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COLLEGE OF ENGINEERING

DEPARTMENT OF BIOMEDICAL ENGINEERING AND MECHANICS

BACHELOR OF SCIENCE IN ENGINEERING SCIENCE AND MECHANICS

BIOMECHANICS OPTION

FOR STUDENT DATE OF ENTRY UNDER UG CATALOG 2021-2022

CREDITS REQUIRED FOR GRADUATION: 132

FALL SEMESTER FRESHMAN 2017	Credits
CHEM 1035 General Chemistry Co: MATH 1025 or MATH 1225	3
CHEM 1045 General Chemistry Lab *Co: CHEM 1035*	1
ENGL 1105 First-Year Writing	3
MATH 1225 Calculus of a Single Variable (C-) *Pre: Math Ready*	4
ENGE 1215 Foundations of Engineering (C-)	2
Pathways 2 or 3	3
TOTAL	**16**

SPRING SEMESTER FRESHMAN 2018	Credits
ENGL 1106 First-Year Writing *Pre: ENGL 1105*	3
MATH 1226 Calculus of a Single Variable *Pre: MATH 1225 (C-)*	4
MATH 2114 Introduction to Linear Algebra *Pre: MATH 1225 (B) or MATH 1226*	3
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 1216 Foundations of Engineering (C-) *Pre: ENGE 1215 (C-)*	2
TOTAL	**16**

FALL SEMESTER SOPHOMORE 2018	Credits
MATH 2204 Intro Multivariable Calculus *Pre: MATH 1226*	3
MATH 2214 Intro Differential Equations *Pre: MATH 1226, (MATH 1114 or 2114 or MATH 2114H or MATH 2405H)*	3
PHYS 2306 Foundations of Physics I w/lab *Pre: (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305*	4
ESM 2014 Professnl Dvlpmnt Seminar ESM[1]	1[F]
ESM 2104 Statics[1] *Pre: MATH 1226 Co: MATH 2204 or MATH 2204H or MATH 2406H*	3
Pathways 2 or 3	3
TOTAL	**17**

SPRING SEMESTER SOPHOMORE 2019	Credits
ESM 2074 (AOE 2074) Computational Methods *Pre: ENGE 1216 or ENGE 1414*	2
ECE 3054 Electrical Theory *Pre: PHYS 2306 Co: MATH 2214*	3
MSE 2034 Elements of Materials Engr *Pre: CHEM 1035 Co: PHYS 2305*	3
ESM 2204 Mech of Deformable Bodies *Pre: ESM 2104 or 2114, (MATH 2204 or MATH 2204H)*	3
ESM 2304 Dynamics *Co: MATH 2214; Pre: ESM 2104 or 2114, (MATH 2204 or MATH 2204H)*	3
Pathways 6a	3
TOTAL	**17**

FALL SEMESTER JUNIOR 2019	Credits
ESM 3034 Fluid Mechanics Lab[1] *Pre: ESM 2304, ECE 3054 Co: 3234*	1[F]
ESM 3054 (MSE 3054) Mech Behavior of Materials[1] *Pre: ESM 2204, (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684)*	3
ESM 3064 (MSE 3064) Mech Behavior Matls Lab[1] *Pre: ESM 2204; Co: ESM 3054*	1
ESM 3124 Dynamics II Analytical & 3-D Motion[1] *Pre: ESM 2304, MATH 2214, (MATH 2204 or MATH 2204H)*	3[F]
ESM 3234 Fluid Mech I-Control Volumes[1] *Pre: ESM 2304, PHYS 2306*	3[F]
MATH 4564 Operational Methods *Pre: (MATH 2214 or MATH 2214H) or MATH 2406H or CMDA 2006*	3
BMES/BMVS 4064 Intro to Medical Physiology	3[F]
TOTAL	**17**

SPRING SEMESTER JUNIOR 2020	Credits
MATH 4574 Vector/Complex Analysis *Pre: MATH 2204 or MATH 2204H*	3
ESM 3114 Prob Definition Engr Design[1] *Pre: Junior Standing in ESM, ESM 2014*	1[S]
ESM 3134 Dyn III Vibration & Control[1] *Pre: ESM 3124, MATH 4564*	3[S]
ESM 3154 Solid Mechanics[1] *Pre: ESM 2204, (MATH 2214 or MATH 2214H) Co: MATH 4574*	3[S]
ESM 3334 Fluid Mechanics II-differential Analysis[1] *Pre: ESM 3234 or ME 3404; Co: MATH 4574*	3[S]
ESM 3444 Mechanics Lab[1] *Pre: ESM 3034, 3054, 3064, 3124, 3234, ECE 3054 Co: ESM 3134, 3154, 3334*	2[S]
Biomechanics Elective	3
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FALL SEMESTER SENIOR 2020	Credits
STAT 4604 Statistical Methods for Engineers *Pre: MATH 1206 or MATH 1226*	3
ESM 4015 Creative Design and Project *Pre: ESM 3114*	3[F]
ESM 4734 (AOE 4024) Intro Finite Elements[1] *Pre: (CS 3414 or MATH 3414 or ESM/ AOE 2074), (MATH 2204 or MATH 2204H)*	3[F]
Biomechanics Elective	3
Thermodynamics Elective[1]	3
Free Elective	1
TOTAL	**16**

SPRING SEMESTER SENIOR 2021	Credits
ESM 4016 Creative Design and Project *Pre: ESM 4015*	3[S]
Biomechanics Elective	3
Biomechanics Elective	3
Pathways 2 or 3	3
Pathways 2/3 & 7	3
TOTAL	**15**

[1] Thermodynamics Elective chosen from: BSE 3154, ME 3134, or PHYS 3704

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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 indication 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)	*Foundational:* **ENGL 1105**	**(3)**	**ENGL 1106**	**(3)**
	Advanced: **ESM 4015 + ESM 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)	*Foundational:* **MATH 1225**	**(3)**	**MATH 1226**	**(3)**
	Advanced: **MATH 2214**			**(3)**
Pathway 6: Critique and Practice in Design and the Arts (7 hrs)	*Arts (6a):*			**(3)**
	Design: **ENGE 1215 + ENGE 1216**			**(4)**
Pathway 7: Critical Analysis of Identity & Equity in the US (3 hrs)[1]				**(3)**

[1]A total of 6 hours of Pathways 2 and 6 hours of Pathways 3 courses must be completed. Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours. Only selected courses can simultaneously satisfy both Pathways 2/3 & 7 requirements. Use extra care when selecting this course.

Electives:
The ESM degree requires 12 credits of technical electives from list, 3 hours of thermodynamics electives from list, and 3 hours of science electives. Free electives offered only on a P/F basis may be taken under the P/F grading option.

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 ESM Department fully supports this policy. Specific expectations for satisfactory progress for Engineering Science and Mechanics 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 completed ESM 2014, 2104, 2204, 2304, MATH 2214, 2204, and PHYS 2305, 2306
- Maintain an in-major GPA (in-major GPA is calculated using all courses taught under the ESM designator) and an extended in-major GPA (extended in-major GPA is calculated using all ESM courses and MATH 2204, 2214, 4564, and 4574) of 2.0 or better
- Complete a minimum of 12 credits that apply toward the ESM 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 132 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. All ESM prefix courses count towards the in-major GPA.

Approved Biomechanics Elective Courses (Choose 4)

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

ESM 4105-6: Engineering Analysis of Physiologic Systems
ESM 4204: Musculoskeletal Biomechanics
ESM 4224: Biodynamics & Control
ESM 4234: Mechanics of Biological Materials and Structures
ESM 4245, 4246: Mechanics of Animal Locomotion
ESM 4304: Hemodynamics
ESM 5405, 5406: Clinical Internship in Biomedical Engineering
BMES 3124: Introduction to Biomechanics
BMES 3134: Introduction to Biomedical Imaging
BMES 3144: Biomedical Devices
BMES 3184: Problem Solving in BME
BMES 4134: Global, Societal, and Ethical Considerations in Biomedical Engineering
BMES 4154: Commercialization in BME Research
BMES 5024 (BMVS 5224): Biomed Engineering and Human Disease
BMES 5174: Biomechanics Of Crash Injury Prevention
BMES 5304: Biological Transport Phenomena
CHE 4104: Process Materials
CHE 4544 (BSE 4544): Protein Separation Engineering
ECE 4580: Digital Image Processing
ECE 4624: Digital Signal Processing and Filter Design
ISE 3614: Introduction to Human Factors Engineering and Ergonomics
ISE 3624: Industrial Ergonomics
ISE 4624: Work Physiology
MSE 4574: Biomaterials
ME 4034: Bio-Inspired Technology
ME 4864: Micro/Nano-Robotics