

COLLEGE OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING AND MECHANICS
DEGREE: BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING
MAJOR: BIOMEDICAL ENGINEERING

370 Castle for
R. Sparks
3-3-2020

FOR STUDENTS GRADUATING IN CALENDAR YEAR 2022 AND FOR STUDENT DATE OF ENTRY UNDER UG CATALOG 2020-2021
CREDITS REQUIRED FOR GRADUATION: 124

FALL SEMESTER FIRST YEAR		Credits	SPRING SEMESTER FIRST YEAR		Credits
CHEM 1035 General Chemistry Co: MATH 1025 or MATH 1225	3		ENGL 1106 First-Year Writing Pre: ENGL 1105	3	
CHEM 1045 General Chemistry Lab Co: CHEM 1035	1		MATH 1226 Calculus of a Single Variable Pre: MATH 1225 (C-)	4	
ENGL 1105 First-Year Writing	3		MATH 2114 Introduction to Linear Algebra Pre: MATH 1225 (B) or MATH 1226	3	
MATH 1225 Calculus of a Single Variable (C-) Pre: Math Ready	4		PHYS 2305 Found of Physics I w/lab Pre: (MATH 1205 or MATH 1205H or MATH 1225) or (MATH 1206 or MATH 1206H or MATH 1226). Co: 2325 or (MATH 1206 or MATH 1206H or MATH 1226)	4	
ENGE 1215 Foundations of Engineering (C-) Pathways 2 or 3	2 3		ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215 (C-)	2	
TOTAL	16		TOTAL	16	
FALL SEMESTER SECOND YEAR		Credits	SPRING SEMESTER SECOND YEAR		Credits
BIOL 1105 Principles of Biology	3		BMES 2104 Intro to Biomedical Engineering ⁽¹⁾ Pre ENGE 1216 or ENGE 1414, PHYS 2306; Co: MATH 2214	3 ^[S]	
MATH 2204 Intro Multivariable Calculus Pre: MATH 1226	3		ECE 3054 Electrical Theory Pre: PHYS 2306 Co: MATH 2214	3	
MATH 2214 Intro Differential Equations Pre: MATH 1226, (MATH 1114 or 2114 or MATH 2114H or MATH 2405H)	3		ESM 2204 Mech of Deformable Bodies Pre: ESM 2104 or ESM 2114, (MATH 2204 or MATH 2204H))	3	
ESM 2104 Statics Pre: MATH 1226 Co: MATH 2204 or MATH 2204H or MATH 2406H	3		ESM 2304 Dynamics Co: MATH 2214; Pre: ESM 2104 or ESM 2114, (MATH 2204 or MATH 2204H)	3	
PHYS 2306 Foundations of Physics I w/lab Pre: (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305	4		MSE 2034 Elements of Materials Engr Pre: CHEM 1035 Co: PHYS 2305	3	
TOTAL	16		TOTAL	15	
FALL SEMESTER THIRD YEAR		Credits	SPRING SEMESTER THIRD YEAR		Credits
BMES 3024 BME Cellular Lab and Design ⁽¹⁾ Co: 2104, BIOL 1105	2 ^[F]		BMES 3034 Bioinstrumentation Laboratory & Design for Living Systems ⁽¹⁾ Pre: 2104	2 ^[S]	
ESM 3234 Fluid Mechanics I Pre: 2304, PHYS 2306	3 ^[F]		BMES 3184 Problem Solving in BME Pre: 2104	3 ^[S]	
CS Programming Course*	3		BMES Technical Elective	3 ^[S]	
STAT Course [†]	3		Technical Elective	3	
BMES/BMVS 4064 Introduction to Medical Physiology ⁽¹⁾ Pre: Junior Standing	3 ^[F]		Pathways 2 or 3	3	
TOTAL	14		TOTAL	14	
FALL SEMESTER FOURTH YEAR		Credits	SPRING SEMESTER FOURTH YEAR		Credits
BMES 4015 BME Senior Design and Project ⁽¹⁾ Pre: 3024	3 ^[F]		BMES 4016 BME Senior Design and Project Pre: 4015	3 ^[S]	
BMES 4134 Global, Societal and Ethics in BME ⁽¹⁾	3 ^[F]		BMES Technical Elective	3	
BMES Technical Elective	3		BMES Technical Elective	3	
Technical Elective	3		Technical Elective	3	
Pathways 2 or 3	3		Pathways 2/7 or 3/7	3	
Pathways 6a	3				
TOTAL	18		TOTAL	15	

*CS Programming course chosen from: CS 1044, 1064, or 1114

† STAT course chosen from: STAT 3615, STAT 4604

General Information about Checksheet: Superscripted annotation after the course number (1) indicates core course of the degree. Additionally, (F, S, SI, SII) in credits column indicates terms when a course is expected to be offered. Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

Pathways to General Education (Pathways)

Consult the pathways courses table: <https://www.pathways.prov.vt.edu/about/table.html>. Pathways courses need to be completed prior to graduation

Pathway 1: Discourse (6 hrs foundational, 3 hrs advanced)	<i>Foundational:</i> ENGL 1105 (3)	<i>Foundational:</i> ENGL 1106 (3)
	<i>Advanced:</i> BMES 4016	(3)
Pathway 2: Critical Thinking in the Humanities (6 hrs)		(3) (3)
Pathway 3: Reasoning in the Social Sciences (6 hrs)		(3) (3)
Pathway 4: Reasoning in the Natural Sciences (8 hrs)	PHYS 2305 (4)	PHYS 2306 (4)
Pathway 5: Quantitative and Computational Thinking (11 hrs)	<i>Foundational:</i> MATH 1225 (4)	<i>Foundational:</i> MATH 1226 (4)
	<i>Advanced:</i> MATH 2214	(3)
Pathway 6: Critique and Practice in Design and the Arts (7 hrs)	<i>Arts:</i>	(3)
	<i>Design:</i> ENGE 1215 + ENGE 1216	(4)
Pathway 7: Critical Analysis of Identity & Equity in the US (3 hrs) ⁽¹⁾	Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours.	
		(3)

¹A total of 6 hours of Pathways 2 and 6 hours of Pathways 3 courses must be completed. Only selected courses can simultaneously satisfy both Pathways 2/3 & 7 requirements. Use extra care when selecting this course.

Electives:

Biomedical Engineering (BMES) Technical Electives (12 credit hours required)

Any BMES 3/4/5000-level course not otherwise used to fulfill a BME requirement can be used as a technical elective. BMES Technical Electives may be chosen from the approved list on page 3 of the checksheet.

Technical Electives (9 credit hours required)

An approved 2/3/4000-level course in another discipline that has significant technical content relevant to the science or application of biomedical engineering can be used as a technical elective. Technical Electives may be chosen from the list on page 4 of the checksheet.

Change of Major Requirements: Please see:

<http://www.enge.vt.edu/undergraduate-changing-majors.html>.

Foreign Language Requirements: Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Satisfactory Progress Towards Degree: University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The BME 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)
- After having completed 72 credit hours (including transfer, advanced placement, advanced standing, and credit by examination) must have:
 - 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).

Statement of Prerequisites:

- Prerequisites for each course are listed after the course title. The (letter grade) notation, such as (C-), indicates the minimum grade students must earn in the prerequisite course.
- There are no hidden prerequisites in this program of study.
- Prerequisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for the most current requirements.

Graduation Requirements: Each student must complete at least 124 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. All BMES prefix courses count towards the in-major GPA.

Approved BMES Technical Electives:

Note: Below listed technical elective courses have pre- and/or co-requisites, be sure to consult the University Catalog or check with your advisor. With the exception of courses listed with a credit hour reference in parentheses, technical electives are 3 credit hour courses

BMES 3114 – Problem Definition in Biomedical Engineering Design
BMES 3124 – Introduction to Biomechanics
BMES 3134 – Introduction to BME Imaging
BMES 3144 – Biomedical Devices
BMES 3154 – Bioinstrumentation and Analysis
BMES 4154 – Commercialization of BME Research

Students in their senior year, with 3.0 or better GPA, may enroll in 5000-level courses satisfying undergraduate degree requirements within their department with the permission of the course instructor and the Department Head.

BMES 5024 (cross-listed with BMVS 5224) – Biomedical Engineering and Human Disease
BMES 5044 (cross-listed with BSE 5044 and CHE 5044)– Engineering Mathematics
BMES 5054 – Quantitative Cell Physiology
BMES 5064 – Quantitative Organ Systems Physiology
BMES 5124 (cross-listed with ESM 5224)– Advanced Musculoskeletal Biomechanics
BMES 5154G – Advanced Commercialization of Biomedical Engineering Research
BMES 5164 – Advanced Impact Biomechanics
BMES 5174 (cross-listed with ME 5174) – Biomechanics of Crash Injury Prevention
BMES 5184 – Injury Physiology
BMES 5204 – Laboratory Techniques in Injury Prevention
BMES 5214 (cross-listed with ISE 5614) – Human Physical Capabilities
BMES 5304G – Advanced Biological Transport Phenomena
BMES 5305 (cross-listed with ESM 5305) – Biomechanics of Cardiovascular System
BMES 5306 (cross-listed with ESM 5306) – Biomechanics of Cardiovascular System
BMES 5314 – Introduction to Regenerative Medicine
BMES 5434 (cross-listed with CHE 5214) – Polymeric Biomaterials
BMES 5514 (cross-listed with ME 5714) – Digital Signal Processing for Mechanical Measurements
BMES 5525 (cross-listed with ECE 5605) – Stochastic Signals and Systems
BMES 5534 – Advanced Computational Methods and Modeling for Biomedical Applications
BMES 5574 - Advanced Biomaterials
BMES 5714 – Biomedical Microdevices
BMES 5724 – Biomedical Nanoengineering
BMES 5764 – Modeling MEMS and NEMS

Approved Technical Electives:

BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	ESM 4245- ESM 4246	Mechanics of Animal Locomotion
BIOL 2004	Genetics	ESM 4304	Hemodynamics
BIOL 3134	Human Genetics	HNFE 3634	Epidemiologic Concepts of Health and Disease
BIOL 4704	Immunology	HNFE 3824	Kinesiology
BIOL 4734	Inflammation Biology	HNFE 4844	Exercise and Neuromuscular Performance
BMVS/BCHM 4034	Environmental Health Toxicology	ISE 3614	Human Factors Engineering and Ergonomics
BMVS 4054	Laboratory Animal Management	ISE 4624	Work Physiology
BMVS 4074	Pharmacology	MATH 3214	Calculus of Several Variables
BSE 3534	Bioprocessing Engineering	MATH 4234	Elementary Complex Analysis
BES 4544/ CHE 4544	Protein Separation Engineering	MATH 4445- MATH 4446	Introduction to Numerical Analysis
CHE 4104	Processing Materials	ME 4034	Bio-inspired Technology
CHE 4304 (ME 4344)	Biological Transport Phenomena	ME 4524	Introduction to Robotics and Automation
CHEM 2535- CHEM 2536	Organic Chemistry	ME 4864	Micro/Nano-Robotics
CHEM 2545- CHEM2546	Organic Chemistry Laboratory (1,1)	MSE 4164	Principles of Materials Corrosion
CHEM 4554	Drug Chemistry	MSE 4304	Metals and Alloys
CS 3824	Introduction to Computational Biology and Bioinformatics	MSE 4574	Biomaterials
CS 4884	Computational Biology and Bioinformatics Capstone	MSE 4584	Biomimetic Materials
ECE 4580	Digital Processing Imaging	MSE 4614	Nanomaterials
ECE 4624	DSP and Filter Design	NEUR 3044	Cellular and Molecular Neuroscience
ECE 4405-ECE 4406	Control Systems	PHYS 3324	Modern Physics (4)
ESM/MSE 3054	Mechanical Behavior of Materials	PHYS 3405- PHYS 3406	Intermediate Electricity and Magnetism
ESM 4024	Advanced Mechanical Behavior of Materials	PHYS 4455- PHYS 4456	Introduction to Quantum Mechanics
ESM 4044	Mechanics of Composite Materials	PHYS 4504	Introduction to Nuclear and Particle Physics
ESM 4105-ESM 4106	Engineering Analysis of Physiologic Systems	PHYS 4574	Nanotechnology
ESM 4204	Musculoskeletal Biomechanics	PHYS 4614	Optics
ESM 4224	Biodynamics & Control	PHYS 4714	Introduction to Biophysics
ESM 4234	Mechanics of Biological Materials and Structures		