# Department of Biomedical Engineering

## Program of Biomedical Engineering

**I. Introduction**

SUSTech Biomedical Engineering Department absorbed Columbia University's Department of biomedical engineering undergraduate training courses, established the cultivating way of the enhanced version of the Columbia University Biomedical Engineering. The programs in biomedical engineering at SUSTech (B.S.,M.S., Ph.D., Eng.Sc.D., and M.D./Ph.D.) prepare students to apply engineering and apply science to problems in biology, medicine, and the understanding of living systems and their behavior, and to develop biomedical systems and devices. Modern engineering encompasses sophisticated approaches to measurement, data acquisition and analysis, simulation, and systems identification. These approaches are useful in the study of individual cells, organs, entire organisms, and populations of organisms. The increasing value of mathematical models in the analysis of living systems is an important sign of the success of contemporary activity. The programs offered in the Department of Biomedical Engineering seek to emphasize the confluence of basic engineering science and applied engineering with the physical and biological sciences, particularly in the areas of biomechanics, cell and tissue engineering, and biosignals and biomedical imaging.

Programs of biomedical engineering are taught by its own faculty, members of other Engineering departments, and faculty from other University divisions who have strong interests and involvement in biomedical engineering. Several of the faculty holds joint appointments in Biomedical Engineering and other University departments. Educational programs at all levels are based on engineering and biological fundamentals. From this basis, the program branches into concentrations along three tracks: biomechanics, cell and tissue engineering, and biosignals and biomedical imaging. The intrinsic breadth of these tracks, and a substantial elective content, prepare bachelor’s and master’s students to commence professional activity in any area of biomedical engineering or to go on to graduate school for further studies in related fields.

**II. Objectives**

The objectives of the undergraduate program in biomedical engineering are as follows:

* Professional employment in areas such as the medical device industry, engineering consulting, and biotechnology;
* Graduate studies in biomedical engineering or related fields;
* Attendance at medical, dental, or other professional schools.

The undergraduate program in biomedical engineering will prepare graduates who will have:

1. An ability to apply knowledge of mathematics, science, and engineering;
2. An ability to design and conduct experiments, as well as to analyze and interpret data;
3. 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;
4. An ability to function on multidisciplinary teams;
5. An ability to identify, formulate, and solve engineering problems;
6. An understanding of professional and ethical responsibility;
7. An ability to communicate effectively;
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
9. A recognition of the need for, and an ability to engage in life-long learning;
10. A knowledge of contemporary issues (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;
11. An understanding of biology and physiology;
12. The capability to apply advanced mathematics (including differential equations and statistics), science, and engineering, to solve the problems at the interface of engineering and biology;
13. The ability to make measurements on and interpret data from living systems, addressing the problems associated with the interaction between living and nonliving materials and systems.

**III. Period of Study and Degree Requirement**

Program length: 4 years

Degree conferred: Bachelor of Engineering

The minimum credit requirement for graduation: 140.5 credits (not including English courses)

**IV. Discipline**

Biomedical Engineering

**V. Main Courses**

Major Foundational Courses：The Fundamentals of Electric Circuits, Fundamentals of Materials Science and Technology, Theoretical Mechanics, Probability and Mathematical Statistics, Cell Biology, Animal Physiology,General Biology Laboratory

Major Core Courses: Quantitative Physiology I, Quantitative Physiology II, Biomedical Engineering I, Biomedical Engineering II, Biomedical Engineering Lab I, Biomedical Engineering Lab II.

**VI. Practice-Based Courses**

Projects of Science and Technology Innovation, Internship, Biomedical Engineering Design I, Biomedical Engineering Design II

**VII. Course Structure and Credit Requirements**

General Education (GE) Required Courses: 52.5 credits (not including English courses);

General Education (GE) Elective Courses: 10 credits;

Major Foundational Courses：21 credits;

Major Core Courses: 18 credits;

Major Elective Courses: 27 credits;

Undergraduate Thesis/Projects, Research Projects, Internship: 12 credits;

The minimum credit requirement for graduation: 140.5 credits (not including English courses).

**VIII. Requirement for GE Required Courses**

|  |  |  |
| --- | --- | --- |
| **Course Code** | **Course Name** | **Credits** |
| MA101B | Calculus 1 A | 4 |
| MA102B | Calculus II A | 4 |
| MA103A | Linear Algebra I A | 4 |
| PHY103B | General Physics I B | 4 |
| PHY105B | General Physics II B | 4 |
| CH101-A | General Chemistry A | 4 |
| CS102B | Computer programming fundamentals B | 3 |
| BIO102A | General Biology | 4 |
| PHY104 | Experiment for Foundation of Physics | 1.5 |

**IX. Pre-requisites for Major Declaration**

|  |  |  |
| --- | --- | --- |
| **Course Code** | **Course Name** | **Notes** |
| MA101B | Caculus 1 A | 4 |
| MA102B | Caculus II A | 4 |
| MA103A | Linear Algebra I-A | 4 |
| PHY103B | General Physics B (I) | 4 |
| PHY105B | General Physics B (II) | 4 |
| CH101-A | General Chemistry A | 4 |
| CS102B | Computer programming fundamentals B | 3 |
| BIO102A | General Biology | 4 |
| NOTE：For the major required courses, there are 17 credits in the first two years and you should complete at least 30% of them. | | |

**X. Course Arrangement**

**Table 1: Major Required Course (Foundational and Core Courses)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Category** | **Course Code** | **Course Name** | | **Credits** | **Lab Credits** | **Hours/week** | **Terms** | **Advised term to take the course** | | **Instruction language** | **Prerequisite** | **Dept.** |
| Major Fundamental Courses | EE104 | The Fundamentals of Electric Circuits | | 2 |  | 2 | Spr. | 1/Spr. | |  | MA101B, MA103A | EEE |
| MSE201 | Fundamentals of Materials Science and Technology | | 4 | 1 | 5 | Fall | | 2/Fall |  | PHY105B,  CH101-A | MSE |
| MAE203 | Theoretical Mechanics I | | 3 |  | 3 | Fall | 2/ Fall | |  |  | MAE |
| MA212 | Probability and Mathematical Statistics | | 3 |  | 3 | Spr./Fall | 2/Spr. | |  | MA102a or MA102B | MATH |
| BIO206-15 | Cell Biology | | 4 |  | 4 | Fall | 2/ Fall | |  | BIO201 | BIO |
| BIO311-14 | Animal Physiology | | 3 |  | 3 | Fall | 3/ Fall | |  |  | BIO |
| BIO104 | General Biology Laboratory | | 2 | 2 | 4 | Spr. | 2/Spr. | |  | BIO102A or BIO102B | BIO |
| **Total** | | | **21** | **3** | **24** |  |  | |  |  |  |
| Major Core Course | BMEB311 | Quantitative Physiology I | 3 | |  | 3 | Fall | 3/ Fall | |  |  | BME |
| BMEB312 | Quantitative Physiology II | 3 | |  | 3 | Spr. | 3/Spr. | |  | BMEB311 | BME |
| BMEB313 | Biomedical Engineering I | 3 | |  | 3 | Fall | 3/ Fall | |  |  | BME |
| BMEB314 | Biomedical Engineering II | 3 | |  | 3 | Spr. | 3/Spr. | |  | BMEB313 | BME |
| BMEB321 | Biomedical Engineering Lab I | 3 | | 3 | 6 | Fall | 3/ Fall | |  |  | BME |
| BMEB322 | Biomedical Engineering Lab II | 3 | | 3 | 6 | Spr. | 3/Spr. | |  | BMEB321 | BME |
| **Total** | | **18** | | **6** | **24** |  |  | |  |  |  |
|  | | | | | | | | | | | | |

**Table 2: Major Elective Courses**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Name** | **Credits** | **Lab Credits** | **Hours/week** | **Terms** | **Advised term to take the course** | **Instruction language** | **Prerequisite** | **Dept.** |
| BMEB131 | Introduction to Biomedical Engineering | 2 |  | 2 | Spr. | 1/Spr. |  |  | BME |
| BMEB317 | Principles of Medical Imaging Systems | 3 |  | 3 | Fall | 3/ Fall |  | EE104,  EE205 | BME |
| BMEB325 | Medical Imaging Systems Laboratory | 2 |  | 2 | Fall | 3/ Fall |  | BMEB317,  EE205 | BME |
| BMEB221 | Biomedical instrumentation | 4 | 2 | 6 | Spr. | 2/ Spr. |  |  | BME |
| BMEB318 | Biomechanics | 3 | 1 | 4 | Fall | 3/ Fall |  |  | BME |
| BIO411-16 | Dynamical Systems Simulation in Biology | 3 |  | 3 | Fall | 4/ Fall |  | BIO206-15,  BIO201,  MA102B,  MA103B | BIO |
| BIO332 | Stem Cell and Regenerative Medicine | 2 |  | 2 | Spr. | 3/Spr. |  | BIO102A | BIO |
| BIO203 | Microbiology | 3 |  | 3 | Fall | 2/ Fall |  |  | BIO |
| BIO201 | Biochemistry（Macromolecules） | 3 |  | 3 | Fall | 2/ Fall |  | BIO102A,  CH101A | BIO |
| BIO405 | Immunology | 3 |  | 3 | Fall | 4/ Fall |  | BIO206-15 | BIO |
| BIO208 | Cell Biology Laboratory | 2 | 2 | 4 | Fall | 3/ Fall |  | BIO206-15 | BIO |
| BIO202 | Biochemistry（Metabolism） | 3 |  | 3 | Spr. | 2/Spr. |  | BIO201 | BIO |
| BIO222 | Biochemistry and Molecular Biology Laboratory | 2 | 2 | 4 | Spr. | 2/Spr. |  | BIO201,  BIO320 | BIO |
| BIO306 | Bioinformatics | 4 | 2 | 6 | Spr. | 3/Spr. |  | BIO309 | BIO |
| BIO304 | Systems Biology | 3 |  | 3 | Spr. | 3/Spr. |  | BIO102A , MA212, BMEB311 | BIO |
| BIO313-15 | Animal Physiology Laboratory | 2 | 2 | 4 | Fall | 3/ Fall |  | BIO311-14 | BIO |
| BIO320 | Molecular Biology | 3 |  | 3 | Spr. | 2/Spr. |  | BIO102A | BIO |
| BIO310 | Neurobiology | 3 |  | 3 | Spr. | 3/Spr. |  | BIO201 | BIO |
| BMEB316 | Medical image processing | 3 | 1 | 4 | Fall | 3/ Fall |  |  | BIO |
| EE326 | Digital image processing | 3 | 1 | 4 | Spr. | 3/Spr. |  | EE205 | EEE |
| BMEB315 | Biomedical Optics | 2 |  | 2 | Spr. | 3/Spr. | CH/EN |  | BME |
| BMEB324 | Biomedical Optics Laboratory | 2 | 2 | 4 | Spr. | 3/Spr. | CH/EN | BMEB315 | BME |
| MSE316 | Biomaterials | 4 | 2 | 6 | Spr. | 3/Spr. | EN |  | MSE |
| MA305 | Numerical Analysis | 3 |  | 3 | Fall | 3/ Fall | CH | MA203a or MA213 | MATH |
| EE306 | Introduction to MEMS | 3 | 1 | 4 | Spr. | 3/Spr. | CH/EN | PHY105B | EEE |
| EE407 | Energy Harvesting Technologies | 3 |  | 3 | Fall | 4/ Fall |  |  | EEE |
| EE419 | Biosensors | 3 | 1 | 4 | Fall | 4/ Fall |  |  | EEE |
| EE208 | Engineering electromagnetics | 3 | 1 | 4 | Spr. | 2/Spr. | CH/EN | MA101B,  MA103A,  EE104 | EEE |
| EE202-17 | Digital Circuit | 3 | 0 | 3 | Spr. | 2/Spr. | CH | PHY105B,  EE201-17 | EEE |
| EE202-17L | Digital Circuit Laboratory | 1 | 1 | 2 | Spr. | 2/Spr. | CH | EE202-17 | EEE |
| EE205 | Signals and Systems | 3 | 1 | 4 | Fall | 2/Fall | CH/EN |  | EEE |
| EE323 | Digital Signal Processing | 3 | 1 | 4 | Fall | 3/Fall | EN | EE205 | EEE |
| EE303 | Fundamental of Optoelectronic Technology | 3 | 1 | 4 | Fall | 3/Fall |  | PHY105B | EEE |
| CS301 | Embedded system and microcomputer principle | 3 | 1 | 4 | Fall | 3/Fall |  | CS207 | CS |
| CS203 | Data structures and algorithm analysis | 3 | 1 | 4 | Fall | 2/Fall |  | CS102A | CS |
| CS202 | Computer organization Principle | 3 | 1 | 4 | Spr. | 2/Spr. |  | CS207 | CS |
| EE201-17 | Analog circuit | 3 | 0 | 3 | Fall | 2/Fall |  | PHY105B,  EE104 | EEE |
| EE201-17L | Analog Circuit Laboratory | 1 | 1 | 2 | Fall | 2/Fall |  | EE201-17 | EEE |
| EE429 | Image and Video Processing | 3 | 1 | 4 | Fall | 4/Fall |  | EE205,  MA103A,  MA212 | EEE |
| EE431 | BioMEMS and Lab-on-a-Chip | 3 |  | 3 | Fall | 4/Fall |  |  | EEE |
| **Total** | | 111 | 31 | 142 |  |  |  |  |  |
| Note: The minimum requirement is 27 credits. | | | | | | | | | |

**Table 3: Overview of Practice-Based Courses**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Code** | **Course Name** | **Credits** | **Lab Credits** | **Hours/week** | **Terms** | **Advised term to take the course** | **Instruction language** | **Prerequisite** | **Dept.** |
| BIO313-15 | Animal Physiology Laboratory | 2 | 2 | 4 | Fall | 3/Fall |  | BIO311-14 | BIO |
| BIO306 | Bioinformatics | 4 | 2 | 6 | Spr. | 3/Spr. |  | BIO309 | BIO |
| BIO222 | Biochemistry and Molecular Biology Laboratory | 2 | 2 | 4 | Spr. | 2/Spr. |  | BIO201,  BIO320 | BIO |
| BIO208 | Cell Biology Laboratory | 2 | 2 | 4 | Fall | Spr |  | BIO206-15 | BIO |
| BMEB316 | Medical Image Processing | 3 | 1 | 4 | Fall | 3/Fall | CH/EN |  | BME |
| CS203 | Data Structure and Algorithm Analysis | 3 | 1 | 4 | Fall | 2/Fall |  | CS102A | EEE |
| BMEB325 | Medical Imaging Systems Laboratory | 2 |  | 2 | Fall | 3/Fall | CH | BMEB317 | BME |
| BMEB221 | Biomedical instrumentation | 4 | 2 | 6 | Spr. | 2/Spr. | CH |  | BME |
| BMEB318 | Biomechanics | 3 | 1 | 4 | Fall | 3/Fall |  |  | BME |
| BMEB324 | Biomedical Optics Laboratory | 2 | 2 | 4 | Spr. | 3/Spr. | CH/EN | BMEB315 | BME |
| EE202-17L | Digital Circuit Laboratory | 1 | 1 | 2 | Spr. | 2/Spr. | CH | EE202-17 | EEE |
| EE326 | Digital image processing | 3 | 1 | 4 | Spr. | 3/Spr. |  | EE205 | EEE |
| EE208 | Engineering electromagnetics | 3 | 1 | 4 | Spr. | 2/Spr. | CH/EN | MA101B,  MA103A,  EE104 | EEE |
| EE303 | Fundamental of Optoelectronic Technology | 3 | 1 | 4 | Fall | 3/Fall | CH/EN | PHY105B | EEE |
| EE323 | Digital Signal Processing | 3 | 1 | 4 | Fall | 3/Fall | EN | EE205 | EEE |
| CS301 | Embedded system and microcomputer principle | 3 | 1 | 4 | Fall | 3/Fall |  | CS207 | CS |
| EE205 | Signals and Systems | 3 | 1 | 4 | Fall | 2/Fall | CH/EN |  | EEE |
| EE306 | Introduction to MEMS | 3 | 1 | 4 | Spr. | 3/Spr. | CH/EN | PHY105B | EEE |
| MSE201 | Fundamentals of Materials Science and Technology | 4 | 1 | 5 | Fall | 2/Fall | EN | PHY105B,CH101-A | MSE |
| MSE316 | Biomaterials | 4 | 2 | 6 | Spr. | 3/Spr. | EN | MSE201 | MSE |
| CS202 | Computer organization Principle | 3 | 1 | 4 | Spr. | 2/Spr. |  | CS207 | CS |
| EE201-17L | Analog Circuit Laboratory | 1 | 1 | 2 | Fall | 2/Fall |  | EE201-17 | EEE |
| BMEB121 | Projects of Science and Technology Innovation | 2 | 2 | 4 |  |  |  |  | BME |
| BMEB321 | \*Internship | 2 | 2 | 4 | Smr. | 3/ Smr. |  |  | BME |
| BMEB422 | Biomedical Engineering Design I | 4 |  | 4 | Fall | 4/Fall | EN |  | BME |
| BMEB423 | Biomedical Engineering Design II | 4 |  | 4 | Spr. | 4/Spr. | EN | BMEB422 | BME |
| **Total** | | 71 | 33 | 103 |  |  |  |  |  |

**Table 4: Overview of Course Hours and Credits**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Category** | **Total Course Hours** | **Total Credits** | **The Minimum Credit Requirement** |
| **General Education (GE) Required Courses** | 880 | 52.5 | 52.5 |
| **General Education (GE) Elective Courses** |  |  | 10 |
| **Major Foundational Courses** | 368 | 21 | 21 |
| **Major Core Courses** | 384 | 18 | 18 |
| **Major Elective Courses** | 2096 | 111 | 27 |
| **Research Projects, Internship**  **and Undergraduate Thesis/Projects** | 448 | 12 | 12 |
| **Total** | 4176 | 214.5 | 140.5 |