590 Directed Research (1-12)

591ab Mathematical Biophysics (a: 3, Fa; b: 3, Sp)

594ab Master’s Thesis (2-2-0)

599 Special Topics (2-4, max 9)

605abL Experimental Projects in Biomedical Engineering (3-3)

620L Applied Electrophysiology (4, Fa)

650 Biomedical Measurement and Instrumentation (3, Sp)

670 Early Visual Processing (4, Fa)

671 Late Visual Processing (4, Sp)

675 Computational Vision (3, Fa)

680 Modeling and Simulation of Physiological Systems (3, Sp)

686 Introduction to Biomedical Research (3)

790 Research (1-12)

794abcdz Doctoral Dissertation (2-2-2-2-0)
# Biomedical Engineering (128 units)

<table>
<thead>
<tr>
<th>Freshman (15 units)</th>
<th>Sophomore (16 units)</th>
<th>Junior (15 units)</th>
<th>Senior (18 units)</th>
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<tr>
<td>GE Cat. I or II (4)</td>
<td>CHEM 105aL (4)</td>
<td>CHEM 120L (4)</td>
<td>BME 405L (4)</td>
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<td>MATH 125 (4)</td>
<td>BME 210 (3)</td>
<td>BME 402 (3)</td>
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<td>BME 101 (3)</td>
<td>MATH 226 (4)</td>
<td>TECH ELEC. (4)</td>
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<td>BME 245 (4)</td>
<td>BME 414 (3)</td>
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<td>PHYS 151L (4)</td>
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### Key:
- prerequisite
- co-requisite
- <<concurrent enrollment>>

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### Mathematics (16 units)
- MATH 125 Calculus I
- MATH 126 Calculus II
- MATH 226 Calculus III
- MATH 245 Mathematics of Phys. and Engr.

### Physics (8 units)
- PHYS 151L Mechanics and Thermodynamics
- PHYS 152L Electricity and Magnetism

### Chemistry (16 units)
- CHEM 105aL General Chemistry
- CHEM 105bL Organic Chemistry
- CHEM 322aL Organic Chemistry

### Biology (12 units)
- BISC 120L Organismal Biology & Evolution
- BISC 220L Cell Biology & Physiology
- BISC 320L Molecular Biology

### General Education (27 units)
- WRIT 140** Writing and Critical Reasoning
- WRIT 340*** Advanced Writing
- GE Cat. I
- GE Cat. II
- GE Cat. IV****
- GE Cat. V
- GE Cat. VI

### Engineering (49 units)
- BME 101 Intro to Biomedical Engineering
- BME 210 Biomed. Comp. Simulation Methods
- BME 302L Medical Electronics
- BME 402 Control & Comm. in Ner. System
- BME 403 Physiological Systems
- BME 405L Senior Projects: Meas. and Inst.
- BME 410 Intro to Biomaterials & Tissue Engr.
- BME 414 Rehabilitation Engineering
- BME 423 Statistical Methods in BME
- CSCI 101L Fund. of Comp. Programming
- EE 202L Linear Circuits
- EE 301 Introduction to Linear Systems

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* Advanced students with departmental approval have the option of completing CHEM 115abL in place of CHEM 105abL.

**Concurrent enrollment in a Social Issues GE Course is required.

*** Pre-Med Students are encouraged to take WRIT 340 for Pre-Health Majors.

**** May take Category I, II, IV or VI GE class.

***** See department for a list of approved technical electives.
biomedical (biochemical) (132 units)

Mathematics (16 units)
- MATH 125: Calculus I
- MATH 126: Calculus II
- MATH 226: Calculus III
- MATH 245: Mathematics of Phys. and Engr.

Physics (8 units)
- PHYS 151L: Mechanics and Thermodynamics
- PHYS 152L: Electricity and Magnetism

Chemistry (16 units)
- CHEM 105aL*: General Chemistry
- CHEM 105bL*: General Chemistry
- CHEM 322aL: Organic Chemistry
- CHEM 322bL: Organic Chemistry

Biology (16 units)
- BISC 120L: Organismal Biology & Evolution
- BISC 220L: Cell Biology & Physiology
- BISC 320L: Molecular Biology
- BISC 330L: Biochemistry

General Education (27 units)
- WRIT 140**: Writing and Critical Reasoning
- WRIT 340***: Advanced Writing
- GE Cat. I
- GE Cat. II
- GE Cat. IV****
- GE Cat. V
- GE Cat. VI

Engineering (49 units)
- BME 101: Intro. to Biomedical Engineering
- BME 402: Control & Comm. in Nervous Sys.
- BME 403: Physiological Systems
- BME 405L: Senior Projects: Meas. & Instrument.
- BME 410: Introduction to Biomat.
- BME 416: Dev. & Reg. of Medical Products
- BME 423: Statistical Methods in BME
- CHE 330: Chemical Engr. Thermodynamics
- CHE 350: Intro. to Separation Processes
- CHE 460L: Chemical Process Dynamics & Control
- CHE 489: Biochemical Engineering
- CSCI 101L: Fund. of Comp. Programming
- EE 202L: Linear Circuits
- MASC 310L: Materials Behavior & Processing

* Advanced students with departmental approval have the option of completing CHEM 115abL in place of CHEM 105abL.
** Concurrent enrollment in a Social Issues GE Course is required.
*** Pre-Med students are encouraged to take WRIT 340 for Pre-Health Majors.
**** May take Category I, II, IV or VI GE class.

KEY: prerequisite [co-requisite] <<concurrent enrollment>>
# Biomedical / Electrical (133 units)

<table>
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<tr>
<th>Year</th>
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<td><strong>Freshman</strong></td>
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<td>BME 101</td>
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<td>(18 units)</td>
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<td>CSCI 101L</td>
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<td>CHEM 105aL</td>
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<td></td>
<td>MATH 125</td>
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<td>GE Cat. VI</td>
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<tr>
<td></td>
<td>WRIT 140</td>
<td>4</td>
</tr>
</tbody>
</table>

| **Sophomore** | | |
| (18 units) | | |
| | CHEM 105bL | 4 |
| | MATH 226 | 4 |
| | PHYS 151L | 4 |
| | EE 101 | 3 |

| **Junior** | | |
| (17 units) | | |
| | CHEM 322aL | 4 |
| | BME 423 | 3 |
| | EE 301 | 3 |
| | GE Cat. II | 4 |
| | BME 403 | 3 |
| | EE 357 | 3 |

| **Senior** | | |
| (15 units) | | |
| | BME 405L | 4 |
| | BME 425 | 3 |
| | EE 454L | 4 |
| | EE 478L | 4 |

| **Technical Elective** | | |
| | or or or or or | |
| | CSCI 101L | 3 |
| | CHEM 105bL | 4 |
| | MATH 245 | 4 |
| | PHYS 152L | 4 |
| | BME 402 | 3 |
| | BME 423 | 3 |
| | EE 348 | 3 |
| | EE 375 | 3 |

**KEY:** prerequisite [co-requisite] <<concurrent enrollment>>

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*Advanced students with departmental approval have the option of completing CHEM 115abL in place of CHEM 105abL.

**Concurrent enrollment in a Social Issues GE Course is required.

*** May take Category I, II, IV or VI GE class.

****See department for a list of approved technical electives.

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**Mathematics (20 units)**
- MATH 125 Calculus I
- MATH 126 Calculus II
- MATH 226 Calculus III
- MATH 245 Mathematics of Phys. and Engr. I
- MATH 445 Mathematics of Phys. and Engr II

**Physics (12 units)**
- PHYS 151L Mechanics and Thermodynamics
- PHYS 152L Electricity and Magnetism
- PHYS 153L Optics and Modern Physics

**Chemistry (12 units)**
- CHEM 105aL General Chemistry
- CHEM 105bL General Chemistry
- CHEM 322aL Organic Chemistry

**Biology (8 units)**
- BISC 220L Cell Biology & Physiology
- BISC 320L Molecular Biology

**General Education (27 units)**
- WRIT 140 Writing and Critical Reasoning
- WRIT 340 Advanced Writing
- GE Cat. I
- GE Cat. II
- GE Cat. IV
- GE Cat. V
- GE Cat. VI

**Engineering (54 units)**
- BME 101 Intro. to Biomedical Engineering
- BME 210 Biomed. Comp. Simulation Methods
- BME 402 Control & Comm. in Nerv. System
- BME 403 Physiological Systems
- BME 405L Senior Projects Meas. & Instrument.
- BME 423 Statistical Methods in BME
- BME 425 Basics of Biomedical Imaging
- CSCI 101L Fund. of Comp. Programming
- EE 101 Introduction to Digital Logic
- EE 102L Introduction to Digital Circuits
- EE 202L Linear Circuits
- EE 301 Introduction to Linear Systems
- EE 338 Physical Electronics
- EE 348L Electronic Circuits I
- EE 357 Basic Organization of Comp. Sys.
- EE 454L Introduction to Systems Design
- EE 478L Digital Electronic Circuit Design

**Technical Elective** (see **** below)
### Biomedical / Mechanical (132 units)

**Mathematics (16 units)**
- MATH 125 Calculus I
- MATH 126 Calculus II
- MATH 226 Calculus III
- MATH 245 Mathematics of Phys. and Engr.

**Physics (12 units)**
- PHYS 151L Mechanics and Thermodynamics
- PHYS 152L Electricity and Magnetism
- PHYS 153L Optics and Modern Physics

**Chemistry (12 units)**
- CHEM 105aL General Chemistry
- CHEM 105bL General Chemistry
- CHEM 322aL Organic Chemistry

**Biology (8 units)**
- BISC 220L Cell Biology & Physiology
- BISC 320L Molecular Biology

**General Education (27 units)**
- WRIT 140** Writing and Critical Reasoning
- WRIT 340 Advanced Writing
- GE Cat. I
- GE Cat. II
- GE Cat. IV**
- GE Cat. V
- GE Cat. VI

**Engineering (57 units)**
- AME 201 Statics
- AME 204 Strength of Materials
- AME 301 Dynamics
- AME 302 Design of Dynamic Systems
- AME 308 Dynamics of Fluids
- BME 101 Intro. to Biomedical Engineering
- BME 210 Biomed. Comp. Simulation Methods
- BME 402 Control & Comm. in Nerv. System
- BME 403 Physiological Systems
- BME 404 Biomechanics
- BME 405L Senior Projects: Meas. and Instruments
- BME 423 Statistical Methods in BME
- CSCI 101L Fund. of Comp. Programming
- EE 202L Linear Circuits
- MASC 310 Materials Behavior and Processing

**Technical Elective (see below)**

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### Key:
- prerequisite
- corequisite
- concurrent enrollment

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*Advanced students with departmental approval have the option of completing CHEM 115abL in place of CHEM 105abL.

**Concurrent enrollment in a Social Issues GE Course is required.

*** May take Category I, II, IV or VI GE class.

****See Department for an approved list of Technical Electives.