

# BIOMEDICAL ENGINEERING

## Undergraduate Study

Minor supervised by an interdisciplinary faculty committee, administered by Chemical and Biological Engineering. The Biomedical engineering minor is a unique opportunity for engineering students to acquire a multidisciplinary engineering and life sciences background for entering the field of biomedical engineering.

The program is open to all undergraduate engineering students at Iowa State University. This minor will provide students with a foundation of core biology and engineering relevant to further study in biomedical engineering along with an introduction to the application of engineering principles to biomedical problems from a multidisciplinary perspective as well as the applications within the majors of the participating departments. Minor requirements are as follows:

A minimum of 16 cr. meeting the six requirements below with a minimum of 9 of those credits not being used to meet degree requirements and a minimum of 6 cr. at the 300 level or above. For most students this last stipulation will probably result in 18 cr. being taken.

|                                     |  |       |
|-------------------------------------|--|-------|
| BIOL 212                            | Principles of Biology II               | 3     |
| B M E/CH E 220                      | Introduction to Biomedical Engineering | 3     |
| BIOL 256                            | Fundamentals of Human Physiology       | 3     |
| Introductory Engineering Elective * |  | 3     |
| Advanced Engineering Elective **    |  | 3     |
| Professional Elective ***           |  | 1-3   |
| Total Credits                       |  | 16-18 |

\*A second (Introductory) engineering course from a department other than that of your major that is not duplicative of material in a course taken in your own department. The topic of the course should have ready application to later B M E-related electives in that discipline (MATE 273; E M 274 or 324; CH E 210; E E 201, 230; or other courses approved by Minor Chair).

\*\* 300-500 level engineering course with clear biomedical engineering application (B M E 341, 450, 450L, 490; B M E/CH E 440, CH E 542; B M E/MAT E 456; I E 571; I E 447 or other courses approved by Minor Chair).

\*\*\* 300-500 level engineering or life sciences course with clear biomedical engineering application OR B M E 490 OR departmental 490 with biomedical engineering topic OR 200+-level life sciences laboratory course (If a 200-level course is chosen here, the student will need to meet the required 6 cr. of 300+ courses by substitution of a higher-level course for the other requirements or by taking an additional course.), OR 300-500 level B M E courses, which may be offered on-line from the University of Iowa.

Courses primarily for undergraduates:

### B M E 220: Introduction to Biomedical Engineering

(Cross-listed with CH E). (3-0) Cr. 3. S.

*Prereq: BIOL 212, ENGR 160 or equiv, MATH 166, CHEM 167 or CHEM 178, PHYS 222*

Engineering analysis of basic biology and engineering problems associated with living systems and health care delivery. The course will illustrate biomedical engineering applications in such areas as: biotechnology, biomechanics, biomaterials and tissue engineering, and biosignal and image processing, and will introduce the basic life sciences and engineering concepts associated with these topics.

### B M E 341: BioMEMs and Nanotechnology

(3-0) Cr. 3.

*Prereq: B M E 220*

Overview of Micro-Electro-Mechanical-System (MEMS) technologies for bioengineering, fundamentals of microfluidic device design, fabrication, and characterization, survey of microfluidic functional building blocks for lab-on-a-chip applications including mixers, valves, channels, and chambers. Topics of nanotechnology in bioengineering, nanoscale building block technologies for bioengineering including self-assembling, surface chemical treatment, nano-imprinting, nano-particles, nano-tubes, nano-wires, and stimuli-responsive biomaterials.

### B M E 341L: BioMEMS and Nanotechnology Laboratory

(0-3) Cr. 1.

*Prereq: B M E 220, concurrent enrollment in B M E 341*

Introductory laboratory course accompanying B M E 341. Design, fabrication, and characterization of BioMEMS lab-on-a-chip devices and nanoscale techniques for bioengineering. Student group projects.

### B M E 352: Molecular, Cellular and Tissue Biomechanics

(3-0) Cr. 3.

*Prereq: B M E 220, E M 324, MAT E 273*

Introduction to the anatomy of the musculoskeletal system and connective tissue. Range of movement, joint dislocation, bone deformity and fracture. Application of continuum mechanics to both living and non-living systems. Laws of motion, free-body diagrams and simple force analysis of musculoskeletal system. Biomechanical response of soft and hard tissues with emphasis on microstructure and mechanical properties. Applications to bioengineering design.

**B M E 428: Image Processing with Biomedical Applications**

(3-0) Cr. 3.

*Prereq: E E 324*

Review of signal processing, linear algebra, probability. Image sampling and quantization. Image transforms, image enhancement, image denoising/restoration. Tomographic reconstruction, segmentation and registration, recognition and shape analysis and applications in Computer Aided disease Detection (CAD).

**B M E 440: Biomedical Applications of Chemical Engineering**

(Cross-listed with CH E). (3-0) Cr. 3.

*Prereq: CH E 210, MATH 266 or MATH 267, PHYS 222*

Applications of material and energy balances, transport phenomena, chemical reaction engineering, and thermodynamics to problems in biomedical engineering and applied physiology; survey of biomedical engineering; biomaterials; biomedical imaging.

**B M E 450: Biosensing**

(Cross-listed with E E). (3-0) Cr. 3.

*Prereq: B M E 220*

Overview of biosensors and bioanalytical challenges; designing for performance including various analytical problems, ion-selective membranes, characteristics of enzymes and basics of bioaffinity sensing; fundamentals of bioselective layers including depositing films and membranes, surfaces for immobilization and bioselective agents; survey of different biosensing technologies including electroanalytical, biomembrane, optical, and acoustic-wave based sensors.

**B M E 450L: Biosensing Laboratory**

(Cross-listed with E E). (0-3) Cr. 1.

*Prereq: B M E 220, concurrent enrollment in B M E 450*

Laboratory course accompanying B M E 450. Design, fabrication, and characterization of various electrical, chemical, polymer, optical and acoustic sensors.

**B M E 456: Biomaterials**

(Cross-listed with MAT E). (3-0) Cr. 3. F.

*Prereq: CHEM 178 and MAT E 216 or MAT E 273 or MAT E 392*

Presentation of the basic chemical and physical properties of biomaterials, including metals, ceramics, and polymers, as they are related to their manipulation by the engineer for incorporation into living systems. Role of microstructure properties in the choice of biomaterials and design of artificial organs, implants, and prostheses.

**B M E 466: Multidisciplinary Engineering Design**

(Cross-listed with A B E, AER E, CPR E, E E, ENGR, I E, M E, MAT E). (1-4)

Cr. 3. Repeatable. F.S.

*Prereq: Student must be within two semesters of graduation; permission of instructor.*

Application of team design concepts to projects of a multidisciplinary nature. Concurrent treatment of design, manufacturing, and life cycle considerations. Application of design tools such as CAD, CAM, and FEM. Design methodologies, project scheduling, cost estimating, quality control, manufacturing processes. Development of a prototype and appropriate documentation in the form of written reports, oral presentations and computer models and engineering drawings.

**B M E 490: Independent Study**

Cr. 1-6. Repeatable, maximum of 6 credits. F.S.SS.

*Prereq: permission of chair for the bioengineering minor*

Investigation of biomedical engineering topics of special interest to student and supervising faculty member with a final written report.