COLLEGE OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING AND MECHANICS
BACHELOR OF SCIENCE IN ENGINEERING SCIENCE AND MECHANICS, ENGINEERING PHYSICS OPTION
FOR STUDENTS GRADUATING IN CALENDAR YEAR 2019
130 CREDITS REQUIRED FOR GRADUATION

FALL SEMESTER FRESHMAN 2015	Credits
CHEM 1035 General Chemistry	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-) Co: MATH 1225	2
CLE (Area 2 or 3)	3
TOTAL	16

SPRING SEMESTER FRESHMAN 2016	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 1226 or a grade of at least B in MATH 1225	3
PHYS 2305 Found of Physics I w/lab Pre: MATH 1225; Co: MATH 1226	4
ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215 (C-) or ENGE 1024 (C-)	2
TOTAL	16

FALL SEMESTER SOPHOMORE 2016	Credits
MATH 2204 Intro Multivariable Calculus Pre: MATH 1226	3
MATH 2214 Differential Equations Pre: MATH 1226, MATH 1114 or 2114	3
PHYS 2306 Foundations of Physics I w/lab Pre: MATH 1226, PHYS 2305	4
ESM 2014 Prof Development Seminar	1[F]
ESM 2104 Statics Co: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H	3
CLE (Areas 2 or 3)	3
TOTAL	17

SPRING SEMESTER SOPHOMORE 2017	Credits
ESM 2074 (AOE 2074) Computational Methods Pre: ENGE 1114 or ENGE 1216 or ENGE 1434	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, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)	3
ESM 2304 Dynamics Pre: ESM 2104, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)	3
TOTAL	14

FALL SEMESTER JUNIOR 2017	Credits
ESM 3034 Fluid Mechanics Lab Pre: ESM 2304, ECE 2054 Co: 3234	1[F]
ESM 3054 (MSE 3054) Mech. Behavior of Matrls Pre: ESM 2204, MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684	3
ESM 3064 (MSE 3064) Mech Beh Matrls Lab Pre: ESM 2204; Co: ESM 3054	1
ESM 3124 Dynamics II Pre: ESM 2304, MATH 2214, (MATH 2224 or MATH 2204 or MATH 2204H)	3[F]
ESM 3234 Fluid Mechanics I Pre: ESM 2304, PHYS 2306	3[F]
MATH 4564 Operational Methods Pre: (MATH 2214 or MATH 2214H) or MATH 2406H or CMDA 2006	3
PHYS 3324 Modern Physics Pre: PHYS 2306 Co: MATH 2214, PHYS 2504	4[F]
TOTAL	18

SPRING SEMESTER JUNIOR 2018	Credits
MATH 4574 Vector and Complex Analysis Pre: MATH 2204 or MATH 2224 or MATH 2204H	3
ESM 3114 Problem Definition & Scoping in Engineering Design Pre: Junior Standing in ESM, ESM 2014	1[S]
ESM 3134 Dyn III Vib/Controls Pre: ESM 3124, MATH 4564	3[S]
ESM 3154 Solid Mechanics Pre: ESM 2204, MATH 2214 Co: MATH 4574	3[S]
ESM 3334 Fluid Mechanics II Pre: ESM 3234 Co: MATH 4574	3[S]
ESM 3444 Mechanics Lab Pre: ESM 3034, 3054, 3064, 3124, 3234, ECE 3054 Co: ESM 3134, 3154, 3334	2[S]
PHYS 3704 Thermal Physics Pre: PHYS 2306, PHYS 3324 Co: MATH 2214, PHYS 2504	3[S]
TOTAL	18

FALL SEMESTER SENIOR 2018	Credits
STAT 4604 Statistical Methods for Eng Pre: MATH 1226	3
ESM 4015 Creative Design and Project Pre: ESM 3114	3[F]
ESM 4734 (AOE 4024) Into to Finite Elements Pre: (CS 3414 or MATH 3414 or AOE 2074), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)	3[F]
PHYS 3405 Intermediate Elec & Mag Pre: MATH 2214, PHYS 2305, PHYS 2306, PHYS 2504	3[F]
CLE (Areas 2 or 3)	3
TOTAL	15

SPRING SEMESTER SENIOR 2019	Credits
ESM 4016 Creative Design and Design Pre: ESM 4015	3[S]
PHYS 4455 Intro Quantum Mechanics Pre: PHYS 3356 Co: PHYS 3406	3[S]
Technical Elective	3
Technical Elective	3
CLE (Area 2/3 & 7)	3
CLE (Area 6)	1
TOTAL	16

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

Curriculum for Liberal Education (CLE)				
Consult the CLE Alphabetical Listing at: http://www.cle.prov.vt.edu/guides/alpha.html, CLE courses need to be completed prior to graduation				
CLE Area 1: Writing and Discourse (6 hrs)	ENGL 1105	(3)	ENGL 1106	(3)
CLE Area 2: Ideas, Cultural Traditions, Values Electives (6 hrs)		(3)		(3)
CLE Area 3: Society & Human Behavior electives (6 hrs)		(3)		(3)
CLE Area 4: Scientific Reasoning and Discovery (8 hrs)	PHYS 2305	(4)	PHYS 2306	(4)
CLE Area 5: Quantitative and Symbolic Reasoning (6 hrs)	MATH 1225	(3)	MATH 1226	(3)
CLE Area 6: Creativity & Aesthetic Experience elective (1 hr)				(1)
CLE Area 7: Global Issues Elective (3 hrs) [1]				(3)

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

Electives:
The ESM PHYS degree requires 6 credits of technical electives from list. Free electives or Area 6 courses 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 130 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00.

Approved Technical Electives:
ESM 4014: Applied Fluids
ESM 4024: Advanced Mechanical Behavior of Materials
ESM 4044: Mechanics of Composite Materials
ESM 4084: Engineering Design Optimization
ESM 4105-4106: Engineering Analysis of Physiologic Systems
ESM 4114: Nonlinear Dynamics and Chaos
ESM 4194: Sustainable Energy Solutions for a Global Society
ESM 4204: Musculoskeletal Biomechanics
ESM 4224: Biodynamics & Control
ESM 4245-6: 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 3024: Thin-Walled Structures
AOE 3104: Aircraft Performance
AOE 3124: Aerospace Structures
AOE 3224: Ocean Structures
AOE 3134: Stability and Control
AOE 4064: Fluid Flows in Nature
AOE 4134: Astromechanics
AOE 4214: Ocean Wave Mechanics
BMES 3124: Introduction to Biomechanics
BMES 3134: Introduction to Biomedical Imaging
BMES 3144: Biomedical Devices
BMES 3184: Problem Solving in BME
CEE 3404: Theory of Structures
CEE 3424: Reinforced Concrete Structures I
CEE 3434: Design of Steel Structures I
ECE 3105-3106: Electromagnetic Fields
ECE 4405-4406: Control Systems
ENGR 3124: Introduction to Green Engineering
ENGR 3134: Environmental Life Cycle Analysis
ME 4224: Aircraft Engines and Gas Turbines
ME 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
MATH 3214: Calculus of Several Variables
MATH 4234: Elementary Complex Analysis
MATH 4445-4446: Introduction to Numerical Analysis
PHYS 3324: Modern Physics
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