COLLEGE OF ENGINEERING - DEPARTMENT OF BIOMEDICAL ENGINEERING AND MECHANICS

BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING

FOR STUDENTS GRADUATING IN CALENDAR YEAR 2022

123 CREDITS REQUIRED FOR GRADUATION

FALL SEMESTER FRESHMAN 2018	Credits	SPRING SEMESTER FRESHMAN 2019	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*	4
ENGL 1105 First-Year Writing	3	MATH 2114 Introduction to Linear Algebra *Pre: MATH 1225 (minimum grade of B) or MATH 1226*	3
MATH 1225 Calculus of a Single Variable **(C-)** *Pre: Math Ready*	4	PHYS 2305 Foundations of Physic I *Pre: (MATH 1205 or MATH 1205H or MATH 1225) or (MATH 1206 or MATH 1206H or MATH 1226)*	4
ENGE 1215 Foundations of Engineering **(C-)** *Co: MATH 1225*	2	ENGE 1216 Foundations of Engineering **(C-)** *Pre: ENGE 1215*	2
Pathways Humanities, Social Sciences, or Equity and Identity[1]	3		
TOTAL	**16**	**TOTAL**	**16**

FALL SEMESTER SOPHOMORE 2019	Credits	SPRING SEMESTER SOPHOMORE 2020	Credits
BIOL 1105 Principles of Biology[7] *Co: BIOL 1115*	3	BMES 2104 Introduction to Biomedical Engineering[6] *Pre: ENGE 1216, PHYS 2305 Co: MATH 2214*	3[F]
MATH 2204 Introduction to Multivariable Calculus *Pre: MATH 1226*	3	ESM 2204 Mechanics of Deformable Bodies *Pre: ESM 2104, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)*	3
MATH 2214 Introduction to Differential Equations *Pre: MATH 1114 or 2114, MATH 1226*	3	ESM 2304 Dynamics *Pre: ESM 2104, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H), Co: MATH 2214*	3
ESM 2104 Statics *Co: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H*	3	MSE 2034 Elements of Materials Engineering *Pre: CHEM 1035, Co: PHYS 2305*	3
PHYS 2306 Foundations of Physics I with lab *Pre: MATH 1226, PHYS 2305*	4	ECE 3054 Electrical Theory *Pre: PHYS 2306, Co: MATH 2214*	3
TOTAL	**16**	**TOTAL**	**15**

FALL SEMESTER JUNIOR 2020	Credits	SPRING SEMESTER JUNIOR 2021	Credits
BMES 3024 BME Cellular Lab and Design[6] *Pre: BMES 2104*	2[F]	BMES 3034 Bioinstrumentation Laboratory & Design for Living Systems[6] *Pre: BMES 2104*	2[S]
ESM 3234 Fluid Mechanics I – Control Volume Analysis *Pre: ESM 2304, PHYS 2306*	3[F]	BMES 3184 Problem Solving in BME[6] *Pre: BMES 2104*	3[S]
CS Programming Course[3]	3	BMES Technical Elective[4]	3
STAT Course[2]	3	Technical Elective[5]	3
Pathways Humanities, Social Sciences, or Equity and Identity	3	BMES/BMVS 4064 Introduction to Medical Physiology[6] *Pre: Junior Standing*	3
TOTAL	**14**		**14**

FALL SEMESTER SENIOR 2021	Credits	SPRING SEMESTER SENIOR 2022	Credits
BMES 4015 BME Senior Design and Project[6] *Pre: BMES 3184*	3[F]	BMES 4016 BME Senior Design and Project[6] *Pre: BMES 4015*	3[S]
BMES 4134 Global, Societal and Ethics in BME[6]	3[F]	BMES Technical Elective[4]	3
BMES Technical Elective[4]	3	BMES Technical Elective[4]	3
Technical Elective[5]	3	Technical Elective[5]	3
Pathways Humanities, Social Sciences, or Equity and Identity	3	Pathways Humanities, Social Sciences, or Equity and Identity	3
Pathways Arts	2		
TOTAL	**17**	**TOTAL**	**15**

[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.

[2] STAT course chosen from: STAT 3615, STAT 4604

Pathways for General Education (Pathways)						
Discourse (6 foundational + 3 advanced)	**ENGL 1105 (Foundational)**	**(3)**	**ENGL 1106 (Foundational)**	**(3)**	**BMES 4015 (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)	**BMES 4016 (Design)**	**(3)**	**(Arts)**	**(3)**		
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/undergraduate-changing-majors

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 Hidden Pre-requisites:

- There are no hidden pre-requisites in this program of study.

Pre-requisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for most current requirements.

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.

Appendix C-2: BMES Technical Electives*

BMES 3124 – Introduction to Biomechanics *Pre: BMES 2104, ESM 2204, ESM 2304*
BMES 3134 – Introduction to Biomedical Imaging *Pre: BMES 2104, (MATH 2204 or 2204H), PHYS 2306*
BMES 3144 - Biomedical Devices *Pre: BMES 2104*
BMES 4134 – 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's with the permission of the course instructor and the Department Head.

BMES 5054 – Quantitative Cell Physiology *Co: BMES 5044*
BMES 5064 – Quantitative Organ Systems Physiology *Co: BMES 5044*
BMES 5024 (cross-listed with BMVS 5224) – BME and Human Disease *Pre: BMES 5004 or BMES/BMVS 4064*
BMES 5044 (cross-listed with BSE 5044 and CHE 5044)– Engineering Mathematics
BMES 5124 (cross-listed with ESM 5224)– Advanced Musculoskeletal Biomechanics
BMES 5184 – Injury Physiology *Pre: BMES 5004, Co: BMES 5164*
BMES 5314 – Introduction to Regenerative Medicine
BMES 5714 – Biomedical Microdevices

*** New courses will be developed as the demand grows.**

Appendix A-3: Approved Technical Electives

Students choose from the courses listed below, noting that some courses are not available to all students because some courses have prerequisites and some are restricted to majors in the offering department.

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