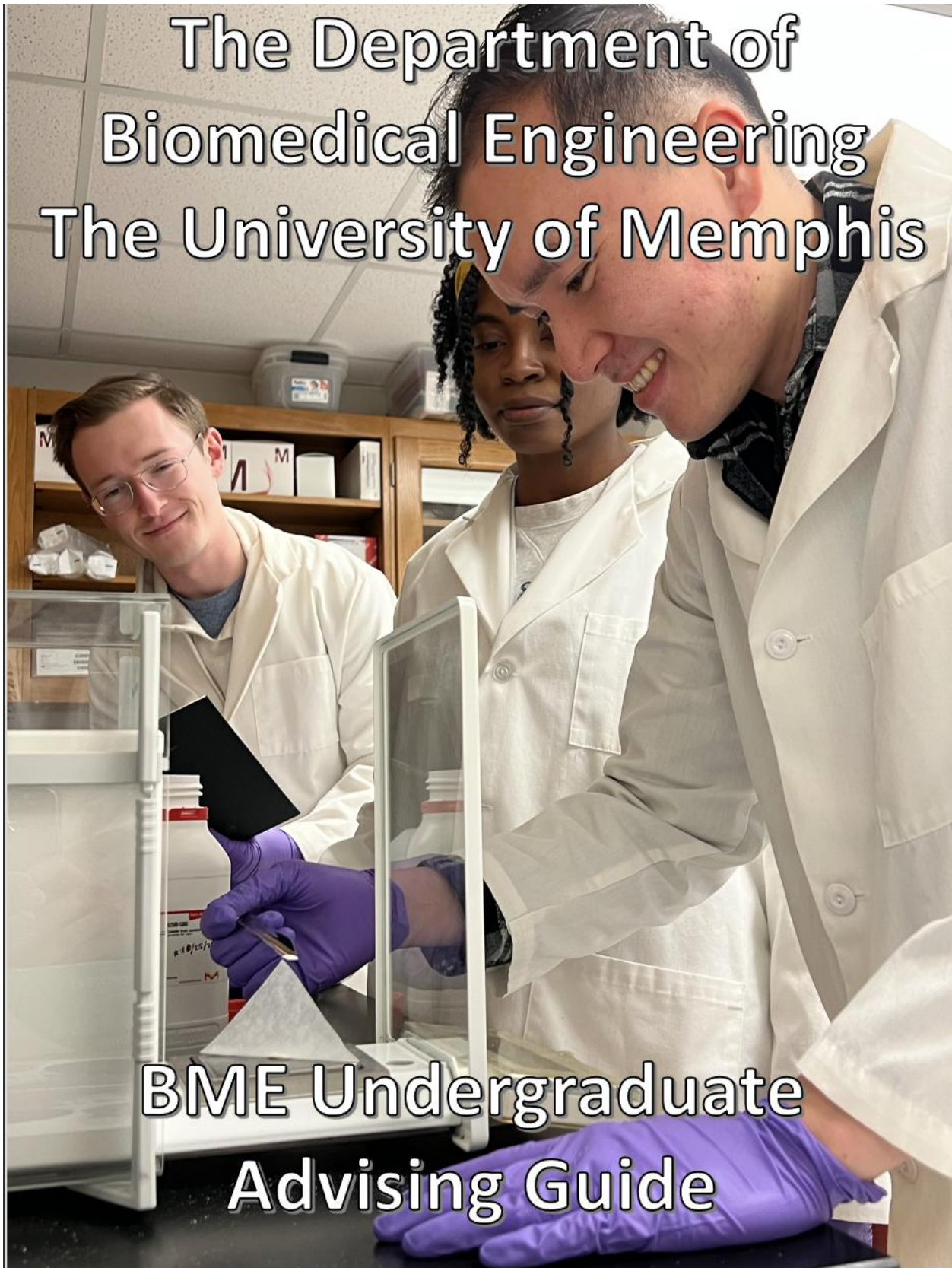


The Department of Biomedical Engineering The University of Memphis



BME Undergraduate Advising Guide

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I. INTRODUCTION

WELCOME! We are delighted you have selected Biomedical Engineering as your undergraduate major! The Biomedical Engineering degree is a wonderful program that provides graduates with unique training, skills, and knowledge for a wide range of career options in medical research, development, education and regulatory oversight, and in medical and legal professions.

This advising guide provides general information about the Biomedical Engineering discipline, and the biomedical engineering program at The University of Memphis. It also provides information about how to plan, with your advisor, a curriculum to help you achieve your career goals.

This document is only a guide; official policies, as updated and or augmented may be found in the University of Memphis Undergraduate bulletin. For more information go [here](#) and click on the academic year in which you began the program.

II. OBJECTIVES AND OUTCOMES

Program Objectives

The Biomedical Engineering Program at the University of Memphis aims to produce graduates who demonstrate the following within the first few years after graduation. Graduates will:

- secure employment in biomedical or related health industries or institutions,
- pursue graduate or professional studies,
- pursue opportunities for professional growth, development, and service.

Student Outcomes

The following outcomes describe what students are expected to know and be able to do by the time of graduation from the Biomedical Engineering undergraduate program. Attainment of these outcomes prepares graduates to pursue program educational objectives.

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. 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
3. an ability to communicate effectively with a range of audiences
4. 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

5. 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
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

In addition, students will have experience in:

- applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations), and statistics;
- solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
- analyzing, modeling, designing and realizing bio/biomedical engineering devices, systems, components, or processes; and
- making measurements on and interpreting data from living systems.

III. WHAT IS BIOMEDICAL ENGINEERING?

Biomedical engineering combines biology and medicine with engineering to advance healthcare through the creation of innovative devices and procedures. The field encompasses many diverse areas for improving human health such as implant devices and Biomechanics, Tissue Engineering/ Regeneration, Biosensors, Imaging, Electrophysiological Technologies. These are used for the prevention, detection, diagnosis, and treatment of diseases such as arthritis, cancer, and heart arrhythmia.

Students who complete an undergraduate program may immediately fill positions such as research and test engineer, regulatory specialist, quality control engineer, R&D design engineer, technical support engineer, or sales engineer. Many students continue their education, earning masters, doctoral, medical, dental, or other professional degrees including law degrees (especially in intellectual property). See the [American Institute for Medical & Biological Engineering](#) - Navigate the Circuit webpages for additional information.

i. Biomedical Engineering at the University of Memphis

Here at the University of Memphis, the curriculum:

1. Prepares graduates for professional practice and provides a foundation for lifelong learning and professional growth.
2. Includes biomedical and engineering foundation courses as well as upper level biomedical, engineering and technical electives (as noted in the typical sequence below) to allow students, with advisor's assistance, to choose their curriculum to match areas of interest in the larger BME discipline and its supporting fields.

3. Culminates in a senior design experience in which a medical device is designed, constructed and evaluated.

ii. Requirements

Admission: Admission requirements to The University of Memphis are located on the [University online catalogue](#). Advising for freshman and transfer students is initially performed by the [Herff College of Engineering \(HCoE\) Academic Advisor](#). The student is then assigned an advisor in the Biomedical Engineering Department.

Graduation Requirements: Students must satisfy all university, college, and departmental degree requirement for the degree desired. University and degree requirements may be found in the [University online catalogue](#). Graduation is NOT automatic and **you must file your intent to graduate by the appropriate deadlines**. Information on the dates and deadlines for filing your intent to graduate form for your intended semester of graduation are published by the Registrar.

All students are required to complete an approved curriculum of a minimum 125 semester hours. All students must obtain a minimum 2.0 grade point average on all work completed and obtain a minimum grade of "C-" in all engineering, mathematics, physics, biology, and chemistry courses used to satisfy degree requirements. **Engineering requires that a minimum of 30 hours of the hours required by the University be taken as upper-division hours in courses in the Herff College of Engineering.** Specific departmental requirements are subject to change and students should consult their advisor regularly to learn of changes that occur. Other [University](#) and [HCoE](#) requirements are located on the University on-line catalogue.

Policy on Repeated Courses:

Students must earn a grade of at least "C-" in all BIOM courses applied toward the major, and in all required engineering, chemistry, physics and mathematical courses. BIOM, BIOL, CHEM, MATH and PHYS courses applicable toward the major **may not be taken more than three times**. To repeat a course a second time, a student must apply for and receive special permission from the department Undergraduate Studies Committee. Application information is available from one of the Academic Coordinators. A student may not attempt the same BIOM, BIOL, CHEM, MATH or PHYS course more than three times, regardless of where it was taken. Courses cross-listed with BIOM (e.g. BIOL 4110, MECH 4365) are also subject to this course repetition policy.

IV. ELECTIVES

Electives may be used to tailor a program of study to match individual student's career goals. These 7 electives provide much flexibility and choices in developing a program of study to meet career goals. The BME degree program requires that students take the following:

- **2 Biomedical Engineering (BIOM) electives**
- **3 Engineering electives**
- **1 Technical Elective**

The **BIOM electives** must be selected from Upper-Division BIOM courses. The **Engineering electives** may be selected from Upper Division Engineering courses in the HCoE (e.g. MECH, EECE, CE). The **Technical elective** may be selected from Upper Division courses in BIOL, CHEM, Engineering (including BIOM), MATH, PHYS, and Engineering Technology (TECH).

Note for students following the pre-med program, there are only 2 Engineering electives since one of the electives is programmed to meet degree requirements while enabling students to meet pre-med application/admission requirements.

These elective courses should be chosen with permission of the advisor, the Chair or the Chair Designee. Students may need to take other courses to satisfy Pre-requisite requirements for Upper Division courses outside of the department.

Below is a brief list of potential technical electives from BIOL, CHEM, MATH, PHYS and TECH. Note this list is not exhaustive and there are other electives which may be discussed with an advisor.

List of Some Potential Technical (non Engr) Electives:

BIOL 3130 - Cell Biology (3)	PHYS 3011 - Math Skill Phys I (3)
BIOL 4094 - Biology of Stem Cells (3)	PHYS 3211 - Electricity and Magnetism (3)
BIOL 4480 - Cellular/Molec Pharm (3)	PHYS 3111 - Mechanics I (3)
BIOL 4402 – Toxicology (3)	PHYS 4020 - Soft Mater (3)
BIOL 3072/3073 – Genetics and Laboratory (3/4)	PHYS 4040 – Med Phys (3)
	PHYS 4620 – Device Physics & MicroFab (3)
BIOL 4445 – Immunology (3)	PHYS 4720 - Material Physics (3)
BIOL 4150 - Developmental Biology (3)	PHYS 4820 - Material Physics Lab (3)
BIOL 4200 - Cell and Developmental Biology Lab (3)	TECH 3044- Analysis for Engineering Technology (4)
BIOL 4380 - Histology (3)	CHEM 3311/3301 –Organic chemistry I (3) + Laboratory (1)
BIOL 3500/3505 – Microbiology I/Fundamental Aspects and Lab (3/4)	CHEM 3312/3202 – Organic chemistry II (3) + Laboratory (1)
MATH 3242 – Introduction to Linear Algebra (3)	CHEM3411- Foundations/Physical Chemistry (3)
MATH 4391 – Partial Differential Equations I (3)	
MATH 4721 – Numerical Analysis (3)	
PHYS 3010 - Modern Physics (3)	CHEM 4511 - Biochemistry I (3) (same as BIOL 4511)

V. CONCENTRATIONS, CERTIFICATES & FOCUS AREAS

Concentrations

A concentration enables students to tailor their degree program to specific aspects of biomedical engineering to meet their professional career goals or interests. Concentrations specify one or two required courses and then student may choose one or two courses from an approved list. Required and selected courses are used to satisfy BIOM, ENGR or technical elective requirements in the degree. Students completing courses for a concentration will have the concentration indicated in their official academic record as part of their B.S. degree and it will be listed on their transcript. Concentrations can be combined with other concentrations, minors, second degrees and certificates. Note student's do not have to select a concentration.

Below are the concentrations for the Biomedical Engineering degree:

i. Bioelectrical Devices and Systems

- Required
- BIOM 4720 – Bioelectricity (credit hours: 4hrs)
- Choose 2 from the following list:
- EECE 3203 - Signals and Systems Credit Hours: (3)
- EECE 3240 - Electromagnetic Field Theory Credit Hours: (3)
- EECE 3201 - Circuit Analysis II Credit Hours: (4)
- EECE 3211 - Electronics I Credit Hours: (3)
- EECE 3213 - Electrical & Computer Engr Lab 2 Credit Hours: (1)
- BIOL 3130 - Cell Biology Credit Hours: (3)
- BIOL 4635 - Neurobiology Credit Hours: (3)
- MATH 4391 - Partial Differential Equations I Credit Hours: (3)

ii. Medical Imaging

- Required
- BIOM 4801 – Intro to Medical imaging (credit hours 4)
- EECE 3203 – Signals and Systems (credit hours 3)
- Choose 1 from the following list:
- BIOM 4150 – Engr Tools Design Med Devices (credit hours 3)
- EECE 4232 – Discrete Signal Processing (credit hours 3)
- EECE 4242 – Electro-Optics (credit hours 3)
- EECE 4243 - Linear Optical Systems (credit hours 3)

iii. *Medical Materials & Manufacturing*

- Required
- BIOM 4340 – Manufacturing Processes (credit hours 3)
- BIOM 4916 – Tissue Engineering (credit hours 3)
 - Choose 1 from the following list:
- BIOM 4702 – Biotech Tools for BME Res (credit hours 3)
- BIOM 4806 – Regulatory Affairs for Medical Devices (credit hours 3)
- BIOM 4150 – Engr Tools Design Med Devices (credit hours 3)
- BIOM 4750 – Biomechanics (credit hours 3)

Note: With approval, BIOM 4210 Research Studies or BIOM 4999 BME Honors Thesis, may be taken for 3 semester hours credit and used to meet concentration course requirements.

Certificate in Regulatory Affairs for Medical Devices

Students may earn additional credentials with the Certificate in Regulatory Affairs for Medical Devices Program. The Certificate program requires four courses for 13 credit hours. The courses may be used to satisfy BIOM, ENGR or technical elective requirements in the degree program. The Certificate is awarded in addition to the B.S. BME degree and shows that the student has gained knowledge and understanding processes that are used to approve medical devices by regulatory agencies such as the US FDA.

- Required courses
- BIOM 4730 Biomaterials (4 credit hours) (offered Fall & Spring terms)
- TECH 4462 Quality Improvement (3 credit hours) (offered Fall & Spring terms)
- BIOM 4340 Manufacturing Processes (3 credit hours) (Fall only terms)
- BIOM 4806 Regulatory Affairs of Medical Devices (3 credit hours) (Fall only terms)

Focus Areas

Focus areas are **NOT** official and do not show up on academic records or transcripts. Students may develop curriculum to overlap/integrate one or more focus areas for their particular career goals or follow a *General* degree program. The Pre-med focus is the degree plan that specifically meets the requirements for medical school applications/admissions as well as the B.S. in BME degree. Please see your advisor for more details.

Undergraduate students may choose a focus area in degree program in the following:

1. *Biomaterials/ Tissue Engineering*
2. *Biomechanics*
3. *Biolmaging*
4. *Pre-medical Professional Studies*
5. *Pre-Orthotics & Prosthetic*

The focus areas below are examples pertaining to specific areas and career paths. It is not necessary for students to select a focus area since students can be well served by choosing topics from each focus area. Not all electives have been specified for each focus area. Selection of additional electives must be done in consultation with an academic advisor.

Biomaterials/ Tissue Engineering Focus: This area provides the student with basic knowledge and background in understanding structure, organization, and properties necessary for materials to be used in medical devices and/or for engineering tissues, to replace, augment and/or restore the function of damaged or diseased tissues. Examples include hip implants, wound dressings, spinal fixation devices, engineered blood vessels, skin and bone. This area involves the development, selection, modification, and evaluation of material structure and properties and interactions with host cells/tissues.

BIOL 4511	Biochemistry
BIOL 3130	Cell Biology (3)
(Or BIOL 4094 - Immunology (3))	Biology of Stem Cells (3) or BIOL 4380 Histology (3) or BIOL 4445

BIOL 4470	Molecular Biology of Gene (3)
BIOM 4702	Biotechnology Tools of Biomedical Engineering Research (3)
BIOM 4150	Engr Tools for Medical Device Design (3)
BIOM 4750	Biomechanics (4)
(Or BIOM 4205 Introduction to Biomedical or Chemical Sensors (3) or BIOM 4110 Science of Medicine (3))	

CHEM 3311/3301	Organic I (3) + Laboratory (1)
CHEM 3312/3302	Organic II (3) + Laboratory (1)
CHEM 4614	Polymer Chemistry (3hrs)
MECH 3331	Fluid Mechanics (3)
MECH 4340	Manufacturing Processes (3)
MECH 4360	Selection of Engineering Materials (3)

Bioelectric Devices and Systems: This area trains students in the basic concepts and principles for detecting, measuring and monitoring chemical and bio-electrical phenomena in cardiovascular, neurological and musculoskeletal tissues, diagnostic interpretation via signal processing and the application of electrical stimulation for tissue function.

BIOL 3130	Cell Biology (3)
BIOM 4720	Bioelectricity (4)
BIOM 4205	Introduction to Biomedical and Chemical Sensors (3) (or BIOM 4110 Science of Medicine (3))
CHEM 3211/3201	Foundations/Analytical CHEM (3) + Laboratory (2)
CHEM 3411/3402	Foundations/Physical Chemistry (3) + Laboratory (2)
CHEM 4211/4201	Instrumental Analysis (3/1)

EECE 3211	Electronics I (3)
EECE 3213	Electronics I Laboratory (1)
EECE 3240	Electromagnetic Field Theory (3)
EECE 3201	Circuit Analysis II (4)
EECE 3203	Signals and Systems I (3)
MATH 4391	Partial Differential Equations I
MATH 3242	Intro to Linear Algebra

Biomechanics: The Biomechanics focus introduces and develops students' skills for examining forces acting upon and within biological/physiological structures and the effects produced by such forces. This includes mechanical analyses of implant devices, hard (e.g. bones) and soft (e.g. ligaments, blood vessels, lung) tissues, and blood and air flow analyses.

BIOM 4750	Biomechanics (4)
BIOM 4150	Engr Tools for Medical Device Design (3) (or BIOM 4730 Biomaterials(4) or BIOM 4110 Science of Medicine)
BIOM 4393	Applied Finite Element Analysis (3)
MECH 3321	Mechanics of Machines (3)
MECH 3331	Fluid Mechanics (3) (or MECH 3330 Introduction to Thermal Systems (3))
BIOL 3620	Comparative Anatomy of Vertebrates (3) (or BIOL 4380 Histology)
MECH 2332	Dynamics (3)
MECH 3341	Numerical & Statistical Methods (3)
MECH 3331	Fluid Mechanics (3)
MECH 4340	Manufacturing Processes

Pre-medical Studies: This area provides students with highly recommended courses, including organic chemistry, to prepare them for pursuing medical, dental and/or related health science programs. This program will require additional hours to meet pre-medical, biology, and chemistry course requirements above and beyond the 125 hours required for the BS BME degree. Additional information and resources are available at the [Pre-Health Advising Center](#). See advisor for additional information.

For Humanities electives, two of the following are suggested:

THEA 1030, COMM 1851, ART 1030 or MUS 1030

Note: PHIL 3514 Biomed Ethics is also highly recommended but cannot be used to satisfy the university's general education humanities requirements.

For Behavioral/Social Sciences Elective:

PSYC 1030 and SOCI 1030 are highly recommended for preparing for the MCAT

Take the following Two (2) Technical Electives:

CHEM 3311/3301	Organic I (3) + Laboratory (1)
CHEM 3312/3302	Organic II (3) + Laboratory (1)

Take BIOM 4110 – Science of Medicine course as either a BIOM or Engr Elective

Students should consider taking at least one to two additional *biology/chemistry courses* from the following:

BIOL 3072/3073 –	Genetics and Lab (<i>note student may take course without the lab</i>)
BIOL 3610 –	Vertebrate Embryology
BIOL 3620 –	Comparative Anatomy
BIOL 3130 –	Cell Biology
BIOL 4380 –	Histology
BIOL 3500 –	Micro I/Fundmntl Aspect
BIOL 4445 –	Immunology
BIOL 4100 –	Evolution
CHEM 4511 –	Biochemistry (same as BIOL 4511)

Pre-Orthotics & Prosthetics: This focus area sets students up to continue their education at a graduate level in Orthotics and Prosthetics. Following this path would cover the majority of the requirements for most of the master's programs currently offered and accredited through the NCOPE and OPCAS. Students may have to take additional courses depending on the program they would like to attend; they should check with their specific program for the requirements.

Students should take the following for General Education requirement:

PSYC 1030 General Psychology

Students should take these courses as an elective:

BIOM 3110 Medical Physiology

BIOM 4900 Intro to Biomechanics*

BIOM 4110 Science of Medicine*

Students should consider taking these extra courses:

BIOL 2010 Human Anatomy & Physiology I

BIOL 2020/2021 Human Anatomy & Physiology II with laboratory **

EDPR 2111 Development Across the Lifespan**

PSYC 3102 Psychopathology (formally called Abnormal Psychology) **

* These courses are not required but recommended electives for orthotics & prosthetics master's programs

**These courses may be required depending on the master's program the student would like to attend

VI. SECOND MAJORS

Second majors provide students the opportunity to expand and build their undergraduate degree program to meet career goals. Students may obtain a second major in physics. This program requires additional hours above and beyond the 125 required semester hours. Second majors may also be obtained in other engineering departments and options should be discussed with an advisor.

i. Pre-law Studies

Biomedical engineers are in unique position to help review and litigate many legal issues in the biotechnology sector, particularly with respect to Copyright and Intellectual Property statutes and laws. Students interested in using the BS degree in biomedical engineering to pursue a legal career are encouraged to talk with their advisor and to review information and resources at the [Pre-law Advising Center](#). This program may require additional hours above and beyond the 125 required semester hours for the degree.

ii. Second Major in Physics and Material Science

Physics remains a key foundation to many Biomedical Engineering activities. Students have the opportunity to enhance their BME degree by obtaining a second major in Physics and Materials Science. For details, please visit the [Department of Physics](#). Please register for the program with your advisor.

2nd Major in Physics requires 26-27 hours. Note that this also requires an additional 3 hours beyond the 125 hour requirement of the BME degree.

<u>PHYS Requires</u>	<u>BME curriculum</u>
MATH 1910 (4)	take MATH 1910 (4)
PHYS 2010+L (4)	take PHYS 2010 +L (4)
PHYS 2020+L (4)	take PHYS 2020+L (4)
PHYS 3010 Modn Phys (3)	take as TECH elective (I) (3)
UD PHYS crs* (3)	take as TECH Elective (II) (3)
UD PHYS crs* [#] (3)	this is an extra course beyond what is needed for BME degree (3)
UD PHYS or BME crs(3)	take BIOM 4730 – Biomaterials (4)
UD PHYS or BME ^s crs (3)	take BIOM elective (3)
Total	27
	28

*recommended PHYS courses:

- PHYS 3111 – Mechanics I (3)
- OR PHYS 4020 Soft Mater (3)
- OR PHYS 4040 – Med Phys (3)
- OR PHYS 4620 – Device Physics & MicroFab (3)
- OR PHYS 4720 Material Physics (3)
- OR PHYS 4820 Material Physics Lab (3)

ARTH 2020—World Art II	CDFS 2101—Family/Global Perspective
CLAS 2481—Mythology	ECON 2010 – Intro to Macroeconomics
COMM 1851—Intro to Film	ECON 2020—Intro to Microeconomics
DANC 1151—Intro to Dance	ESCI 1301—Survey of World Regions
JDST 2850—Religions of Abraham	ESCI 1401—Intro/Cultural Geography
MUS 1030—Intro to Music	FIR 1220—Personal Financial Management
MUS 1040—Music in America	HLSC 2100—Wellness Concepts Practice
PHIL 1101— Intro to Philosophy	INTL 1101 – Intro to International Studies
PHIL 1102— Intro to Ethics	JRSM 1700—Intro to Media
POLS 1101—Intro Ancient Political Thought	POLS 1030—American Government
POLS 1102—Intro Modern Political Thought	POLS 1301—Comparative Politics
RLGN 1100—Intro to Religion	POLS 1501—International Relations
THEA 1030—Intro to Theater	PSYC 1030—General Psychology
UNIV 3580—Hebrew and Greek Legacy	PSYC 3510—Deviance/ Role History
UNIV 3581—Faith/Reason/Imagination	SOCI 1010—Intro to Sociology
	SOCI 2100—Sociology of Globalization
	WMST 2100—Intr/Women/ Gender Study

Transfer Students: Biomedical Engineering requires that 12 of the last 60 hours required by the University for residency be taken as upper-division engineering courses in the Herff College of Engineering and, specifically, include *BIOM 4760*, *BIOM 4782*, and *BIOM 4784*.

Transfer Credit: Any University of Memphis student considering taking courses at another institution, to satisfy degree requirements, should meet with his/her academic advisor, to see how those courses will transfer back to the University of Memphis and students should complete a [transfer credit request form](#). For program degree credits, please contact your advisor or the Herff College student advisor.

Cooperative/Internship Education: The Cooperative (co-op) and Internship Education Program adds a real-world engineering experience to students' education. The Herff College of Engineering Co-op and Internship program provide opportunities for students to earn academic credit towards degree through real-world, on the job education and practical experience in their chosen field of study. Students interested in co-op or internship opportunities should contact Ms. Shelia Moses, Program Services Specialist in the HCoE Dean's office (phone 678-4933; srmoses@memphis.edu).

International/Study Abroad Programs: Opportunities for students to experience work and education in different countries and experience different cultures will allow them to be more competitive and successful in the international engineering and business markets and in the changing global environment. Contact The University of Memphis Study Abroad Office (<http://www.memphis.edu/abroad/>) to find out about different study abroad programs, requirements, and scholarships.

Overload: Students are allowed to register for a maximum of 20.5 hours each semester without prior approval. To register for more than 20.5 hours in any one term, the student must fill the [Course Overload Form](#) with a signature from the authorized personnel for the department or college.

To Change Major: If you have decided to change your major, contact the [faculty/departmental advisor for your NEW major](#).

Withdrawing from the Current or Upcoming Term: We hope it is not necessary, but if you need to withdraw completely from the University, your first step should be to drop all of your courses online on or before the "Last Day to Drop a Class" for the term/part(s)-of-term. See the appropriate [Dates & Deadlines calendar](#) to find this date. **Do not make the mistake of thinking that you are withdrawing by simply not attending your classes.** You must drop the classes you have enrolled in; otherwise, you may receive F grades and owe the University money.

You must have permission to drop all of your courses if you are a **scholarship athlete**, are under contract due to **academic suspension, high school deficiencies, or remediation** or are receiving **a Lottery Scholarship**. You will need to contact the athletic academic services, academic status and retention office and/or financial aid office to obtain permission.

It is possible to withdraw from a term after the drop deadline has passed; this is a [Late Withdrawal](#). It is even possible to withdraw from a term after it has ended and grades have been issued; this is a [Retroactive Withdrawal](#). In either instance, however, you must apply for permission to withdraw, and your withdrawal will be permitted only if you have the proper approval. To apply for either late or retroactive withdrawal, please contact your advisor or the HCoE advisor.