Bachelor of Science in Biomedical Engineering

The mission of the Department of Biomedical Engineering is to develop clinically translatable solutions for human health by training the next generation of biomedical engineers, cultivating leaders, and nurturing the integration of science, engineering, and medicine in a discovery-centered environment. The main educational objective is to provide a thorough training in the fundamentals of engineering science, design, and biology. The curriculum is designed to provide concepts central to understanding living systems from the molecular and cellular levels to the tissue and organismal levels. The curriculum incorporates principles of vertical integration, leading to the choice of a technical area (biomedical imaging and instrumentation, cellular and biomolecular engineering, computational biomedical engineering, or molecular, cellular, and tissue biomechanics), and culminates in a team capstone design experience. Students are expected to develop an understanding of industrial, research, and clinical biomedical engineering environments; an understanding of regulatory issues and biomedical ethics; the ability to create, identify, formulate, and solve biomedical engineering problems; the ability to design systems to meet needs in medical/life science applications; an understanding of life processes at the molecular, cellular, tissue, and organismal levels; the ability to use instrumentation and to make measurements and interpret data in living systems; and an appreciation of the interdisciplinary nature of biomedical engineering research.

Portable Computing Devices

Students entering biomedical engineering are required to have a laptop computer. Laptops do not need to be brought to campus on a daily basis, but individual courses may require that a laptop be brought to certain lectures, labs, and/or exams. Minimum requirements for the laptop are listed on the department's website.

Student Outcomes

Graduates of the biomedical engineering program are expected to have:

a. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

b. an ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, societal, environmental, and economic factors

c. an ability to communicate effectively with a range of audiences

d. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

e. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

f. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions

g. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Program Educational Objectives

Achievement of the preceding program outcomes gives students the foundation for accomplishing the biomedical engineering program educational objectives. A few years after graduation, students are expected to be able to:

- Conduct themselves with exemplary professional ethics and highest integrity
- Demonstrate a quantitative, analytical, and systems approach to problem solving in their professional practice
- Demonstrate a continuous quest for professional excellence and success
- Participate in continuing education to expand their knowledge of contemporary professional issues
- Exhibit effective scientific, technical, communication, and resource management skills in their professional practice

Curriculum

Course requirements include courses within the Cockrell School of Engineering, and other required courses. In addition, each student must complete the University's core curriculum. In some cases, a course that fulfills one of the following requirements may also be counted toward core curriculum or flag requirements; these courses are identified below.

In the process of fulfilling engineering degree requirements, students must also complete coursework to satisfy the following flag requirements: one independent inquiry flag, one quantitative reasoning flag, one ethics flag, one global cultures flag, one cultural diversity in the United States flag, and two writing flags. The independent inquiry flag, the quantitative reasoning flag, the ethics flag, and the two writing flags are carried by courses specifically required for the degree; these courses are identified below. Courses that may be used to fulfill flag requirements are identified in the Course Schedule.

Prior to registration, students must receive approval from the Biomedical Engineering Academic Advising Office for courses to be used to fulfill technical and nontechnical course requirements. The student must take all courses required for the degree on the letter-grade basis and must earn a grade of at least *C-* in each, except for those listed as remaining Core Curriculum Courses, including flags.

Requirements		Hours
Biomedical Engineering Courses		
BME 214L	Computational Fundamentals of Biomedical Engineering Design	2
BME 245L	Experimental Principles of Biomedical Engineering Design	2
BME 261L	Development and Analysis in Biomedical Engineering Design	2
BME 303	Introduction to Computing	3
BME 303L	Introduction to Biomedical Engineering Design	3
BME 311	Network Analysis in Biomedical Engineering	3
BME 313L	Introduction to Numerical Methods in Biomedical Engineering	3
BME 335	Engineering Probability and Statistics	3
BME 343	Biomedical Engineering Signal and Systems Analysis	3
BME 344	Biomechanics	3
BME 349	Biomedical Instrumentation	3

BME 352	Engineering Biomaterials	3
BME 353	Transport Phenomena in Living Systems	3
BME 355	Molecular Engineering	3
BME 365R	Quantitative Engineering Physiology I	3
BME 365S	Quantitative Engineering Physiology II	3
BME 370	Biomedical Engineering Capstone Design I (writing flag)	3
BME 371	Biomedical Engineering Capstone Design II (independent inquiry flag)	3
Approved technical area elective		12
Biochemistry and Biology		
BCH 369	Fundamentals of Biochemistry	3
BIO 206L	Introductory Laboratory Experiments in Biology	2
BIO 311C	Introductory Biology I	3
Chemistry		
CH 301	Principles of Chemistry I	3
CH 302	Principles of Chemistry II	3
CH 204	Introduction to Chemical Practice	2
CH 320M	Organic Chemistry I	3
or CH 328M	Organic Chemistry I	
Mathematics		
M 408C	Differential and Integral Calculus (mathematics; quantitative reasoning flag)	4
M 408D	Sequences, Series, and Multivariable Calculus	4
M 427J	Differential Equations with Linear Algebra (quantitative reasoning flag)	4
Physics		
PHY 105M	Laboratory For Physics 302K, 303K, and 317K	1
PHY 105N	Laboratory For Physics 302L, 303L, and 317L	1
PHY 303K	Engineering Physics I (part I science and technology; quantitative reasoning flag)	3
PHY 303L	Engineering Physics II (part I science and technology; quantitative reasoning flag)	3
Rhetoric and Writing		
RHE 306	Rhetoric and Writing (English composition)	3
Other Required Courses		
E S 333T	Engineering Communication (writing flag and ethics flag)	3
Remaining Core Curriculum Courses		
E 316L	British Literature [1]	3
or E 316M	American Literature	
or E 316N	World Literature	
or E 316P	Masterworks of Literature	
American and Texas government [2]		6
American history [2]		6
Social and behavioral sciences [3]		3
Visual and performing arts [3]		3
UGS 302	First-Year Signature Course [4]	3
or UGS 303	First-Year Signature Course	

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1. Some sections of the English humanities courses (E 316L, 316M, 316N, 316P) carry a global cultures or cultural diversity flag.

2. Some sections carry a cultural diversity flag.

3. Some sections carry a global cultures and/or cultural diversity flag.

4. In UGS 302, all sections carry a writing flag. In UGS 303, some sections carry a writing flag.

Minimum Required   **132**

Integrated Bachelor of Science in Biomedical Engineering/Master of Science in Engineering Program

The integrated degree program results in simultaneously awarding a Bachelor of Science in Biomedical Engineering (BSBME) and a Master of Science in Engineering (MSE) degree offered by the graduate program in biomedical engineering. The objective of the Integrated BSBME/MSE Program is to enable prepared undergraduates in Biomedical Engineering to earn two degrees in a shortened time period. By applying AP and Credit by Exam courses, having students take recommended summer courses, and allowing seniors to enroll in graduate-level engineering courses reserved for graduate credit, the program enables graduates to complete both degree requirements in five years.

Admissions. Current undergraduate BME students may begin the application process to the Integrated BSBME/MSE Program option in the first term of their third year. Admission includes the two steps outlined below. Undergraduate students not in the biomedical engineering major are not eligible to apply. It is expected that all students selected for the program in Step 1 and have been successful in their first graduate-level coursework will be selected for admission in Step 2. Successful completion will be evaluated and determined by the department's Domestic Graduate Admission Committee and the Graduate Advisor.

Step 1. Students go through the first step in application for admission to the Integrated BSBME/MSE Program in the second term of the third year. The Step 1 application is internal through the department and includes a resume, statement of purpose, and letters of recommendation. Qualified applicants will be selected based on the applicant's progress to degree completion, grade point average, and other qualifications included in the application materials. Selected students will be notified early in the summer after the third year of their admission status for the integrated program, allowing them to meet with an academic advisor to plan graduate coursework in the first term of their fourth year.

Step 2. Students go through the second step in the application after the second term of their fourth year. The Step 2 application is formal through the Office of Graduate Admissions (OGA) and includes a resume, statement of purpose, letters of recommendation, and a TOEFL score (if required). Qualified applicants will be selected based on success in graduate-level engineering courses in the first term of their fourth year, grade point average, and other qualifications included in the application materials.

If a student in their fourth year is taking graduate courses and would be on track to complete the integrated program but did not apply in their third year through Step 1, they may also choose to apply in Step 2 and

formally apply through OGA by the normal admission deadline. These students will be evaluated for admission on the same criteria.

Degree Requirements. In order for integrated program students to complete both the BSBME and MSE degrees in five years, the department waives six semester credit hours (SCH) of technical area electives in lieu of six SCH of graduate engineering coursework reserved for graduate credit taken in the fourth year. This reduces the total BSBME degree requirements for integrated program students from 132 to 126 SCH. The remaining required six SCH of technical area electives required for the BSBME degree must be taken in engineering (see Technical Area Options section below).

Students in the integrated program complete 12 SCH of graduate coursework in their fourth year and 18 SCH of graduate coursework in their fifth year to complete a total of 30 SCH of graduate coursework for the MSE degree as described in the Graduate Catalog. Students have the option of choosing the coursework or thesis options for the MSE degree as described in the Graduate Catalog. Which courses the student takes will be determined with the graduate advisor and academic advisor to ensure compliance with degree requirements and meet the students' career goals.

Students unable to successfully complete the integrated program, or who wish to terminate pursuit of the MSE for any reason, may obtain a BSBME degree by satisfying all of the requirements for the standalone degree. Two of the graduate courses (six SCH) taken in the fourth year may count toward the 12 SCH of technical area electives required to complete the entire 132 SCH requirements. An undergraduate student leaving the integrated program will be on a trajectory to graduate with the regular BSBME degree in the same timeframe prior to admission to the integrated program.

Graduates of the integrated program will receive the BSBME and MSE degrees simultaneously after successfully completing the 126 SCH for the BSBME and 30 SCH for the MSE, a total of 156 SCH. It is expected that students in this program will graduate with both degrees in a total of five years to completion.

Advising. Once admitted, students will be advised each semester by the graduate advisor and an academic advisor to complete coursework required for the BSBME degree in their fourth year, and completion of the coursework required for the MSE degree in their fourth and fifth years.

Information regarding the integrated program requirements and policies may be obtained from the Biomedical Engineering Academic Advising Office in BME 3.308.

Technical Area Options

The technical area option allows the student to build on the biomedical engineering core curriculum by choosing 12 semester hours of technical area coursework. A minimum of six semester hours of the 12 semester hours of technical area coursework must be taken within engineering. Students choose coursework in one of the following four areas: biomedical imaging and instrumentation; cellular and biomolecular engineering; computational biomedical engineering; or molecular, cellular and tissue biomechanics. Within some technical areas, career emphases are available for students to focus coursework toward a particular career track. Students have flexibility to take technical elective coursework from more than one career emphasis under the same technical area. Each student should choose a technical area by the end of the sophomore year and plan an academic program to meet the area requirements during the next two years. Students can visit the Biomedical Engineering Academic Advising Office in BME 3.308 for more information about the Technical Area Options.

Preparation for health professions. Students who plan to attend medical, veterinary, or dental school in Texas must complete coursework in addition to that required for the BS in Biomedical Engineering in order to meet professional school admission requirements; those who plan to attend schools outside Texas may need additional coursework. The student is responsible for knowing and meeting these additional requirements, but assistance and information are available in the Health Professions Office in the College of Natural Sciences, PAI 5.03. Additional information about preparation for health professions is available online at https://cns.utexas.edu/health-professions.

Preparation for law. There is no sequential arrangement of courses prescribed for a pre-law program. The Association of American Law Schools puts special emphasis on comprehension and expression in words, critical understanding of the human institutions and values with which the law deals, and analytical power in thinking. Courses relevant to these objectives deal with communication of ideas, logic, mathematics, social sciences, history, philosophy, and the physical sciences. Services for pre-law students are provided to students in all colleges by Liberal Arts Career Services in FAC 18, and to engineering students by the Engineering Career Assistance Center (ECAC) in EER 2.604. Additional information about preparation for law is available online at https://liberalarts.utexas.edu/lacs/index.php.

Plan II Honors Program. Students enrolled in the Plan II Honors Program are encouraged to contact the Biomedical Engineering Academic Advising Office, in addition to the Plan II Office to ensure that requirements for both programs are met. Plan II courses may count toward biomedical engineering program requirements.

Minors and Certificate programs. Biomedical engineering students may enrich their education through minors and certificate programs. For a full list please see Minor and Certificate Programs. Common examples of certificates completed by Biomedical engineering students are as follows:

Business Minor. Students who wish to learn about fundamental business concepts and practices may take supplemental coursework that leads to the Business Minor, awarded by the Red McCombs School of Business. The certificate description is provided in the Minor and Certificate Programs section of the McCombs School of Business in the Undergraduate Catalog.

Business of Healthcare Certificate. The Red McCombs School of Business offers this certificate to prepare students for the unique challenges and opportunities in the field of healthcare. The certificate description is provided in the Minor and Certificate Programs section of the McCombs School of Business in the Undergraduate Catalog.

Computational Science and Engineering (CSE) Certificate. This certificate offers the opportunity for in-depth study and research in computational science and engineering, including computational and applied mathematics, numerical simulation, scientific computation, and visualization. The certificate is administered by the Oden Institute for Computational Engineering and Sciences and its description is provided in the Minor and Certificate Programs section of the Cockrell School of Engineering in the Undergraduate Catalog.

Elements of Computing. Students who wish to learn about computer science may take the coursework that leads to the certificate in the Elements of Computing, awarded by the Department of Computer Science. The certificate description is provided in the Minor and Certificate Programs section of the College of Natural Science in the Undergraduate Catalog.

Pre-Health Professions Certificate. This certificate provides majors outside of the College of Natural Sciences (CNS) access to the courses required

to complete health professions prerequisites. The certificate description is provided in the <u>Minor and Certificate Programs section of the College of Natural Science in the Undergraduate Catalog</u>.

Bridging Disciplines Programs. These interdisciplinary programs offer students the opportunity to develop skills to collaborate across disciplines and cultures. The certificate description is provided in the <u>Minor and Certificate Programs section of the School of Undergraduate Studies in the Undergraduate Catalog</u>.

Technical Area 1, Biomedical Imaging and Instrumentation

This technical area is designed for students interested in the general area of medical imaging science and instrumentation design. Two career emphases are available in this area: biomedical imaging and biomedical instrumentation. Students are required to select 12 semester hours from any of the Technical Area 1 electives; six of the 12 hours must be within engineering.

Career Emphasis A: Biomedical Imaging

The main objective of this emphasis is to prepare students for a career in biomedical imaging. A solid foundation, practical knowledge, and skills are established in optics, imaging modalities, and image and signal processing.

While students are required to select 12 hours from any of the Technical Area 1 electives, the following are recommended for the biomedical imaging career emphasis:

Biomedical Engineering 336, *Cancer Bioengineering*
Biomedical Engineering 337, *Nanomedicine*
Biomedical Engineering 347, *Fundamentals of Biomedical Optics*
Biomedical Engineering 350, *Computational Methods for Biomedical Engineers*
Biomedical Engineering 357, *Biomedical Imaging Modalities*
Biomedical Engineering 358, *Medical Decision Making*
Biomedical Engineering 358M, *Imaging Clinical Immersion*
Biomedical Engineering 368, *Introduction to Mathematical and Physical Biology*
Biomedical Engineering 372, *Computational Modeling of the Cardiovascular System*
Electrical and Computer Engineering 347, *Modern Optics*
Electrical and Computer Engineering 351M, *Digital Signal Processing*
Electrical and Computer Engineering 371Q, *Digital Image Processing*
An approved upper-division biomedical engineering, electrical engineering, or physics course

Career Emphasis B: Biomedical Instrumentation

The main objective of this emphasis is to prepare students to design and use biomedical instrumentation for imaging, diagnostic, and therapeutic applications. A solid foundation, practical knowledge, and skills are established in analog and digital network analysis, software and hardware programming, electronic circuits, sensors, data acquisition systems, image and signal processing, and computational analysis of data as it applies to living systems.

While students are required to select 12 hours from any of the Technical Area 1 course options, the following are recommended for the biomedical instrumentation career emphasis:

Biomedical Engineering 306, *Fundamentals of Computing*
Biomedical Engineering 338, *Thin Film Mechanics*
Biomedical Engineering 354, *Molecular Sensors and Nanodevices for Biomedical Engineering Applications*
Biomedical Engineering 363, *Bioelectronics and Biointerfaces*

Biomedical Engineering 363E, *Medical Device Design and Manufacturing*
Biomedical Engineering 367, *Design of Artificial Organs*
Biomedical Engineering 374K, *Biomedical Instrument Design*
Biomedical Engineering 374L, *Applications of Biomedical Instrumentation Lab*
Electrical and Computer Engineering 312, *Software Design and Implementation I*
Electrical and Computer Engineering 319K, *Introduction to Embedded Systems*
Electrical and Computer Engineering 438, *Fundamentals of Electronic Circuits I Laboratory*
Electrical and Computer Engineering 445L, *Embedded Systems Design Laboratory*
Electrical and Computer Engineering 445M, *Embedded and Real-Time Systems Laboratory*
Electrical and Computer Engineering 445S, *Real-Time Digital Signal Processing Laboratory*
Electrical and Computer Engineering 351M, *Digital Signal Processing*

Technical Area 2, Cellular and Biomolecular Engineering

The major objective of this area is to teach students how to integrate knowledge in cell and molecular biology with engineering analysis, so that they can address problems in molecular-based medicine. Two career emphases are available in this area: biomaterials/regenerative medicine and nanotechnology. Students are required to select 12 semester hours from any of the Technical Area 2 electives; six of the 12 hours must be within engineering.

Career Emphasis A: Biomaterials/Regenerative Medicine

The objective of this emphasis is to prepare students for a career in biomaterials and regenerative medicine engineering. This emphasis includes solid foundation in cell and tissue engineering, biomaterials, and pharmacology. While students are required to select 12 hours from any of the Technical Area 2 course options, the following are recommended for the biomaterials/regenerative medicine career emphasis:

Molecular Biosciences 320, *Cell Biology*
Biology 325, *Genetics*
Molecular Biosciences 326M, *Introductory Medical Microbiology and Immunology*
Biomedical Engineering 336, *Cancer Bioengineering*
Biomedical Engineering 339, *Biochemical Engineering*
Biomedical Engineering 340, *Soft Tissue Biomechanics*
Biomedical Engineering 356, *Polymer and Bioconjugate Chemistry*
Biomedical Engineering 359, *Cellular and Molecular Biomechanics*
Biomedical Engineering 363, *Bioelectronics and Biointerfaces*
Biomedical Engineering 363E, *Medical Device Design and Manufacturing*
Biomedical Engineering 364, *Biological Responses to Medical Devices*
Biomedical Engineering 365, *Tissue Microenvironments*
Biomedical Engineering 366, *Immune Engineering*
Biomedical Engineering 367, *Design of Artificial Organs*
Biomedical Engineering 369, *Biomimetic Design and Engineering*
Biomedical Engineering 369C, *Matrices, Organoids, and Microphysiological Systems*
Biomedical Engineering 373, *Tissue, Scaffold, and Cell Biomechanics Applications*
Biomedical Engineering 375, *Stem Cells in Cell and Tissue Engineering*
Biomedical Engineering 376, *Cell Engineering*
Biomedical Engineering 379, *Tissue Engineering*
An approved topic of Chemical Engineering 379, *Topics in Chemical Engineering*

Chemistry 320N, *Organic Chemistry II* or Chemistry 328N, *Organic Chemistry II*

Pharmacy PharmD 338, *Introduction to Pharmacology*

An approved upper-division biomedical engineering, chemical engineering or mechanical engineering course

Career Emphasis B: Nanotechnology

The objective of this emphasis is to prepare students for a career in nanotechnology. This emphasis includes solid foundation in nanodevices and sensors, biological physics, and nanocomposites. While students are required to select 12 hours from any of the Technical Area 2 course options, the following are recommended for the nanotechnology career emphasis:

Biomedical Engineering 337, *Nanomedicine*

Biomedical Engineering 346, *Computational Biomolecular Engineering*

Biomedical Engineering 348P, *Introduction to Computational and Systems Biology*

Biomedical Engineering 354, *Molecular Sensors and Nanodevices for Biomedical Engineering Applications*

Biomedical Engineering 356, *Polymer and Bioconjugate Chemistry*

Biomedical Engineering 358M, *Imaging Clinical Immersion*

Biomedical Engineering 359, *Cellular and Molecular Biomechanics*

Chemical Engineering 339P, *Introduction to Biological Physics*

An approved topic of Chemical Engineering 379, *Topics in Chemical Engineering*

Chemistry 320N, *Organic Chemistry II* or Chemistry 328N, *Organic Chemistry II*

An approved topic of Mechanical Engineering 379M, *Topics in Mechanical Engineering*

An approved upper-division biomedical engineering, chemical engineering or mechanical engineering course

Technical Area 3, Computational Biomedical Engineering

The objective of this area is to provide students with the knowledge and skills that will enable them to design and use computational algorithms to address problems in biomedical research and health care. Examples include (a) designing medical decision aids using statistical and machine learning models, (b) dynamic modeling and computer simulation to study the biomechanics and control of movement, (c) development of thermodynamic models of dynamic processes at the microscopic and macroscopic scales in biological systems, and (d) image processing techniques for quantitative measurement and interpretation of biomedical images. Students are required to select 12 semester hours from any of the Technical Area 3 electives; six of the 12 hours must be within engineering.

Students must select 12 hours from the following:

Biomedical Engineering 306, *Fundamentals of Computing*

Biomedical Engineering 336, *Cancer Bioengineering*

Biomedical Engineering 345, *Graphics and Visualization Laboratory*

Biomedical Engineering 346, *Computational Biomolecular Engineering*

Biomedical Engineering 347, *Fundamentals of Biomedical Optics*

Biomedical Engineering 348, *Modeling of Biomedical Engineering Systems*

Biomedical Engineering 348P, *Introduction to Computational and Systems Biology*

Biomedical Engineering 350, *Computational Methods for Biomedical Engineers*

Biomedical Engineering 357, *Biomedical Imaging Modalities*

Biomedical Engineering 358, *Medical Decision Making*

Biomedical Engineering 358M, *Imaging Clinical Immersion*

Biomedical Engineering 363E, *Medical Device Design and Manufacturing*

Biomedical Engineering 367, *Design of Artificial Organs*

Biomedical Engineering 368, *Introduction to Mathematical and Physical Biology*

Biomedical Engineering 372, *Computational Modeling of the Cardiovascular System*

Biomedical Engineering 372P, *Mathematical Physiology*

Biomedical Engineering 373, *Tissue, Scaffold, and Cell Biomechanics Applications*

Electrical and Computer Engineering 312, *Software Design and Implementation I*

Electrical and Computer Engineering 319K, *Introduction to Embedded Systems*

Electrical and Computer Engineering 422C, *Software Design and Implementation II*

Electrical and Computer Engineering 360C, *Algorithms*

Electrical and Computer Engineering 371Q, *Digital Image Processing*

Mathematics 325K, *Discrete Mathematics*

Mathematics 340L, *Matrices and Matrix Calculations*

A computer science course from an approved list

Technical Area 4, Molecular, Cellular, and Tissue Biomechanics

The major objective of this area is to provide students with knowledge of the structure and function of biological systems by means of the methods of mechanics. Students will learn skills to apply engineering principles to understand how living systems function at all scales of organization and to translate this understanding to the design of devices and procedures that will improve diagnostic and therapeutic methods in health care.

Students must select 12 hours from the following; six of the 12 hours must be within engineering:

Biomedical Engineering 336, *Cancer Bioengineering*

Biomedical Engineering 338, *Thin Film Mechanics*

Biomedical Engineering 340, *Soft Tissue Biomechanics*

Biomedical Engineering 342, *Biomechanics of Human Movement*

Biomedical Engineering 346, *Computational Biomolecular Engineering*

Biomedical Engineering 347, *Fundamentals of Biomedical Optics*

Biomedical Engineering 354, *Molecular Sensors and Nanodevices for Biomedical Engineering Applications*

Biomedical Engineering 358M, *Imaging Clinical Immersion*

Biomedical Engineering 359, *Cellular and Molecular Biomechanics*

Biomedical Engineering 362, *Introduction to Nonlinear Dynamics in Biological Systems*

Biomedical Engineering 363E, *Medical Device Design and Manufacturing*

Biomedical Engineering 365, *Tissue Microenvironments*

Biomedical Engineering 367, *Design of Artificial Organs*

Biomedical Engineering 369, *Biomimetic Design and Engineering*

Biomedical Engineering 372, *Computational Modeling of the Cardiovascular System*

Biomedical Engineering 372P, *Mathematical Physiology*

Biomedical Engineering 373, *Tissue, Scaffold, and Cell Biomechanics Applications*

Biomedical Engineering 376, *Cell Engineering*

Chemical Engineering 339P, *Introduction to Biological Physics*

Kinesiology 326K, *Biomechanical Analysis of Movement*

Mechanical Engineering 314D, *Dynamics*

Mechanical Engineering 344, *Dynamic Systems and Controls*

Mechanical Engineering 354, *Introduction to Biomechanical Engineering*

Mechanical Engineering 372J, *Robotics and Automation*

An approved upper-division biomedical engineering or mechanical engineering course