

# Bioengineering - Undergraduate Programs

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## Overview

The Department of Bioengineering offers a Bachelor of Science (BS) degree in Biomedical Engineering (BS BME). The goal of the program is to prepare students for bioengineering careers requiring skills in research, development, and teaching in a variety of setting in industry, hospitals, research facilities of educational and medical institutions and government regulatory agencies. Graduates may also pursue their continuing education in the medical and dental field or graduate studies in bioengineering.

BS BME degree offers two areas for concentration: Biomaterials and Tissue Engineering; and Medical Imaging.

## Educational Objectives of the Undergraduate Program

The purpose of the Bioengineering Department is to advance the cause of the profession through teaching and research and to produce technically knowledgeable, well rounded graduates who have the capability of developing into professionally competent engineers pursuing lifelong learning and assuming leadership roles in the profession. The BE Department supports the University and College of Engineering mission by offering a broad-based undergraduate education leading to a degree of bachelor of science in Biomedical Engineering with emphasis on technical, professional, ethical, and societal responsibilities associated with the practice of engineering. Advanced masters and doctoral degrees are offered with emphasis on technical specialization and the advancement of knowledge in several areas of bioengineering.

The overall goal of the Biomedical Engineering undergraduate program is to promote intellectual development of those interested in the bioengineering profession, and to produce graduates who possess the knowledge, tools and traits necessary for a successful career, and for assuming a leadership role in the bioengineering profession. More specifically, the educational program objectives are to produce graduates who:

- Possess a broad-based bioengineering education to successfully obtain professional positions, and practice bioengineering in a wide range of professional settings including industries, healthcare facilities, and consulting firms.
- Exhibit professional growth throughout their careers by taking on increasing professional responsibilities, and pursue life-long learning by participation in job-related advanced training activities, and/or attending graduate school, or professional school (medical or dental school).
- Demonstrate success and leadership in practice of engineering by contributing to the economic well-being of their employers and society, and by dedicated service to professional societies.

## Student Outcomes of the Undergraduate Program

From these Program Educational Objectives, the department designed its baccalaureate program to offer its graduates:

- 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 specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, 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 judgments, 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 judgment to draw conclusions
- g. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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## Admission Requirements

Requirements for admission as a Biomedical Engineering major are governed by the requirements stated under the College of Engineering section of this catalog. Biomedical Engineering majors are only allowed to enroll in pre-professional courses until they meet the requirements for the professional program as outlined below. They must register only for courses approved by their faculty advisor and obtain their advisor's authorization for add/drops.

## Undergraduate Advising

Students entering directly from high school and those with less than 24 hours of transferrable credit are advised initially in the University College. Students are transitioned to advising in the College of Engineering as they progress successfully in their degree programs.

Biomedical Engineering majors are required to be advised by an assigned advisor during the period set aside each semester by the College of Engineering for this purpose. Students are responsible for meeting with their advisors during the advising period. Periods set aside for advising

and registration may be different, and students who do not meet with their advisors during the regular advising period may not be able to complete registration. All students should consult the departmental bulletin board for advisors' names and periods set aside for advising.

Biomedical Engineering students who have not been admitted to the professional program must register only for courses approved by their faculty advisor and obtain their advisor's authorization for add/drops. Failure to do so is grounds for dismissal from the Biomedical Engineering program. Students, including those in the professional program, who enroll in courses before taking the proper prerequisites or co-requisites, will be subject to dismissal from the Biomedical Engineering program.

Transfer students registering for the first time are advised separately prior to the beginning of the semester they enroll in courses. They should contact the department to set up an appointment for advising with a departmental undergraduate advisor prior to registration.

## Admission to the Professional Program

Requirement for admission to the professional program in Biomedical Engineering are in accordance with those of the College of Engineering and additional requirements as follows.

- Application to the professional program is to be submitted to the BE Department after completion of all the pre-professional required courses and prior to taking any Bioengineering 3000 level course.
- No 3000 level Bioengineering course may be taken until the student is admitted into the professional program or obtains the written consent for the BE Department Chair.
- Each student must complete all the courses in the pre-professional required courses with a minimum grade of C in each course and a minimum GPA of 2.25
  - i. in all courses,
  - ii. in math, science, and engineering courses.
  - iii. in bioengineering courses
- Upon receipt of the application, a student's record is individually reviewed including grades, academic and personal integrity, record of drops and course withdrawals, the order in which courses have been taken, the number of times a student has attempted a course for credit, and any other aspect of the student's record that may be deemed pertinent to admission.

The student must be admitted to the professional program and have an approved degree plan on file in order to graduate. The degree plan is generated upon entry to the professional program. Graduating seniors should apply to graduate during the next-to-last semester.

## Prior Preparation and Course Requirements

The undergraduate baccalaureate degree in Biomedical Engineering is a four-year program and requirements for the degree are based upon prior high school preparation through either an honors or college track program. Students who have not had the appropriate prior preparation should contact the departmental advising office for a curriculum guide that will assist them in structuring a study plan that will include leveling courses. Students requiring leveling courses may require a period of time greater than four years to complete their undergraduate degree.

## Academic Requirements

Academic performance requirements establishing satisfactory progress and grade point requirements are given in the College of Engineering section of this catalog.

### Grade Requirements for BE Course Prerequisites

Biomedical Engineering majors (BE-Intended or BE) may not attempt a BE course until they have earned a grade of C or better in the prerequisite course(s).

### Repeating Courses

Biomedical Engineering majors (BE-Intended or BE) may not attempt any course more than three times and apply that course toward a degree in Biomedical Engineering. Enrollment in a course for a period of time sufficient for assignment of a grade, including a grade of W, is considered an attempt.

### Grounds for Dismissal from the BE Program

Requirements for grounds for dismissal as a Biomedical Engineering major are governed by the requirements stated under the College of Engineering section of this catalog.

## Requirements for a Bachelor of Science Degree in Biomedical Engineering

### Pre-Professional Courses

### Recommended Core Requirements

UNIV 1131

STUDENT SUCCESS (or)

or ENGR 1101	ENTRANCE TO ENGINEERING FOR TRANSFER STUDENTS	
BIOL 1441	BIOLOGY I FOR SCIENCE MAJORS: CELL AND MOLECULAR BIOLOGY	4
ENGL 1301	RHETORIC AND COMPOSITION I	3
HIST 1301	HISTORY OF THE UNITED STATES TO 1865	3
HIST 1302	HISTORY OF THE UNITED STATES, 1865 TO PRESENT	3
MATH 1426	CALCULUS I <sup>1</sup>	4
MATH 2425	CALCULUS II	4
PHYS 1443	GENERAL TECHNICAL PHYSICS I	4
POLS 2311	GOVERNMENT OF THE UNITED STATES	3
POLS 2312	STATE AND LOCAL GOVERNMENT	3
	A course on Creative Arts chosen by the student.	3
	A course on Language, Philosophy, & Culture (for Biomedical Engineering majors, PHIL 1304 must be used to satisfy this requirement.)	3
	A course on Social and Behavioral Sciences chosen by the student.	3
	A course on Communication (for Biomedical Engineering majors, COMS 2302 must be used to satisfy this requirement)	3

**Program Requirements**

BE 1105	MEDICAL APPLICATIONS OF ENGINEERING	1
BE 1325	INTRODUCTION TO BIOENGINEERING	3
BE 2315	INTRODUCTORY COMPUTATIONAL TOOLS FOR BIOENGINEERS	3
CHEM 1441	GENERAL CHEMISTRY I	4
CHEM 1442	GENERAL CHEMISTRY II	4
MATH 2326	CALCULUS III	3
MATH 3319	DIFFERENTIAL EQUATIONS & LINEAR ALGEBRA	3
PHYS 1444	GENERAL TECHNICAL PHYSICS II	4

**Professional Courses**

BE 3101	SEMINAR IN BIOENGINEERING	1
or BE 3191	DIRECTED RESEARCH IN BIOENGINEERING	
BE 3180	INTRODUCTION TO MEDICAL DEVICE REGULATORY REQUIREMENTS AND QUALITY STANDARDS	1
BE 3301	CELL PHYSIOLOGY FOR BIOENGINEERS	3
BE 3317	LINEAR SYSTEMS IN BIOENGINEERING	3
BE 3320	MEASUREMENT LABORATORY	3
BE 3380	HUMAN PHYSIOLOGY IN BE	3
BE 4350	SENIOR DESIGN PROJECT I	3
BE 3415	FUNDAMENTALS OF BIOMOLECULAR ENGINEERING	4
BE 4355	SENIOR DESIGN PROJECT II	3
BE 4382	LABORATORY PRINCIPLES	3
IE 3301	ENGINEERING PROBABILITY	3
or MATH 3316	STATISTICAL INFERENCE	

<sup>1</sup> The Mathematics Department requires passing a placement test provided by the Mathematics Department before enrolling in MATH 1426 CALCULUS I.

**Tissue Engineering Concentration**

BE 3310	BIOMECHANICS AND FLUID FLOW WITH COMPUTATIONAL LABORATORY	3
or BE 4312	TISSUE BIOMECHANICS AND BIOENGINEERING	
BE 3367	CELL CULTURE AND DRUG DELIVERY LABORATORY	3
or BE 4365	TISSUE ENGINEERING LABORATORY	
or BE 4373	FORMULATION AND CHARACTERIZATION OF DRUG DELIVERY SYSTEMS	
BE 4333	NANO BIOMATERIALS AND LIVING-SYSTEMS INTERACTION	3
or BE 4331	BIOPOLYMERS AND BIOCOMPATIBILITY	
BE 4337	TRANSPORT PHENOMENA IN BIOMEDICAL ENGINEERING	3
or BE 4314	BIOMEDICAL IMPLANTS	
BE 4368	AN INTRODUCTION TO TISSUE ENGINEERING AND DRUG DELIVERY	3

or BE 4364	TISSUE ENGINEERING LECTURE	
or BE 4372	DRUG DELIVERY SYSTEMS	
CSE 2440	CIRCUIT ANALYSIS	4
or EE 2440	CIRCUIT ANALYSIS WITH LAB	
Choose three additional courses from list available at BE Advising Office.		9
<b>Total Hours</b>		<b>127</b>

### Medical Imaging Concentration

BE 3344	BIOINSTRUMENTATION	3
BE 3346	MEDICAL IMAGING	3
BE 3352	DIGITAL PROCESSING OF BIOLOGICAL SIGNALS	3
BE 4324	BIOMEDICAL OPTICS LABORATORY	3
CSE 2440	CIRCUIT ANALYSIS	4
or EE 2440	CIRCUIT ANALYSIS WITH LAB	
Choose four additional courses from list available at BE Advising Office.		12
<b>Total Hours</b>		<b>127</b>

More hours may be required to strengthen student's program or demonstrate proficiency. See Prior Preparation and Course Requirements.

Note: Total hours will depend upon prior preparation and academic qualifications. Also, students who do not have two units of high school foreign language will be required to take modern and classical languages courses in addition to the previously listed requirements.

Refer to the College of Engineering section of this catalog for information concerning the following topics: Admission into Engineering, Admission into Pre-Engineering, Admission into the Professional Program, Counseling or Advising, Transfer and Change of Major Policies, Honors Program, Academic Regulations, Professional Engineering Registration, Cooperative Education, Academic Probation, Repeating Course Policy and Academic Dishonesty.

### Health Profession Track (Pre-Med or Pre-Dental, etc.)

For those who plan to pursue degrees in medicine or dental science, the following additional course are required in preparation for taking MCAT or DAT. Six hours from the following listed BIOL courses.

BIOL 2444	GENERAL MICROBIOLOGY	4
BIOL 3312	IMMUNOLOGY	3
BIOL 3315	GENETICS	3
BIOL 3442	HUMAN PHYSIOLOGY	4
CHEM 2321	ORGANIC CHEMISTRY I	3
CHEM 2181	ORGANIC CHEMISTRY I LABORATORY	1
CHEM 2322	ORGANIC CHEMISTRY II	3
CHEM 2182	ORGANIC CHEMISTRY II LABORATORY	1
CHEM 4311	BIOCHEMISTRY I	3
PSYC 1315	INTRODUCTION TO PSYCHOLOGY	3
SOCI 1311	INTRODUCTION TO SOCIOLOGY	3

One of the above two can be taken under Social and Behavioral Science of General Core Requirement.

For details, please visit Health Professions Advisor, UT Arlington College of Science (<http://www.uta.edu/science/programs/health-professions.php>)

### Minor in Biomedical Engineering

To receive a minor in Biomedical Engineering a student must complete at least 18 hours in bioengineering courses listed below with a grade of C or better in each. Admission to the minor program in Biomedical Engineering requires 1) a minimum GPA of 2.25 derived from courses completed at UTA and 2) approvals from Undergraduate Advisor of Bioengineering and the student's home department. Upon admission to the program, check with the BE Undergraduate Advisor for advising and for enrollment in courses.

#### Required Courses (3 courses at 9 hours)

BE 3380	HUMAN PHYSIOLOGY IN BE	3
BE 4382	LABORATORY PRINCIPLES	3
BE 1325	INTRODUCTION TO BIOENGINEERING	3

**Elective Courses Choose a minimum of 3 courses (with hours > or = 9) from below**

## Courses in Tissue Engineering, Biomaterials, or Biomechanics Areas

BE 3367	CELL CULTURE AND DRUG DELIVERY LABORATORY	3
BE 4368	AN INTRODUCTION TO TISSUE ENGINEERING AND DRUG DELIVERY	3
BE 4329	NEURAL ENGINEERING	3
BE 4364	TISSUE ENGINEERING LECTURE	3
BE 4365	TISSUE ENGINEERING LABORATORY	3
BE 4372	DRUG DELIVERY SYSTEMS	3
BE 4373	FORMULATION AND CHARACTERIZATION OF DRUG DELIVERY SYSTEMS	3
BE 4385	STEM CELL TISSUE ENGINEERING	3
BE 4331	BIOPOLYMERS AND BIOCOMPATIBILITY	3
BE 4333	NANO BIOMATERIALS AND LIVING-SYSTEMS INTERACTION	3
BE 3310	BIOMECHANICS AND FLUID FLOW WITH COMPUTATIONAL LABORATORY	3
BE 4337	TRANSPORT PHENOMENA IN BIOMEDICAL ENGINEERING	3
BE 3415	FUNDAMENTALS OF BIOMOLECULAR ENGINEERING	4
BE 4312	TISSUE BIOMECHANICS AND BIOENGINEERING	3
BE 4314	BIOMEDICAL IMPLANTS	3

## Courses in Medical Imaging or Bioinstrumentation Areas

BE 3317	LINEAR SYSTEMS IN BIOENGINEERING	3
BE 3344	BIOINSTRUMENTATION	3
BE 4345	BIOSENSORS	3
BE 4324	BIOMEDICAL OPTICS LABORATORY	3
BE 3346	MEDICAL IMAGING	3
BE 3327	TISSUE OPTICS	3
BE 3325	FLUORESCENCE MICROSCOPY	3
BE 3352	DIGITAL PROCESSING OF BIOLOGICAL SIGNALS	3
BE 4366	PROCESS CONTROL IN BIOTECHNOLOGY	3
BE 4326	TISSUE ULTRASOUND-OPTICAL IMAGING	3
EE 3407	ELECTROMAGNETICS	4
EE 2440	CIRCUIT ANALYSIS WITH LAB	4

## Transfer Students and Transfer Credit

When a student transfers to the Bioengineering Department from another department or institution or vice versa, a loss of credit can occur and his/her academic plans may have to be changed. Courses that appear to be similar may be different in either content or level of difficulty and, as a result, cannot be used for degree credit. For transferred courses that cannot be deemed equivalent to a required UTA course in content or in credit hours, students will be required to submit acceptable scores from CLEP, ASE for Undergraduate Advisor's approval. When a student's record indicates weakness in certain areas of study, he/she will be required to retake courses or to take additional courses. Transfer students should contact the Department of Bioengineering after admission and prior to registration.

Transfer students with 24 hours or more of transferable credit must meet the following requirements:

- Completed prerequisites necessary to enroll in MATH 1426 CALCULUS I and PHYS 1443 GENERAL TECHNICAL PHYSICS I
- Students for whom English is a primary language must present two high school units in a single foreign language or will be admitted with a foreign language deficiency that must be removed prior to graduation.
- A GPA of 3.0 or above calculated on transferred credits which include at least 15 hours of applicable math, science, and engineering courses.
- Students must be prepared to repeat any transferred courses below a C until a grade of C or higher is obtained prior to enrolling in any course for which such courses are prerequisite. To transfer bioengineering course credits, the limitation on the number of times a course can be repeated is three.

Students who do not meet these criteria will be reviewed and considered on individual merits for admission into the BE Intended (or Pre) Major.

Prior to advising, a transfer student should present to an undergraduate advisor a transcript (official or copy) from each school previously attended. Only the equivalent courses in a program accredited by ABET or equivalent freshman and sophomore courses accepted by the department can be counted toward a degree in Biomedical Engineering. To be acceptable as an equivalent course, it must be equivalent to our corresponding course in credit value and course content. Junior and senior level courses taken at a college or university which does not have a Bioengineering program accredited by ABET cannot be used to satisfy the requirements for a degree in Biomedical Engineering.

A student in the Department of Bioengineering at UT Arlington who wishes to enroll in courses at another college or university for transfer credit toward a degree in Biomedical Engineering should, first, consult with an undergraduate advisor to verify that the course credits can be used in the student's Biomedical Engineering degree plan.

## Competence in Oral Communication and Computer Use

Completion of COMS 2302 PROFESSIONAL AND TECHNICAL COMMUNICATION FOR SCIENCE AND ENGINEERING, with a grade of C or better, is required to earn a degree in Biomedical Engineering. Also, successful completion of COMS 2302 PROFESSIONAL AND TECHNICAL COMMUNICATION FOR SCIENCE AND ENGINEERING meets the University's oral communication requirement.

All Bioengineering students are required to complete BE 1105 MEDICAL APPLICATIONS OF ENGINEERING, and BE 1325 INTRODUCTION TO BIOENGINEERING with a grade of C or better in each. Successful completion of these courses satisfies the University's computer proficiency requirement.

## Bioengineering Degree Programs at UT Arlington

At the undergraduate level, the department offers a Bachelor of Science in Biomedical Engineering degree with two concentrations for the undergraduate program:

- a. Biomaterials and Tissue Engineering and,
- b. Medical Imaging.

Descriptions of BE degree options are available in the BE Advising Office. All degree options are designed to provide a strong foundation in science, mathematics, and engineering science; technical competence in multiple areas of Bioengineering practice; and an understanding of the importance of ethics, safety, professionalism, and socioeconomic concerns in resolving technical problems through synthesis, planning, and design. Elements of design are introduced at the freshman level. This is followed by an analysis and design component in professional program courses, culminating in a comprehensive design experience.

At the graduate level, the Master of Engineering, Master of Science, and Doctor of Philosophy degrees are offered. Graduate bioengineering degrees are concentrated in one of the areas of specialization available within the department: Bioinstrumentation, Biomaterial/Tissue Engineering, Biomechanics/Orthopedics, Medical Imaging, or Protein Engineering (Doctor of Philosophy only)

The Department of Bioengineering has active student chapters associated with the Biomedical Engineer Student Society (BMESS). Students are encouraged to participate in the activities of the organization. Membership is by election and is limited to students in the upper third of the junior and senior classes who satisfy other requirements listed in the society's bylaws.

## Fast Track Program for a Master of Science in Biomedical Engineering and a Bachelor of Science in Biomedical Engineering

The Fast Track Program enables outstanding UT Arlington senior undergraduate students in Biomedical engineering program to satisfy degree requirements leading to a master's degree in Biomedical Engineering while completing their undergraduate studies.

When students with Biomedical Engineering major are within 30 hours of completing their undergraduate degree requirements, they may take up to 9 hours of graduate level coursework approved by the program to satisfy both undergraduate and graduate degree requirements. In the limiting case, a student completing the maximum allowable hours (9) while in undergraduate status would have to take only 21 additional hours to meet the minimum requirements for graduation in a 30-hour thesis-substitute master's degree program. Students pursuing a thesis master's degree program would have to take 15 additional hours of coursework and to complete 6 hours of Master Thesis with a P grade at the graduating semester.

Students interested in this program should consult with Bioengineering Advisors when they are within 30 hours of completing their bachelor's degrees.

They must have completed at least 30 hours of relevant course work at UT Arlington, achieving a GPA of at least 3.0 in those courses, and have an overall GPA of 3.0 or better in all UT Arlington College of Engineering courses. Additionally, they must have completed a set of specified undergraduate foundation courses with a minimum GPA of 3.3 in those courses. Contact Bioengineering Advisors for more information about the program.

## Fast Track Programs for a Master of Science in Biomedical Engineering and a Bachelor of Science in Physics, Biochemistry or Mathematics

The Department of Bioengineering also offers Fast Track dual degree program in collaboration with the Chemistry and Biochemistry, Physics, and Mathematics departments at UT Arlington. These programs offer the interested students an opportunity to earn a Master's Degree in Biomedical Engineering (MS) and a Bachelor of Science Degree in Biochemistry, Physics, or Mathematics. The Fast Track Program enables outstanding senior undergraduate students in Physics, Biochemistry or Mathematics to receive dual undergraduate and graduate course credits leading to receiving both a Bachelor of Science Degree in either Physics, Biochemistry, or Mathematics and a Master's Degree in Biomedical Engineering. See the departmental advisors for additional information on these programs.

Students interested in this program should consult with Bioengineering Advisors when they are within 30 hours of completing their bachelor's degrees.

They must have completed at least 30 hours of relevant course work at UT Arlington, achieving a GPA of at least 3.0 in those courses, and have an

overall GPA of 3.0 or better in all UT Arlington College of Science courses. Additionally, they must have completed a set of specified undergraduate foundation courses with a minimum GPA of 3.3 in those courses. Contact Bioengineering Advisors for more information about the program.

## Emphasis in Bioengineering

Undergraduate students in other engineering or science disciplines may develop a fundamental knowledge of the field of bioengineering. Student having permission from their department's undergraduate advisor may enroll in the courses listed below and obtain an emphasis in bioengineering. Ordinarily, the student will take these courses as technical elective, free electives and science electives. Interested students should contact the undergraduate advisor of the Department of Bioengineering for additional information.

Elective courses for students who wish to obtain an emphasis in bioengineering:

BE 1325	INTRODUCTION TO BIOENGINEERING	3
BE 3380	HUMAN PHYSIOLOGY IN BE	3
BE 4382	LABORATORY PRINCIPLES	3

At the graduate level, the Department of Bioengineering offers a program of studies leading to masters and doctoral degree in Biomedical Engineering.