COLLEGE OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING AND MECHANICS

BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING

FOR STUDENTS GRADUATING IN CALENDAR YEAR 2022
123CREDITS REQUIRED FOR GRADUATION

FALL SEMESTER FRESHMAN 2018	Credits
CHEM 1035 General Chemistry	3
CHEM 1045 General Chemistry Lab *Co: CHEM 1035*	1
ENGL 1105 First-Year Writing[4]	3
MATH 1225 Calculus of a Single Variable[4] (C-) *Pre: Math Ready*	4
ENGE 1215 Foundations of Engineering[4] (C-)	2
Pathways Humanities, Social Sciences, or Equity and Identity[1, 4]	3
TOTAL	**16**

SPRING SEMESTER FRESHMAN 2019	Credits
ENGL 1106 First-Year Writing[4] *Pre: ENGL 1105*	3
MATH 1226 Calculus of a Single Variable[4] *Pre: MATH 1225 (C-)*	4
MATH 2114 Introduction to Linear Algebra[5] *Pre: MATH 1225 (B) or MATH 1226*	3
PHYS 2305 Found of Physics I w/lab[4] *Pre: MATH 1225; Co: MATH 1226*	4
ENGE 1216 Foundations of Engineering[4] (C-) *Pre: ENGE 1215 (C-) or ENGE 1024 (C-)*	2
TOTAL	**16**

FALL SEMESTER SOPHOMORE 2019	Credits
BIOL 1105 Principles of Biology[5] *Co: BIOL 1115*	3
MATH 2204 Intro Multivariable Calculus[5] *Pre: MATH 1226*	3
MATH 2214 Differential Equations[4] *Pre: MATH 1226, MATH 1114 or 2114*	3
ESM 2104 Statics[5] *Pre: MATH 1226 Co: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H*	3
PHYS 2306 Foundations of Physics I w/lab[4] *Pre: MATH 1226, PHYS 2305*	4
TOTAL	**16**

SPRING SEMESTER SOPHOMORE 2020	Credits
BMES 2104 Introduction to Biomedical Engineering[5] *Pre: ENGE 1104 or ENGE 1114 or ENGE 1216, PHYS 2306*	3[S]
ECE 3054 Electrical Theory[5] *Pre: PHYS 2306 Co: MATH 2214*	3
ESM 2204 Mech of Deformable Bodies[5] *Pre: ESM 2104 or 2114, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)*	3
ESM 2304 Dynamics[5] *Pre: ESM 2104 or 2114, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)*	3
MSE 2034 Elements of Materials Engr[5] *Pre: CHEM 1035 Co: PHYS 2305*	3
TOTAL	**15**

FALL SEMESTER JUNIOR 2020	Credits
BMES 3024 BME Cellular Lab and Design[5] *Pre: BMES 2104*	2[F]
ESM 3234 Fluid Mechanics I[5] *Pre: ESM 2304, PHYS 2306*	3[F]
CS Programming Course[2, 5]	3
STAT Course[3, 5]	3
BMES/BMVS 4064 Introduction to Medical Physiology[5] *Pre: Junior Standing*	3[F]
TOTAL	**14**

SPRING SEMESTER JUNIOR 2021	Credits
BMES 3034 Bioinstrumentation Laboratory & Design for Living Systems[5] *Pre: BMES 2104*	2[S]
BMES 3184 Problem Solving in BME[5] *Pre: BMES 2104*	3[S]
BMES Technical Elective	3[S]
Technical Elective	3
Pathways Humanities, Social Sciences, or Equity and Identity[1, 4]	3
	14

FALL SEMESTER SENIOR 2021	Credits
BMES 4015 BME Senior Design and Project[5]	3[F]
BMES 4134 Global, Societal and Ethics in BME[5]	3[F]
BMES Technical Elective	3
Technical Elective	3
Pathways Humanities, Social Sciences, or Equity and Identity[1, 4]	3
Pathways Arts[4]	2
TOTAL	**17**

SPRING SEMESTER SENIOR 2022	Credits
BMES 4016 BME Senior Design and Project[4] *Pre: BMES 4015*	3[S]
BMES Technical Elective	3
BMES Technical Elective	3
Technical Elective	3
Pathways Humanities, Social Sciences, or Equity and Identity[1, 4]	3
TOTAL	**15**

[1] A total of 6 hours of Reasoning in the Social Sciences and 6 hours of Critical Thinking in the Humanities must be completed. Three hours of Critical Analysis of Equity and Identity in the United States is also required and may be double-counted with another area of Pathways. Use extra care when selecting this course.
[2]CS Programming course chosen from: CS 1044, 1064, or 1114
[3]STAT course chosen from: STAT 3615, STAT 4604
[4]Pathways Requirement
[5]BME Degree Core Requirement

Superscripted annotation (F, S, SI, SII) in credits column indicates terms when a course is expected to be offered.

Pathways for General Education (Pathways)						
Discourse (6 foundational + 3 advanced)	**ENGL 1105 (Foundational)**	**(3)**	**ENGL 1106 (Foundational)**	**(3)**	**BMES 4016 (Advanced)**	**(3)**
Quantitative and Computational Thinking (6 foundational + 3 advanced)	**MATH 1225 (Foundational)**	**(4)**	**MATH 1226 (Foundational)**	**(4)**	**MATH 2214 (Advanced)**	**(3)**
Reasoning in the Natural Sciences (6 hrs)	**PHYS 2305**	**(4)**	**PHYS 2306**	**(4)**		
Critique and Practice in Design and the Arts (6 hrs)	**ENGE 1215+ENGE 1216**	**(4)**	**(Arts)**	**(2)**		
Reasoning in the Social Sciences (6 hrs)		**(3)**		**(3)**		
Critical Thinking in the Humanities (6 hrs)		**(3)**		**(3)**		
Critical Analysis of Equity and Identity in the United States (3 hrs)[1]				**(3)**		

[1]A total of 6 hours of Reasoning in the Social Sciences and 6 hours of Critical Thinking in the Humanities courses must be completed. Three hours of Critical Analysis of Equity and Identity in the United States is also required and may be double-counted with another area of Pathways. Use extra care when selecting this course.

Electives:

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

Any 3-credit 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 4 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 3 of the checksheet.

Change of Major Requirements: For 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:

- Pre-requisites 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 pre-requisite course. There are no hidden pre-requisites in the 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 pre-requisites.

Graduation Requirements: Each student must complete at least 123 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:

BMES 3124 – Introduction to Biomechanics *Pre: BMES 2104, ESM 2204, ESM 2304*
BMES 3134 – Introduction to BME Imaging *Pre: BMES 2104, (MATH 2204 or 2204H), PHYS 2306*
BMES 3144 – Biomedical Devices *Pre: BMES 2104*
BMES 4154 – Commercialization of BME Research *Pre: BMES 2104, 3024*

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 *Pre: BMES 5004 or BMES/BMVS 4064*
BMES 5044 (cross-listed with BSE 5044 and CHE 5044)– Engineering Mathematics
BMES 5054 – Quantitative Cell Physiology *Co: BMES 5044*
BMES 5064 – Quantitative Organ Systems Physiology *Co: BMES 5044*
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 *Pre: BMES 5004, Co: BMES 5164*
BMES 5214 (cross-listed with ISE 5614) – Human Physical Capabilities
BMES 5304 – Biological Transport Phenomena
BMES 5304 – Advanced Biological Transport Phenomena *Pre: CHE 3114, (CHE 3044 OR CHE 3144) OR (ME 3304 OR ME 3404)*
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 5574 (cross-listed with ECE 5605) – Stochastic Signals and Systems *Pre: STAT 4714*
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	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
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		