



Biomedical Engineering Undergraduate Student Guide

2023-2024

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I. Introduction

This guide has been prepared to aid students who are currently enrolled in the Department of Biomedical Engineering and Mechanics (BEAM) in fulfilling the requirements for a B.S. in Biomedical Engineering (BME), as well as provide information for individuals who may be interested in becoming BME majors. This guide should be considered as a supplement to the requirements published in the Virginia Tech Undergraduate Catalog and in no way is intended to supercede any statements in the Undergraduate Catalog, statements from the Dean of Engineering Academic Affairs Office, or information from the University Registrar. This guide is also subject to revision by the faculty, and notices of changes will be circulated through email to students. Changes will not be enforced retroactively. Students affected by curriculum revisions should see the BME Undergraduate Program Chair.

It is the student's responsibility to ensure that they fulfill all BS BME program requirements specified in the appropriate checksheet. The BEAM Undergraduate Academic Advisor will assist as much as possible but are not responsible for checking that all requirements have been satisfied.

II. BEAM and the UG BME Program

BEAM Department Vision Statement: To be the premier program for improving the human condition and the communities we serve through our unique intersection of biomedical engineering, mechanics, and science.

BEAM Mission Statement: Our department leverages broad expertise in biomedical engineering, foundational mechanics, and sciences to solve significant health and technological challenges through cutting edge research, strategic partnerships, and educating students to be critical thinkers, and ethical innovators and leaders.

BME Undergraduate Program:

The BEAM Department has established Program Educational Objectives (PEOs) and Student Outcomes (SOs) that support our BME Undergraduate Program mission. PEOs describe the expected accomplishments of BME graduates within a few years of graduation. PEOs are based on the needs of the programs constituencies and are systematically reviewed. SOs described what students are expected to know and be able to do by the time of graduation (knowledge, skills, and behaviors).

The BME Curriculum Committee was established to act as the executive body of the department in matters relating to the BME undergraduate curriculum, its degree program and courses. The committee will proactively assess and evaluate the undergraduate curriculum, implement necessary changes and minor improvements, propose significant improvements for faculty decision, and respond to faculty, administration, staff and student issues on matters within its scope. The committee is composed of members of the advising and faculty, as well as at least one undergraduate BME student representative selected by the BME UCC with ex officio (nonvoting) membership.

BME Program Educational Objectives (PEOs):

Biomedical Engineering is a multidisciplinary field, using engineering principles and design concepts to advance healthcare treatment and find innovative solutions. We strive to prepare our graduates to succeed in advanced graduate or professional study, industry, and government. Within a few years after graduation, we expect our graduates to productively contribute to improving the human condition. In these activities, our alumni will:



1. Develop and advance in their professional careers within industry, academia, and/or healthcare.
2. Communicate and collaborate effectively across professional and disciplinary boundaries while exhibiting self-awareness of their role within the profession.
3. Continually build knowledge and skills to successfully navigate the changing technology and healthcare challenges.
4. Embody Ut Prosim through application of their engineering knowledge and experience in ethical service to local, national, and global communities.




BME Student Outcomes (SOs):

These educational objectives are supported by a curriculum that seeks to have its graduates achieve the following student outcomes:

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.

III. Leadership & Support

BME Undergraduate Program Leadership & Support		
Department Head and Professor	Dr. Jennifer Wayne 313 Kelly Hall 325 Stanger St. Blacksburg, VA 24061 (540) 231-2569 jswayne@vt.edu	
BME Undergraduate Program Chair and Collegiate Associate Professor	Dr. Sara Arena Collegiate Square, Suite 302 460 Turner St. Blacksburg, VA 24060 (540) 232-8441 smatrang@vt.edu	
BEAM Undergraduate Academic Advisor	Ms. Amanda Sandridge 225-B Norris Hall 495 Old Turner St. Blacksburg, VA 24061 (540) 231-4965 asandridge@vt.edu	

Accelerated Undergraduate/Graduate (UG/G) Program Leadership & Support		
Department Head and Professor	<p>Dr. Jennifer Wayne 313 Kelly Hall 325 Stanger St. Blacksburg, VA 24061 (540) 231-2569 jswayne@vt.edu</p>	
BME Graduate Chair and Associate Professor	<p>Dr. Yong Woo Lee 337 Kelly Hall 325 Stanger St. Blacksburg, VA 24061 (540) 231-8484 ywlee@vt.edu</p>	
BME Graduate Academic Advisor	<p>Ms. Kelsey Wall 333-N Norris Hall 495 Old Turner St. Blacksburg, VA 24061 (540) 231-0752 kelseywall@vt.edu</p>	

IV. Advising

The BEAM Department has one undergraduate academic advisor who serves as a resource for all BME major and minor students. Students with interests or questions in specific technical areas are referred to the appropriate faculty in that research area.

The BEAM Undergraduate Academic Advisor is the primary contact for all students regarding questions about University, College, and Departmental policies and procedures, the BME curriculum, program of study planning, registration procedures, course loads, course substitutions, prerequisite rules, transfer credit, changing majors, and other related matters. When appropriate, the BEAM Undergraduate Academic Advisor will refer students to campus resources, such as Cook Counseling Center or Services for Students with Disabilities.

Advising at Virginia Tech is a collaborative process between student and advisor, leading to the exchange of information that encourages the individual student to make responsible academic and career decisions.

Statement of Student Responsibility

The student shares the responsibility for developing an advising partnership with the advisor. Over time, the partnership results in increased responsibility for the student. The student will:

- Communicating goals, needs, wants, and concerns to the advisor in a respectful and sincere manner;
- Keeping abreast of their own academic progress and requirements related to their academic program;
- Making, keeping, and being prepared for appointments with an advisor;
- Informing the advisor of changes in plans and/or circumstances that might impact academic performance;
- Knowing departmental procedures for changing advisors; and
- Bringing concerns regarding the quality of advising to the attention of the advisor.

Statement of Advisor Responsibility

The advisor shares the responsibility for developing an advising partnership with undergraduate students. This is achieved through the advisor:

- Communicating with students and delivering individualized and accurate information in a professional, sincere manner;
- Being informed of, and providing accurate information about current academic policies and procedures;
- Keeping appointments and being available for assistance;
- Providing appropriate referrals, contacts, and information;
- Doing appropriate follow-up with students; and
- Seeking out and taking advantage of opportunities for professional development

Additional Campus Resources

<p>College of Engineering Academic Affairs Office 212 Hancock Hall www.eng.vt.edu 540-231-3244</p>	<p>Schiffert Health Center McComas Hall www.healthcenter.vt.edu 540-231-5313</p>
<p>Career and Professional Development Smith Career Services Bldg. www.career.vt.edu 540-231-6241</p>	<p>Services for Students with Disabilities Lavery Hall, Suite 310 www.ssd.vt.edu 540-231-0858</p>
<p>Cook Counseling Center 240 McComas Hall www.ucc.vt.edu 540-231-6657</p>	<p>Student Success Center 110 Femoyer Hall www.studentsuccess.vt.edu 540-231-5499</p>
<p>Dean of Students 109 East Eggleston Hall www.dos.vt.edu 540-231-3787</p>	<p>Undergraduate Honor System 104 Hillcrest Hall www.honorsystem.vt.edu 540-231-9876</p>
<p>Global Education Office 526 Prices Fork Road, Room 131 www.globaleducation.vt.edu 540-231-5888</p>	<p>University Scholarships and Financial Aid 200 Student Services Bldg. www.finaid.vt.edu 540-231-5179</p>
<p>Honors College 137 Hillcrest Hall www.honorscollege.vt.edu 540-231-4591</p>	<p>Writing Center Newman Library, 2nd Floor www.composition.english.vt.edu/writing-center 540-231-5436</p>
<p>Recreational Sports 142 McComas Hall www.recsports.vt.edu 540-231-6856</p>	

V. BME Satisfactory Progress towards Degree

Policy 91

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The BEAM Department fully supports this policy. Specific expectations for satisfactory progress for Biomedical Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Maintain an in-major GPA (in-major GPA is calculated using all courses taught under the BMES designator) and an extended in-major GPA (extended in-major GPA is calculated using all BMES courses and ESM 2104, 2204, and 2304) of 2.0 or better
- Complete a minimum of 12 credits that apply toward the BME degree per academic year (including summer and winter sessions).

VI. Graduation Requirements

Checksheets for each class are available on the BEAM Department website and on the Registrar's website. Students must fulfill the checksheet requirements according to the calendar year of their date of entry. Required BME courses are offered during the academic year, with expected offerings indicated on the checksheet. These checksheets are available publicly through the Registrar's website (<https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html>). Students should plan to take each course during the academic-year semester as indicated on the appropriate checksheet. The minimum number of credits for graduation is specified on the checksheet as well. Each student must complete the credit hour minimum specified on the checksheet for their date of entry with a minimum overall GPA of 2.00 and minimum in-major GPA of 2.00. All BMES prefix courses count towards the in-major GPA.

All courses for the degree must be taken on an A-F basis, including technical electives. A course that is taken on an audit cannot be repeated for credit and a course taken on a P/F basis cannot be repeated under the A-F system.

Pathways to General Education

All students who were admitted to Virginia Tech in Fall 2018 or later follow the Pathways to General Education. The Pathways curriculum includes a total of 45 credits over 7 core concepts and 2 integrative concepts. Some of these requirements are met by required courses for the degree. Pathways credits that are not included within the BME degree requirements are:

- (Pathway 2) Critical Thinking in the Humanities: 6 credits required
- (Pathway 3) Reasoning in the Social Sciences: 6 credits required
- (Pathway 6a) Critique and Practice in Design and the Arts: 3 credits required (Arts)
- (Pathway 7) Critical Analysis of Identity and Equity in the US: 3 credits required
 - Pathway 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking additional credit hours. Only select courses can simultaneously satisfy both Pathways 2/3/6a & 7 requirements. Use extra care when selecting this course.

All courses taken to fulfill Pathways requirements must be taken on an A-F basis (not P/F). Consult the latest Undergraduate Catalog or Pathways Guide for course descriptions, prerequisite requirements, and restrictions.

Technical Electives

Students are required to complete 21 credits of Technical Electives, of which a minimum of 12 credits must be taken from List A (see latest checksheet). All Technical Electives must be taken on an A-F grade basis. The BME program provides courses offerings within the BME subfields of Biomechanics, Cell & Tissue Engineering, and Biomedical Devices & Imaging. With the required 12 credits from List A, students will obtain depth by taking at least two courses (6 credits) within a subfield. The listing of List A and List B courses within each subfield are available in BME Undergraduate Student Guide in [Appendix A Technical Elective Course Options for BME Sub-Disciplines](#).

New courses may be added under the course number BMES 3984 or BMES 4984 (Special Study), and are announced to students via the undergraduate listserv. Announcements will indicate which technical elective list (A or B) for which the course can be substituted.

Courses listed as Technical Elective options on the checksheets are not meant to be all-inclusive. A 3/4000-level course not included on these lists that is in another discipline can be used as a technical elective **only with approval** and only if it has significant technical content relevant to the science or application of biomedical engineering. Please consult with the BEAM Undergraduate Academic Advisor for additional information prior to enrolling in courses not included in the technical elective lists on the checksheet.

Students in their senior year with a 3.0 or better GPA may enroll in 5000-level courses to satisfy undergraduate degree requirements. Please consult with the BEAM Undergraduate Academic Advisor for additional information.

Currently, there are no concentrations or options within the BME program that require specific selection for your Technical Elective Choices. However, if you are interested in a specific sub-discipline of BME, Appendix A Technical Elective Course Options for BME Sub-Disciplines provides suggested options from those courses in List A and List B.

Independent Study and Undergraduate Research

Students may take either BMES 4974 (Independent Study) or BMES 4994 (Undergraduate Research) to satisfy 3 credits of Technical Electives. These courses are arranged on an individual basis with a BME faculty member, and involves two approval processes:

1. COE approval process to register for independent study or undergraduate research (<https://eng.vt.edu/academics/undergraduate-students/undergraduate-research-independent-study.html>)
2. BEAM department approval process to count for technical elective credit (<https://beam.vt.edu/forms.html>).

The forms for COE approval to register for independent study or undergraduate research must be submitted by the deadline specified by the COE. **Forms for BEAM department approval for technical elective credit can be submitted prior to, during, or after enrollment in the undergraduate research or independent study. However, the full syllabus and research advisor approval must be available in order to submit for consideration.** The BEAM department form will be reviewed by the BME Undergraduate Curriculum Committee (UCC) to determine if it will be accepted for technical elective credit, and if it will be considered to satisfy List A or List B. Please see the BEAM Undergraduate Academic Advisor for the related form and any questions on this process.

If a design project-based course has already been approved and used for Technical Elective credit, you are not eligible to submit Undergraduate Research or Independent Study credits to count for Technical Elective Credit. A maximum of 3 credits between design project-based courses, Undergraduate Research, and Independent Study is allowed to meet this requirement.

Senior Design and Project

Each student must take 6 hours of a culminating design experience: Senior Design and Project (BMES 4015-4016). The project consists of an independent or group investigation to design formulations of an experimental apparatus, process, or product. Specifically, each student will follow the following process to achieve his or her design:

- Develop the scope and technical details required to solve a design-focused engineering problem
- Develop a set of specifications for the construction of the component, machine, device, or system, where appropriate
- Derive the specifications and form of the design from principles secured through the BME curriculum
- Identify the market, social, environmental, political, ethical, etc. constraints that influence the design, and vice-versa;
- Incorporate both quantitative (mechanics, economics) and qualitative (social, environmental, political, ethical, etc.) constraints necessary to derive a compromise on the design;
- Deliver hardware and/or software in a prototype form, when possible and where appropriate;
- Develop performance verification tests to assess if the system meets/exceeds design specifications, when possible and where appropriate
- Communicate the progress and specifics of the design with team members, advisor, and other audiences

VII. Minors for BME Students

Overview

Minors allow students to develop expertise or pursue an interest in a subject in addition to their major. A minor has a group of courses, fewer than the number of courses required for a major. Minors are optional, but can help students stand out and enhance what you are already learning within your degree. If there is a minor you are interested in pursuing, schedule a meeting with the BEAM Undergraduate Academic Advisor for more information on the requirements. Two popular minors for BME students to pursue are the Engineering Science and Mechanics (ESM) Minor and Mathematics Minor.

Engineering Science and Mechanics (ESM) Minor

The BME degree includes a focus on fundamental engineering principles, making completion of an ESM Minor feasible without additional credits beyond the BS BME requirements by purposeful selection of technical elective courses and Senior Design project. An ESM Minor complements the degree to provide a student with a strong foundation for a variety of employment opportunities within BME, including pursuit of graduate education.

Mathematics Minor

A Mathematics Minor requires 26 credits, of which 17 credits are already included within the BS BME requirements. The additional 9 credits of 3000-level or higher MATH courses to complete the minor can also be completed within the BS BME requirements with purposeful selection of technical electives. A Mathematics Minor complements the engineering mechanics foundation of the BME degree.

VIII. Additional Professional Development Information

Biomedical Engineering Society (BMES)

The Biomedical Engineering Society (BMES) is the professional society for biomedical engineering and bioengineering, whose mission is to promote and enhance knowledge and education in biomedical engineering and bioengineering worldwide and its utilization for human health and well-being. Our chapter services both Virginia Tech and Wake Forest, as our graduate biomedical engineering program is joined between the two schools. Each school has its own executive board consisting of a president, vice president, secretary, and treasurer where both executive teams work together to manage the chapter. The goal of our chapter is to provide members with opportunities surrounding biomedical engineering through professional development events, volunteer work, social events and diversity, equity & inclusion topics.

The BMES student chapter is registered at the graduate level, but most of the events are open to the undergraduate community. The chapter also supports an undergraduate mentoring program where UG students are paired with a graduate biomedical engineering mentor(s). The objective of the program is to offer an additional resource to UG students to help them navigate classes, internships, the job hunt, graduate school, or anything else that may come up. Information on receiving the weekly newsletter (where chapter events are advertised) and for signing up for the mentoring program are typically sent out to the undergraduate listservs at the beginning of each semester.

60 Hour UG Research Program

The BEAM Department offers a UG research internship program. For this program, BEAM will pay for the first 60 hours for a BME student in a student-wage undergraduate research position with a BEAM faculty member. The use of student-wage undergraduate research positions is at the discretion of each individual faculty member. BME students cannot receive undergraduate research, independent study, or other course credit for work completed in a student-wage undergraduate position. For more information, please speak with the BEAM Undergraduate Academic Advisor and your BEAM faculty research mentor.

IX. Graduate Program Considerations

Accelerated Undergraduate/Graduate (UG/G) Degrees

Upon completion of 90 credit hours and with at least one semester remaining until all requirements for the bachelor's degree are completed, BME students at Virginia Tech with an overall grade GPA of at least 3.3 may apply for the Accelerated Undergraduate/Graduate Degree Program (BS/MS or BS/PhD). This program allows the student to count up to 12 credit hours taken during the last twelve months before the awarding of the bachelor's degree toward both the bachelor's and graduate (MS or PhD) degrees. All courses that are to be double counted toward the graduate degree must be 5000-level or higher and must be taken (1) before the completion of the undergraduate degree and (2) after admission into the Undergraduate/Graduate Degree Program.

Students must apply during the junior year of their bachelor's program and have a **faculty member agree to serve as their faculty advisor for the graduate degree before starting any of the double-counted courses.** Additional information is available at <https://beam.vt.edu/graduate/biomedical/ugg.html>. Please also consult with the BEAM Undergraduate Academic Advisor if interested in the UG/G degrees.

BME Degree as a Pathway to Health Professional Programs

With enough planning and careful selection of coursework, it is possible for BME students to pursue Pre-Med and other Pre-Health professional tracks (dentistry, occupational therapy, physician's assistant, physical therapy, etc). Health Professions Advising (HPA) handles advising for students pursuing graduate health professions (<https://career.vt.edu/advising/hpa.html>). It is very important that you begin planning your coursework as soon as possible (preferably prior to the start of the sophomore year) in order to adequately plan your course load. Please contact the BEAM Undergraduate Academic Advisor and HPA for more information.

Appendix A. Technical Elective Course Options for BME Sub-Disciplines

Table A.1. List A Technical Elective Course Options

Note: Below listed technical elective courses have pre- and/or co-requisites, be sure to consult the University Catalog or check with your advisor.

	BME Sub-Discipline		
	Biomechanics	Cell & Tissue Engineering	Biomedical Devices & Imaging
BMES 3114 Needs Identification in Healthcare	*	*	*
BMES 3124 – Introduction to Biomechanics	*		
BMES 3134 – Introduction to BME Imaging			*
BMES 3144 – Biomedical Devices			*
BMES 3154 – Biosignal Processing and Classification			*
BMES 3844 / NEUR 3844 Computational Neuroscience and Neural Engineering		*	*
BMES 4032 Wearable Bioinstrumentation			*
BMES/ESM 4614 – Probability-based Modeling, Analysis, and Assessment	*		*
ESM 4105-4106 – Engineering Analysis of Physiologic Systems	*	*	*

ESM 4204 – Musculoskeletal Biomechanics	*		
ESM 4224 – Biodynamics and Control	*		
ESM 4234 / BMES 4234 – Mechanics of Biological Materials and Structures	*		
ESM 4245, ESM 4246 – Mechanics of Animal Locomotion	*		
ESM 4304 – Hemodynamics	*		
†BMES/BMVS 5024 – Biomedical Engineering and Human Disease		*	
†BMES/BSE/CHE 5044 – Engineering Mathematics	*		
†BMES 5054 – Quantitative Cell Physiology		*	*
†BMES 5064 – Quantitative Organ Systems Physiology	*	*	*
†BMES/ESM 5124 – Advanced Musculoskeletal Biomechanics	*		
†BMES 5164 – Advanced Impact Biomechanics	*		
†BMES/ME 5174 – Biomechanics of Crash Injury Prevention	*		
†BMES 5184 – Injury Physiology		*	
†BMES 5204 – Laboratory Techniques in Injury Prevention (4)	*		*
†BMES/ISE 5214 – Human Physical Capabilities	*		

†BMES 5304G – Advanced Biological Transport Phenomena		*	
†BMES/ESM 5305 – Biomechanics of Cardiovascular System	*		
†BMES/ESM 5306 – Biomechanics of Cardiovascular System	*		
†BMES 5314 – Introduction to Regenerative Medicine		*	
†BMES/CHE 5434 – Polymeric Biomaterials		*	
†BMES 5514/ME 5714 – Digital Signal Processing for Mechanical Measurements			*
†BMES 5525/ECE 5605 – Stochastic Signals and Systems			*
†BMES 5534 – Advanced Computational Methods and Modeling for Biomedical Applications	*		*
†BMES 5574 – Advanced Biomaterials	*		*
†BMES 5614 – Multi-Scale Cancer Engineering		*	
†BMES 5714 – Biomedical Microdevices			*
†BMES 5724 – Biomedical Nanoengineering		*	*
†BMES/ME 5764 – Modeling MEMS and NEMS		*	*

† Students in their senior year, with 3.0 or better GPA, may enroll in 5000-level courses satisfying undergraduate degree requirements within their department.

* denotes an option for that particular sub-discipline

Table A.2. List B Technical Elective Course Options

Note: Below listed technical elective courses have pre- and/or co-requisites, be sure to consult the University Catalog or check with your advisor.

	BME Sub-Discipline		
	Biomechanics	Cell & Tissue Engineering	Biomedical Devices & Imaging
BCHM 3114 Biochemistry for Biotechnology and the Life Sciences		*	
BMES 4154 Commercialization of BME Research	*	*	*
†BMES 5154G Advanced Commercialization of BME Research			*
BMVS 4054 Laboratory Animal Management		*	
BMVS 4074 Pharmacology		*	
CHEM 2535-CHEM 2536 Organic Chemistry		*	
CHEM 2545-CHEM 2546 Organic Chemistry Lab (1,1)		*	
CHEM 4554 Drug Chemistry		*	
ESM/MSE 3054 Mechanical Behavior of Materials	*		*
ESM 3124 Dynamics II – Analytical and 3-D Motion	*		
ESM 3334 Fluid Mechanics II: Differential Analysis	*		

ESM 4024 Advanced Mechanical Behavior of Materials	*		
ESM 4044/CEE 4610 Mechanics of Composite Materials	*		
ESM 4734 Introduction to the Finite Element Method	*	*	
HNFE/PHYS 3634 Epidemiologic Concepts of Health and Disease		*	*
HNFE 3824 Kinesiology	*		*
MATH 3214 Calculus of Several Variables	*		*
MATH 4234 Elementary Complex Analysis	*		*
MATH 4445, MATH 4446 Introduction to Numerical Analysis	*		*
MSE 4164 Principles of Materials Corrosion			*
MSE 4304 Metals and Alloys			*
MSE 4574 Biomaterials	*		*
MSE 4584 Biomimetic Materials	*		*
MSE 4614 Nanomaterials	*		*
NEUR 3044 Cellular and Molecular Neuroscience		*	
PHYS 3324 Modern Physics (4)	*		*

PHYS 3405-PHYS 3406 Intermediate Electricity and Magnetism			*
PHYS 4455-PHYS 4456 Introduction to Quantum Mechanics			*
PHYS 4504 Introduction to Nuclear and Particle Physics			*
PHYS 4574 Nanotechnology			*
PHYS 4614 Optics			*
PHYS 4714 Introduction to Biophysics			*

† Students in their senior year, with 3.0 or better GPA, may enroll in 5000-level courses satisfying undergraduate degree requirements within their department.

* denotes an option for that particular sub-discipline