

COLLEGE OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING AND MECHANICS
BACHELOR OF SCIENCE IN ENGINEERING SCIENCE AND MECHANICS, ENGINEERING PHYSICS OPTION
FOR STUDENT DATE OF ENTRY UNDER UG CATALOG 2021-2022
CREDITS REQUIRED FOR GRADUATION: 132

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-)	2		ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215 (C-)	2	
Pathways 2 or 3	3				
TOTAL	16		TOTAL	16	
FALL SEMESTER SECOND YEAR		Credits	SPRING SEMESTER SECOND YEAR		Credits
MATH 2204 Intro Multivariable Calculus Pre: MATH 1226	3		ESM 2074 (AOE 2074) Computational Methods Pre: ENGE 1216 or ENGE 1414	2	
MATH 2214 Intro Differential Equations Pre: MATH 1226, (MATH 1114 or 2114 or MATH 2114H or MATH 2405H)	3		ECE 3054 Electrical Theory Pre: PHYS 2306 Co: MATH 2214	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	
ESM 2014 Professnl Dvlpmnt Seminar ESM ^[1]	1 ^[F]		ESM 2204 Mech of Deformable Bodies Pre: ESM 2104 or 2114, (MATH 2204 or MATH 2204H)	3	
ESM 2104 Statics ^[1] Pre: MATH 1226 Co: MATH 2204 or MATH 2204H or MATH 2406H	3		ESM 2304 Dynamics Co: MATH 2214; Pre: ESM 2104 or 2114, (MATH 2204 or MATH 2204H)	3	
Pathways 2 or 3	3		Pathways 6a	3	
TOTAL	17		TOTAL	17	
FALL SEMESTER THIRD YEAR		Credits	SPRING SEMESTER THIRD YEAR		Credits
ESM 3034 Fluid Mechanics Lab ^[1] Pre: ESM 2304, ECE 3054 Co: 3234	1 ^[F]		MATH 4574 Vector/Complex Analysis Pre: MATH 2204 or MATH 2204H	3	
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 3114 Prob Definition Engr Design ^[1] Pre: Junior Standing in ESM, ESM 2014	1 ^[S]	
ESM 3064 (MSE 3064) Mech Behavior Matls Lab ^[1] Pre: ESM 2204; Co: ESM 3054	1		ESM 3134 Dyn III Vibration & Control ^[1] Pre: ESM 3124, MATH 4564	3 ^[S]	
ESM 3124 Dynamics II Analytical & 3-D Motion ^[1] Pre: ESM 2304, MATH 2214, (MATH 2204 or MATH 2204H)	3 ^[F]		ESM 3154 Solid Mechanics ^[1] Pre: ESM 2204, (MATH 2214 or MATH 2214H) Co: MATH 4574	3 ^[S]	
ESM 3234 Fluid Mech I-Control Volumes ^[1] Pre: ESM 2304, PHYS 2306	3 ^[F]		ESM 3334 Fluid Mechanics II-differential Analysis ^[1] Pre: ESM 3234 or ME 3404; Co: MATH 4574	3 ^[S]	
MATH 4564 Operational Methods Pre: (MATH 2214 or MATH 2214H) or MATH 2406H or CMDA 2006	3		ESM 3444 Mechanics Lab ^[1] Pre: ESM 3034, 3054, 3064, 3124, 3234, ECE 3054 Co: ESM 3134, 3154, 3334	2 ^[S]	
PHYS 3324 Modern Physics Pre: PHYS 2306 Co: MATH 2214, PHYS 2504	4 ^[F]		PHYS 3704 Thermal Physics Pre: PHYS 2306, PHYS 3324 Co: MATH 2214, PHYS 2504	3 ^[S]	
TOTAL	18		TOTAL	18	
FALL SEMESTER FOURTH YEAR		Credits	SPRING SEMESTER FOURTH YEAR		Credits
STAT 4604 Statistical Methods for Engineers Pre: MATH 1206 or MATH 1226	3		ESM 4016 Creative Design and Project Pre: ESM 4015	3 ^[S]	
ESM 4015 Creative Design and Project Pre: ESM 3114	3 ^[F]		PHYS 4455 Intro Quantum Mechanics Pre: PHYS 3356 Co: PHYS 3406	3 ^[S]	
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]		Technical Elective	3	
PHYS 3405 Intermed Elec & Mag Pre: (MATH 2214 or MATH 2214H), PHYS 2305, PHYS 2306, PHYS 2504	3 ^[F]		Technical Elective	3	
Pathways 2 or 3	3		Pathways 2/3 & 7	3	
TOTAL	15		TOTAL	15	

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)	<i>Foundational:</i> ENGL 1105	(3)	ENGL 1106	(3)
	<i>Advanced:</i> 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)	<i>Foundational:</i> MATH 1225	(3)	MATH 1226	(3)
	<i>Advanced:</i> MATH 2214			(3)
Pathway 6: Critique and Practice in Design and the Arts (7 hrs)	<i>Arts (6a):</i>			(3)
	<i>Design:</i> ENGE 1215 + ENGE 1216			(4)
Pathway 7: Critical Analysis of Identity & Equity in the US (3 hrs) ¹				(3)

¹A 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 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

ESM 4014: Applied Fluids
ESM 4024: Advanced Mechanical Behavior of Materials
ESM 4044 (CEE 4610): Mechanics of Composite Materials
ESM 4084 (AOE 4084): Engineering Design Optimization
ESM 4105-4106: Engineering Analysis of Physiologic Systems
ESM 4114: Nonlinear Dynamics and Chaos
ESM 4194 (ME 4194): Sustainable Energy Solutions for a Global Society
ESM 4204: Musculoskeletal Biomechanics
ESM 4304: Hemodynamics
ESM 4224: Biodynamics & Control
ESM 4234: Mechanics of Biological Materials and Structures
ESM 4245, 4246: Mechanics of Animal Locomotion
ESM 4614: Probability-Based Modeling, Analysis, and Assessment
ESM 4994: Undergraduate Research
ESM 5014: Introduction to Continuum Mechanics
ESM 5405 or 5406: Clinical Internship in Biomedical Engineering
AOE 3124: Aerospace Structures
AOE 3224: Ocean Structures
AOE 3134: Air Vehicle Dynamics
AOE 4064: Fluid Flows in Nature
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 of BME Research
CEE 3014: Construction Management
CEE 3104: Introduction to Environmental Engineering
CEE 3404: Theory of Structures
CEE 3424: Reinforced Concrete Structures I
CEE 3434: Design of Steel Structures I **(4)**
ECE 3105-3106: Electromagnetic Fields
ENGR 3124: Introduction to Green Engineering
ENGR 3134: Environmental Life Cycle Analysis
ME 4224: Aircraft Engines and Gas Turbines
ME 4234 (AOE 4234): Aerospace Propulsion Systems
ME 4524: Introduction to Robotics and Automation
MSE 4055: Materials Selection and Design I
MSE 4164: Corrosion
MSE 4304: Metals and Alloys
MSE 4574: Biomaterials
MSE 4614: Nanomaterials
CHEM 2535, 2536: Organic Chemistry
CHEM 2545, 2546: Organic Chemistry Laboratory **(1,1)**
MATH 3214: Calculus of Several Variables
MATH 4234: Elementary Complex Analysis
MATH 4445, 4446: Introduction to Numerical Analysis
PHYS 3324: Modern Physics **(4)**
PHYS 3405, 3406: Intermediate Electricity and Magnetism
PHYS 3655, 3656: Introduction to Astrophysics
PHYS 4455, 4456: Introduction to Quantum Mechanics
PHYS 4504: Introduction to Nuclear and Particle Physics
PHYS 4714: Introduction to Biophysics