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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 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 focus¹ their curriculum to 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 for residency 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. FOCUS AREAS

Undergraduate students may focus * their degree program in the following:

1. *Biomaterials/ Tissue Engineering*
2. *Bioelectrical Devices and Systems*
3. *Biosensor Devices and Systems*
4. *Biomechanics*
5. *Pre-medical Professional Studies*

* Note: Focus areas are **NOT** official; however, medical schools do require focus areas (Pre-med), please see your advisor for more details. Students may develop curriculum to overlap/integrate one or more focus areas for their particular career goals.

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 should 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. 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 3310/3301	Foundations/Organic Chemistry (3) + Laboratory (1)
CHEM 3511/3501	Foundations/BioOrganic Chemistry (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)
TECH 4472	Computer Aided Drafting and Design (3))

Bioelectric & Biosensors 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))
MECH 4324	Computer Methods/Design (3) (or TECH 4472 Computer Aided Drafting and Design (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
TECH 4472	Computer Aided Drafting and Design (3)

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 B S in Biomedical Engineering. 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 or SOCI 101 are highly recommended (PSYC 1030 is preferred for MCAT)

Take the following Two (2) Technical Electives:

CHEM 3311 and CHEM 3301 – Foundations/Organic Chemistry + Lab

CHEM 3511 and CHEM 3501 - Foundations/Bioorganic + Lab

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

V. ELECTIVES

Electives may be used to tailor a program of study to match individual student's career goals. These 5 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**
- **2 Technical Electives**

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. The Technical electives may be selected from Upper Division courses in BIOL, CHEM, Engineering (including BIOM), MATH, PHYS, and Engineering Technology (TECH).

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.

There are other electives and they should be discussed with the advisor.

General List of Technical Electives:

BIOL 3130 - Cell Biology (3)	PHYS 3211 - Electricity and Magnetism (3)
BIOL 4094 - Biology of Stem Cells (3)	PHYS 3111 - Mechanics I (3)
BIOL 4480 - Cellular/Molec Pharm (3)	PHYS 4020 - Soft Mater (3)
BIOL 4402 – Toxicology (3)	PHYS 4040 – Med Phys (3)
BIOL 3072/3073 – Genetics and Laboratory (3/4)	PHYS 4620 – Device Physics & MicroFab (3)
BIOL 3620 - Comparative Anatomy of Vertebrates (3)	PHYS 4720 - Material Physics (3)
BIOL 4445 – Immunology (3)	PHYS 4820 - Material Physics Lab (3)
BIOL 4150 - Developmental Biology (3)	TECH 4462 - Quality Improvement (3)
BIOL 4200 - Cell and Developmental Biology Lab (3)	TECH 4463 - Quality Systems (3)
BIOL 4380 - Histology (3)	TECH 4472 – Computer Aided Design (3)
BIOL 3500/3505 – Microbiology I/Fundamental Aspects and Lab (3/4)	CHEM 3310/3301 – Foundations Organic Chemistry (3) + Laboratory (1)
MATH 3242 – Introduction to Linear Algebra (3)	CHEM 3511/3501 – Foundations of BioOrganic chemistry (3) = Laboratory (1)
MATH 4391 – Partial Differential Equations I (3)	CHEM 3211/ 3201 - Foundations/Analytical CHEM (3) + Lab (2)
MATH 4721 – Numerical Analysis (3)	CHEM 3411/3402 - Foundations/Physical Chemistry (3) + Lab (2)
PHYS 3010 - Modern Physics (3)	CHEM 5411 - Biochemistry I (3)
PHYS 3011 - Theoretical Physics(3)	

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 128 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 B S in Biomedical Engineering degree 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 128 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 ^{\$} 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)

This course is required for 2nd Major in Physics

§recommended BIOM courses: BIOM 4702 - Biotech Tools Biomed Engr Res (3)
 BIOM 4150 - Engr Tools for Medical Device
 Design (3)
 BIOM 4750 - Biomechanics (4)

VII. Honors in Biomedical Engineering

Biomedical Engineering Honors Program is for strongly motivated and high achieving students and provides special opportunities to advance their career and professional development. Students are eligible to apply for the [honors program](#) in biomedical engineering if they have and maintain a cumulative GPA of 3.4, with at least junior standing and have received approval for department honors committee.

Accelerated BS/MS Program in Biomedical Engineering

Highly qualified students are allowed to earn a Bachelor's degree in an approved undergraduate discipline and a Master's degree in BME in five years. See [here](#) for more information.

Combination Senior Status

The Combination Senior Program allows qualified undergraduates to register for graduate classes, offering a chance to explore graduate coursework before committing to a formal degree program. Click [here](#) for more information.

VIII. Additional Information

University Curriculum

The *only* courses that satisfy the University's Humanities and Social/Behavioral Science elective requirements are listed below. Other courses may be taken but cannot be used to satisfy graduation requirements in the HCOE.

HUMANITIES (6 hrs) Select 2 courses	Social/Behavioral Science (pick 1)*
ART 1020—Intro to Art	ANTH 1100—Biol Anth & Prehistory
ARTH 2010—World Art I	ANTH 1200—Cultural Anthropology
ARTH 2020—World Art II	CDFS 2101—Family/Global Perspective
CLAS 2481—Mythology	ECON 2020—Intro to Microeconomics
COMM 1851—Intro to Film	ESCI 1301—Survey of World Regions
DANC 1151—Intro to Dance	ESCI 1401—Intro/Cultural Geography
JDST 2850—Religions of Abraham	FIR 1220—Personal Financial Management
MUS 1030—Intro to Music	HLSC 2100—Wellness Concepts Practice
PHIL 1101—Fundamental Issues/ Philosophy	JRSM 1700—Survey of Media

PHIL 1102—Values and Modern Thought	POLS 1030—American Government
POLS 1101—Intro Ancient Political Thought	POLS 1301—Intro to Comparative Politics
POLS 1102—Intro Modern Political Thought	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
MUS 1040—Music in America	SOCI 2100—Sociology of Globalization
RLGN 100—Intro to Religion	WMST 2100—Intr/Women/ Gender Study

* Note: ECON 2010 is already a requirement for the BME curriculum

Transfer Students: A student will satisfy residence requirements for graduation by earning at least twenty-five (25) percent of credit hours required for the degree at the University of Memphis. At least thirty (30) of the final sixty (60) hours required for the degree must be completed at the University of Memphis. A student transferring credits from a two-year college or institution must complete, as a requirement for the baccalaureate degree, a minimum of sixty semester hours in an accredited senior institution.

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 Education: The Cooperative (co-op) Education Program offers students a real-world engineering dimension to their education often referred to as ‘total education.’ The Herff College of Engineering Co-op program may best be summarized as being a singular and specific educational opportunity by which students obtain an academic education and at the same time obtain a minimum of one year of vitally needed practical experience in their chosen field of study. Students interested in co-op opportunities should contact Ms. Shelia Moses, Program Services Specialist in the HCoE Dean’s office (phone 678-4933; srmoses@memphis.edu). *Note, co-op course credits do not satisfy degree requirements. Grades assigned for co-op courses are used in calculating student’s GPA.*

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 (<http://www.memphis.edu/registrar/forms.htm>)

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.