

COLLEGE OF ENGINEERING
DEPARTMENT OF AEROSPACE AND OCEAN ENGINEERING
DEGREE: BACHELOR OF SCIENCE IN AEROSPACE AND OCEAN ENGINEERING
MAJOR: OCEAN ENGINEERING
FOR STUDENTS ENTERING UNDER UG CATALOG 2022-2023
CREDITS REQUIRED FOR GRADUATION: 127

FALL SEMESTER FIRST YEAR		Credits	SPRING SEMESTER FIRST YEAR		Credits
CHEM 1035 ⁽¹⁾ General Chemistry	<i>Pre: Eligible to enroll</i>	3	ENGL 1106 ⁽¹⁾ First-Year Writing	<i>Pre: ENGL 1105</i>	3
CHEM 1045 ⁽¹⁾ General Chemistry Lab	<i>Co: CHEM 1035</i>	1	MATH 1226 ⁽¹⁾ Calculus of a Single Variable	<i>Pre: MATH 1225 (C-)</i>	4
ENGL 1105 ⁽¹⁾ First-Year Writing		3	PHYS 2305 ⁽¹⁾ Foundations of Physics	<i>Pre: MATH 1225 or MATH 1226 Co: MATH 1226</i>	4
MATH 1225 ⁽¹⁾ Calculus of a Single Variable (C-)	<i>Pre: Eligible to enroll</i>	4	ENGE 1216 ⁽¹⁾ Foundations of Engineering (C-)	<i>Pre: ENGE 1215 (C-)</i>	2
ENGE 1215 ⁽¹⁾ Foundations of Engineering (C-)		2	Pathways ⁽²⁾ 2 and/or 7*		3
Pathways ⁽²⁾ 2 and/or 7*		3			
TOTAL		16	TOTAL		16
FALL SEMESTER SECOND YEAR		Credits	SPRING SEMESTER SECOND YEAR		Credits
ESM 2114 ⁽³⁾ Statics and Structures	<i>Co: MATH 2204 or MATH 2204H or MATH 2406H</i>	3	ESM 2304 ⁽³⁾ Dynamics	<i>Pre: (2104 or 2114), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H), Co: MATH 2214</i>	3
MATH 2114 ⁽³⁾ Introduction to Linear Algebra	<i>Pre: MATH 1225 (min grade of B) or MATH 1226</i>	3	MATH 2214 ⁽¹⁾ Introduction to Differential Equations	<i>Pre: (1114 or 2114 or 2114H or 2405H), 1226</i>	3
MATH 2204 ⁽³⁾ Introduction to Multivariable Calculus	<i>Pre: MATH 1226</i>	3	AOE 2024 ⁽³⁾ Thin-Walled Structures	<i>Pre: ESM 2114 or (ESM 2104, ESM 2204), (MATH 2224 or MATH 2224H or MATH 2204 or 2204H); Co: MATH 2214</i>	3 ^[F, S]
AOE 2054 ⁽³⁾ Electronics for Aerospace and Ocean Engineers		3 ^[F]	PHYS 2306 ⁽³⁾ Foundations of Physics	<i>Pre: MATH 1226, PHYS 2305</i>	4
AOE 2074 ⁽³⁾ (ESM 2074) Computational Methods	<i>Pre: ENGE 1114 or ENGE 1216 or ENGE 1414</i>	2 ^[F, S]	Pathways ⁽¹⁾ 3 ECON 2005 Principles of Economics		3
AOE 2204 ⁽⁴⁾ Introduction to Ocean Engineering	<i>Pre: PHYS 2305; Co: MATH 2204</i>	3 ^[F]			
TOTAL		17	TOTAL		16
FALL SEMESTER THIRD YEAR		Credits	SPRING SEMESTER THIRD YEAR		Credits
MATH 4564 ⁽³⁾ Operational Methods for Engineers	<i>Pre: (2214 or 2214H) or 2406H or CMDA 2006</i>	3	GEOS 3034 ⁽⁴⁾ Oceanography		3
AOE 3014 ⁽³⁾ Fluid Dynamics for Aerospace and Ocean Engineers	<i>Pre: (2104 or 2204), ESM 2304, (MATH 2214 or MATH 2214H)</i>	3 ^[F, S]	AOE 3234 ⁽⁴⁾ Ocean Vehicle Dynamics	<i>Pre: 3014, 3034, 3214</i>	3 ^[S]
AOE 3034 ⁽³⁾ System Dynamics and Control	<i>Pre: ESM 2304, (MATH 2214 or MATH 2214H)</i>	3 ^[F, S]	AOE 3264 ⁽⁴⁾ Thermodynamics and Marine Propulsion	<i>Pre: 2204, 3014</i>	3 ^[S]
AOE 3214 ⁽⁴⁾ Ocean Wave Mechanics	<i>Co: 3014, MATH 4564</i>	3 ^[F]	AOE 3054 ⁽¹⁾ Experimental Methods	<i>Pre: 2024, 2054, 3014, 3034</i>	3 ^[F, S]
AOE 3224 ⁽⁴⁾ Ocean Structures	<i>Pre: 2024</i>	3 ^[F]	Track Technical Elective		3
TOTAL		15	TOTAL		15
FALL SEMESTER FOURTH YEAR		Credits	SPRING SEMESTER FOURTH YEAR		Credits
AOE 4205 ^(1, 4) Experiments for Ocean Vehicle Design	<i>Pre: 3054; Co: 4265</i>	1 ^[F]	AOE 4206 ^(1, 4) Experiments for Ocean Vehicle Design	<i>Pre: 4205; Co: 4266</i>	1 ^[S]
AOE 4265 ^(1, 4) Ocean Vehicle Design	<i>Pre: 2204, 3214, 3224, 3234, 3264; Co: 4205</i>	3 ^[F]	AOE 4266 ^(1, 4) Ocean Vehicle Design	<i>Pre: 4265; Co: 4206</i>	3 ^[S]
STAT 4705 ⁽⁴⁾ Probability and Statistics for Engineers	<i>Pre: MATH 2224 or MATH 2204 or MATH 2204H nor MATH 2406H</i>	3	Track Technical Elective		3
Track Technical Elective		3	Technical Elective		3
Technical Elective		3	Technical Elective		3
Pathways ⁽²⁾ 6a and/or 7*		3	Pathways ⁽²⁾ 3 and/or 7*		3
TOTAL		16	TOTAL		16

* If a Pathways course is taken that does not double-count Pathways 7 with Pathways 2, 3 or 6a, then three more Pathways credits are needed (130 credits total).

General Information about Checksheet: Superscripted annotation [F,S,SI,SII] in Credits column indicates 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. Specific courses required by the major and used to satisfy Pathways requirements are shaded in Peach (superscript 1 after the course number). Elective Pathways courses are shaded in Gray (superscript 2). AOE degree core courses common to the AE and OE majors are shaded in Green (superscript 3). AOE courses specific to the OE Major are shaded in Blue (superscript 4). OE primary majors with an AE secondary major may substitute 4265-4266 for (4065-4066 or 4165-4166) and 4205-4206 for 4105-4106 in their secondary AE major (substitutions are not permitted for dual degrees).

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

Pathways Concept 1: Discourse (6 hrs foundational, 3 hrs advanced)	<i>Foundational:</i> ENGL 1105	(3)	<i>Foundational:</i> ENGL 1106	(3)
	<i>Advanced:</i> AOE 3054, 4205-06, and (4265-66)			(3)
Pathways Concept 2: Critical Thinking in the Humanities (6 hrs)		(3)		(3)
Pathways Concept 3: Reasoning in the Social Sciences (6 hrs)	ECON 2005	(3)		(3)
Pathways Concept 4: Reasoning in the Natural Sciences (8 hrs)	CHEM 1035 + CHEM 1045	(4)	PHYS 2305	(4)
Pathways Concept 5: Quantitative and Computational Thinking (11 hrs)	<i>Foundational:</i> MATH 1225	(4)	<i>Foundational:</i> MATH 1226	(4)
	<i>Advanced:</i> MATH 2214			(3)
Pathways Concept 6: Critique and Practice in Design and the Arts (7 hrs)	<i>Arts (6a):</i>			(3)
	<i>Design:</i> ENGE 1215 + ENGE 1216			(4)
Pathways Concept 7*: Critical Analysis of Identity & Equity in the US (3 hrs)	Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours.			(3)

* If a Pathways course is taken that does not double-count Pathways 7 with Pathways 2, 3 or 6a, then three more Pathways credits are needed (130 credits total).

Technical Electives: The AOE department requires 18 credits of technical electives. **Students are required to take a minimum of 9 credits from one of the approved Tracks.** The remaining credits must be AOE courses not otherwise required for the OE major. Up to 6 of the 18 credits may be non-AOE technical courses selected either from the Tracks or from the attached list of approved non-AOE technical courses.

Change of Major Requirements: Please see <https://eng.vt.edu/em>

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 AOE Department fully supports this policy. Specific expectations for satisfactory progress for OE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog: <https://www.undergradcatalog.registrar.vt.edu/>
- A student must have at least 2.0 overall and in-major GPAs. (The in-major GPA consists of all courses taken under the AOE designation).

Statement of Hidden Prerequisites: Prerequisites 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. Prerequisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for the most current requirements. There are no hidden prerequisites in this program of study.

Graduation Requirements: Students must pass all required courses and both the in-major and overall GPA must be at least 2.0 for graduation. The in-major GPA consists of all courses taken under the AOE designation. No courses on this checksheet may be taken on a Pass/Fail basis.

AOE DEPARTMENT ELECTIVE REQUIREMENTS
For students entering under UG Catalog 2022-2023

AOE students have several types of electives required in their program of study. Listed below are departmental, College and University requirements governing those electives.

PATHWAYS to GENERAL EDUCATION: Satisfaction of Pathways requirements is required of all students in the university. Engineering students satisfy this requirement in Concepts 1f (foundational), 4, 5, and 6d (design) through curricular engineering, math, science and English courses. Concept 1a (advanced/applied discourse) will be satisfied through the senior design and lab courses. Concepts 2, 3, 6a (arts), and 7 are satisfied through elective courses; six credits are required in Concepts 2 and 3, three credits in Concept 6a and 3 credits in Concept 7. The one course required for Concept 7 may, if carefully selected, simultaneously satisfy a Concept 2 or 3 requirement. Several courses appear on both the Concept 2 and Concept 6a (arts) lists, but they can be used to satisfy only one of these requirements. Concept 7 is the only concept in which a course may “double count.” **All Pathways requirements must be met with courses taken on an A/F basis unless a course is only offered on the P/F basis.** Each year, courses may be added to or removed from each Concept. A course may be used to satisfy a Concept, if it appears on the list of approved courses for that Concept during the year it was taken. A link to the *Pathways to General Education Course Catalog* guide is maintained at <https://www.pathways.prov.vt.edu/about/course-catalog.html>.

ECON 2005 (Principles of Economics) is required for graduation and may be taken as one of the two Concept 3 requirements in the Pathways. If a student chooses to satisfy the Concept 3 requirements with courses not including ECON 2005, ISE 2014 (Engineering Economy) may also be used to satisfy this requirement but this requires additional credits.

ESM 2114 (Statics and Structures) is required for graduation. ESM 2104 (Statics) and ESM 2204 (Mechanics of Deformable Bodies) may be substituted in place of ESM 2114. However, doing so requires that a student take 6 credits instead of the 3 required for ESM 2114.

MATH ELECTIVE: All AE students must take MATH 4574 (Vector and Complex Analysis for Engineers), MATH/AOE 4404 (Applied Numerical Methods) or STAT 4705 (Probability and Statistics for Engineers) on an A/F basis. STAT 4705 is required for OE majors. AOE 5404 (Numerical Methods for AOE) may be substituted in place of AOE 4404 (Applied Numerical Methods)

TECHNICAL ELECTIVES: The AOE Department requires 18 credits of technical electives, all of which must be taken on an A/F basis. This includes at least 9 credits from one of the approved Tracks. If a track includes a foundational course, the foundational course is required in that track, but it does not necessarily need to be taken first unless it is a prerequisite. The remaining credits must be AOE courses not otherwise required for the major. Up to 6 of the 18 credits may be non-AOE technical courses selected either from the Tracks or from the list below. Students pursuing both AE and OE majors may fill all technical elective requirements with required courses from their second major. Otherwise, required courses may not double count as (track) tech electives. Courses other than those below may be acceptable as technical electives; however, substitutions must be approved by the AOE Academic Advisor **before the course is taken**. Students are responsible for the satisfaction of prerequisites required for their chosen technical electives.

CEE: 4384 Coastal Engineering Pre: 3304 (3C)
 4674 Airport Planning and Design Pre: 3604 (3C)

CHEM: 4615 Physical Chemistry for the Life Sciences Pre: (1036 or 1056 or 1056H), (MATH 1026 or
 MATH 1226), (PHYS 2206 or PHYS 2306) (3C)

- CS: 1044 Introduction to Programming in C (3C)
1054 Introduction to Programming in JAVA (3C)
1064 Introduction to Programming in PYTHON (3C)
1114 Introduction to Software Design (3C)
1124 Introduction to Media Computation (3C)
2064 Intermediate Prog in Python Pre: 1064 (3C)
2114 Software Design & Data Structures Pre: 1114 (3C)
- ECE: 1574 Object-Oriented Engineering Problem Solving with C++ Pre: (ENGE 1024 or ENGE 1215 or ENGE 1414), (MATH 1205 or MATH 1205H or MATH 1225) (3C)
3054 Electrical Theory Pre: PHYS 2305. Co: MATH 2214 (3C)
3714 Introduction to Control Systems Pre: 3704 (3C)
4164 Introduction to Global Positioning System (GPS) Theory and Design Pre: (3105, 2014) or AOE 4134 (4C)
4364 Alternate Energy Systems Pre: STAT 4714 (3C)
4624 Digital Signal Processing and Filter Design Pre: 3704 (3C)
4634 Digital Communication Pre: 3614 (3C)
4644 Satellite Communication Pre: 3614 (3C)
- ENGR: 3124 Introduction to Green Engineering Pre: (CHEM 1035 or CHEM 1074), (ENGE 1216 or ENGE 1104 or ENGE 1114), PHYS 2306 (3C)
- ESM: 3054 (MSE 3054) Mechanical Behavior of Materials Pre: ESM 2204, (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684) (3C)
4024 Advanced Mechanical Behavior of Materials Pre: 3054 or MSE 3054 (3C)
4044 Mechanics of Composite Materials Pre: 2204 (3C)
4114 Nonlinear Dynamics and Chaos Pre: (2304 or PHYS 2504), (MATH 2214 or MATH 2214H) (3C)
4154 Nondestructive Evaluation of Materials Pre: 3054, (PHYS 2206 or PHYS 2306) (3C)
4194 (ME 4194) Sustainable Energy Solutions for a Global Society Pre: (CHEM 1035 or CHEM 1055), PHYS 2306, ENGL 3764 (3C)
4614 Probability-Based Modeling, Analysis, and Assessment Pre: 2204 (3C)
- GEOG: 4354 (GEOS 4354) Introduction to Remote Sensing (3C)
- GEOS: 3024 Computational Geosciences Pre: (1004 or 2004 or 2104), (MATH 1225 or MATH 1025) (3C)
3034 (for AE majors only) Oceanography (3C)
4354 (GEOG 4354) Introduction to Remote Sensing (3C)
- ISE: 4404 Statistical Quality Control Pre: 3414, STAT 4105, STAT 4706 (3C)
- MSE: 2034 Elements of Materials Engineering Pre: CHEM 1035. Co: PHYS 2305 (3C)
3054 (ESM 3054) Mechanical Behavior of Materials Pre: ESM 2204, (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684) (3C)
4055 Materials Selection and Design I and II Pre: 3044, 3054, (3204, 3304) or (3204, 4414) or (3204, 4554) or (3304, 4414) or (3304, 4554) or (4414, 4554) (3C)
- MATH: 3214 Calculus of Several Variables Pre: 2224 or 2224H or 2204 or 2204H or 2406H or CMDA 2005 (3C)
4144 Linear Algebra II Pre: 3144 (3C)
4225 Elementary Real Analysis Pre: 3224 (3C)
4226 Elementary Real Analysis Pre: 4225 (3C)
4234 Elementary Complex Analysis Pre: 3224 (3C)

- 4245 Intermediate Differential Equations Pre: 3324 (3C)
- 4246 Intermediate Differential Equations Pre: 3324 (3C)
- 4425 Fourier Series and Partial Differential Equations Pre: 2406H or CMDA 2006 or MATH 2214 or MATH 2214H, MATH 3224 (3C)
- 4426 Fourier Series and Partial Differential Equations Pre: 4425 (3C)
- 4445 Introduction to Numerical Analysis Pre: 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H) or (MATH 2204 or MATH 2204H) (3C)
- 4446 Introduction to Numerical Analysis Pre: 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H) or (MATH 2204 or MATH 2204H) (3C)
- 4574 (if not used as math elective) Vector and Complex Analysis for Engineers Pre: 2224 or 2204 or 2204H (3C)

- ME:
- 2134 Thermodynamics Pre: MATH 2204, CHEM 1035, PHYS 2306 (4C)
 - 4194 (ESM 4194) Sustainable Energy Solutions for a Global Society Pre: (CHEM 1035 or CHEM 1055), PHYS 2306, ENGL 3764 (3C)
 - 4204 Internal Combustion Engines Pre: 3124, 3404 (3C)
 - 4224 Aircraft Engines and Gas Turbines Pre: 4234 or 4124 (3C)
 - 4524 Introduction to Robotics and Automation Pre: (ECE 2574, STAT 4714) or (ME 3514, STAT 3704). Co: 4584 (3C)
 - 4534 Land Vehicles Dynamics Pre: 3514 (3C)
 - 4624 Finite Element Practice in Mechanical Design Pre: 3614 (3C)
 - 4634 Introduction to Computer-Aided Design and Manufacturing (3C)
 - 4644 Introduction to Rapid Prototyping (3C)
 - 4724 Engineering Acoustics Pre: 3514 (3C)

- MGT:
- 3304 Management Theory and Leadership Practice Pre: Sophomore standing (3C)

- NSEG:
- 3145 Fundamentals of Nuclear Engineering Pre: MATH 2214 or MATH 2214H (3C)
 - 3146 Fundamentals of Nuclear Engineering Pre: 3145 (3C)

- PHIL:
- 4324 (MGT 4324) Business and Professional Ethics (3C)

- PHYS:
- 3324 Modern Physics Pre: 2306. Co: MATH 2214 or MATH 2214H (4C)
 - 3405 Intermediate Electricity and Magnetism Pre: (MATH 2214 or MATH 2214H), PHYS 2305, PHYS 2306, PHYS 2504 (3C)
 - 3406 Intermediate Electricity and Magnetism Pre: 3405 (3C)
 - 3655 Introduction to Astrophysics Pre: 2306 (3C)
 - 3656 Introduction to Astrophysics Pre: 2306 (3C)
 - 4455 Introduction to Quantum Mechanics Pre: 3356. Co: 3406 (3C)
 - 4456 Introduction to Quantum Mechanics Pre: 4455 (3C)
 - 4504 Introduction to Nuclear and Particle Physics Co: 4456 (3C)
 - 4554 Introduction to Solid State Physics Co: 4456 (3C)
 - 4614 Optics Pre: 2306, (MATH 2214 or 2214H), (MATH 2224 or 2204 or MATH 2204H) (3C)

- STAT:
- 4105 Theoretical Statistics Pre: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005 (3C)
 - 4106 Theoretical Statistics Pre: 4105 (3C)
 - 4705 (for AE majors only, if not used as the math elective) Probability and Statistics for Engineers Pre: MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H (3C)
 - 4706 Probability and Statistics for Engineers Pre: 4705 or 4105 (3C)

AEROSPACE AND OCEAN ENGINEERING TECHNICAL TRACKS
For students entering under UG Catalog 2022-2023

The AOE department requires 18 credits of technical electives. Students are required to take a minimum of 9 credits from one of the approved Tracks. Up to 6 of the 18 credits may be non-AOE technical courses selected either from Tracks or from the list of approved non-AOE technical courses. If a track includes a foundational course, the foundational course is required in that track, but it does not necessarily need to be taken first unless it is a prerequisite.

FOUNDATIONAL TRACK

The courses in the Foundational Track span the core areas in both Aerospace and Ocean Engineering. Achieving greater depth in analysis and understanding of these materials is very useful in building a strong general background in Aerospace and Ocean Engineering, and the Foundational Track allows students to acquire greater depth across the range of core areas in both aerospace and ocean engineering. This Track is available to all Aerospace and Ocean Engineering majors. Acceptable Substitution: AOE 5144 (Boundary-Layer Theory) may be substituted in place of the required course AOE 3044 (Boundary Layer and Heat Transfer).

Required: Choose a minimum of 9 credit hours from the following courses.

Course	Title	CH
AOE 3044	Boundary Layer and Heat Transfer <small>Pre: 3014, (3164 or 3264 or ME 2134 or ME 3134), MATH 4564</small>	3
AOE 4004	State-Space Control <small>Pre: 3034</small>	3
AOE 4084 (ESM 4084)	Engineering Design Optimization <small>Pre: (MATH 2224 or MATH 2204 or MATH 2204H)</small>	3
AOE 4324	Energy Methods for Structures <small>Pre: 2024, (3124 or 3224)</small>	3

AERO/HYDRODYNAMICS TRACK

Aero/Hydrodynamics is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of Fluid Flows about vehicles is critical to the design of those vehicles. The Aero/Hydrodynamics Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors. Acceptable Substitution: AOE 5144 (Boundary-Layer Theory) may be substituted in place of the required course AOE 3044 (Boundary Layer and Heat Transfer).

Required:

Course	Title	CH
AOE 3044	Boundary Layer and Heat Transfer <small>Pre: 3014, (3164 or 3264 or ME 2134 or ME 3134), MATH 4564</small>	3

Choose a minimum of 6 credit hours from the following courses.

Course	Title	CH
AOE 4064	Fluid Flows in Nature <small>Pre: 3014 or CEE 3304 or ESM 3024 or ME 3404</small>	3
AOE 4114	Applied Computational Aerodynamics	3
AOE 4124	Configuration Aerodynamics <small>Pre: 3014, 3114</small>	3

AOE 4434	Introduction to Computational Fluid Dynamics Pre: MATH 2214. Co: AOE 3044 or ME 3404 or ESM 3016	3
AOE 4474	Propellers and Turbines Pre: 3014	3
AOE 4624	Foundations of Aero/Hydroacoustics Pre: 3014, 3054	3
AOE 5104*	Advanced Aero and Hydrodynamics	3
AOE 5114*	High Speed Aerodynamics	3
AOE 5144*	Boundary Layer Theory and Heat Transfer Pre: 5104	3

*Graduate School policy: seniors with ≥ 3.0 GPA may take graduate course with instructor's permission.

DYNAMICS, CONTROL AND ESTIMATION TRACK

Dynamics, Control and Estimation is a core topic area in both Aerospace and Ocean Engineering. The ability to model and predict the motion of a vehicle, and to modulate that motion through proper control design, is critical to the design of those vehicle systems. The Dynamics, Control and Estimation Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Required:

Course	Title	CH
AOE 4004	State-Space Control Pre: 3034	3

Choose a minimum of 6 credit hours from the following courses.

Course	Title	CH
AOE 3134	Air Vehicle Dynamics (If not taking as required major course) Pre: 3034	3
AOE 3144	Space Vehicle Dynamics (If not taking as required major course) Pre: 3034, 3154	3
AOE 3234	Ocean Vehicle Dynamics (If not taking as required major course) Pre: 3014, 3034, 3214	3
AOE 4344	Dynamics of High-Speed Marine Craft Pre: 3264. Co: 4334 or 3234	3
AOE 4454	Spacecraft Position/Navigation/Timing and Orbit Determination Pre: 3154	3
AOE 4514	Nonlinear Dynamics and Chaos Pre: (ESM 2304 or PHYS 2504), (MATH 2214 or MATH 2214H)	3
AOE 4804	Special Topics in Dynamics, Control, and Estimation Pre: 4004	3
ECE 3714	Introduction to Control Systems Pre: 3704	3
ECE 4624	Digital Signal Processing and Filter Design Pre: 3704	3
ESM 4114	Nonlinear Dynamics and Chaos Pre: (2304 or PHYS 2504), (MATH 2214 or MATH 2214H)	3
ME 4534	Land Vehicle Dynamics Pre: 3514	3
AOE 5204*	Vehicle Dynamics and Control	3
AOE 5234*	Orbital Mechanics	3
AOE 5334*	Advanced Ship Dynamics	3
AOE 5744*	Linear Systems Theory (ME 5544) (ECE 5744)	3

AOE 5754*	Applied Linear Systems (ECE 5754) (ME 5554)	3
AOE 5764*	Applied Linear Control (ME 5564) (ECE 5764)	3
	Pre: AOE 5744 OR AOE 5754 OR ME 5554 OR ME 5544 OR ECE 5744 OR ECE 5754	
AOE 5774*	Nonlinear Systems Theory (ECE 5774) (ME 5574)	

*Graduate School policy: seniors with ≥ 3.0 GPA may take graduate course with instructor's permission.

ENERGY AND THE ENVIRONMENT TRACK

Energy and the Environment, a major application area in both Aerospace and Ocean Engineering, focuses on imparting specific skills required to understand the nature, scope, and challenges of environmental impact and the science behind energy and propulsion systems that minimize that impact. The Energy and the Environment Track will allow students with a particular interest in environment impact, energy systems and renewable energy to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Choose a minimum of 9 credit hours from the following courses.

Course	Title	CH
AOE 4064	Fluid Flows in Nature <small>Pre: 3014 or CEE 3304 or ESM 3024 or ME 3404</small>	3
AOE 4474	Propellers and Turbines <small>Pre: 3014</small>	3
AOE 4624	Foundations of Aero/Hydroacoustics <small>Pre: 3014, 3054</small>	3
AOE 4634	Wind Turbine Technology and Aerodynamics <small>Pre: 3014, 3124</small>	3
AOE 4824	Special Topics in Energy and the Environment <small>Pre: 3014</small>	3
ECE 4364	Alternate Energy Systems <small>Pre: STAT 4714</small>	3
ENGR 3124	Introduction to Green Engineering <small>Pre: (CHEM 1035 or CHEM 1074), (ENGE 1216 or ENGE 1104 or ENGE 1114), PHYS 2306</small>	3
ESM 4194 (ME 4194)	Sustainable Energy Solutions for a Global Society <small>Pre: (CHEM 1035 or CHEM 1055), PHYS 2306, ENGL 3764</small>	3

NAVAL ENGINEERING TRACK

Naval Engineering is an application track in both Aerospace and Ocean Engineering. Understanding naval missions, capability requirements and the broad scope of engineering applications to naval missions, and developing particular technical application knowledge in elective courses, will provide students with a unique and valuable skill set. These skills will enable the student to perform research and work in this field. This Track is available to all Aerospace and Ocean Engineering majors.

Required:

Course	Title	CH
AOE 4264	Principles of Naval Engineering <small>Pre: 2204, (MATH 2224 or MATH 2204 or MATH 2204H), PHYS 2306</small>	3

Choose a minimum of 6 credit hours from the following courses.

Course	Title	CH
AOE 4244	Naval and Marine Engineering Systems Design Pre: 2054, 2204, 3264, 4264	3
AOE 4274	Intermediate Ship Structural Analysis Pre: 3224	3
AOE 4344	Dynamics of High-Speed Marine Craft Pre: 3264. Co: 4334 or 3234	3
AOE 4474	Propellers and Turbines Pre: 3014	3
AOE 5074*	Advanced Ship Structural Analysis	3
AOE 5334*	Advanced Ship Dynamics Pre: 3234, MATH 4564	3
AOE 5444	Advanced Dynamics of High Speed Marine Craft	3
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design Pre: (3105, 2014) or AOE 4134	4
ECE 4364	Alternate Energy Systems Pre: STAT 4714	3

*Graduate School policy: seniors with ≥ 3.0 GPA may take graduate course with instructor's permission.

PROPULSION TRACK

The study of Propulsion, a core technology in Aerospace and Ocean Engineering, focuses on learning and applying fundamental knowledge to understand the nature, scope, opportunities and challenges of designing, specifying and integrating propulsion technologies. The Propulsion Track will allow students with a particular interest in the design, and analysis of aircraft, spacecraft or ocean propulsion to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Choose a minimum of 9 credit hours from the following courses.

Course	Title	CH
AOE 4174 (ME 4174)	Spacecraft Propulsion Pre: 3164 or 4234 or ME 4234	3
AOE 4234 (ME 4234)	Aerospace Propulsion Systems Pre: (3114, (3164 or 3264 or ME 3134) or (ME 3404 or ME 3414), ME 2134 or ME 3124)	3
AOE 4474	Propellers and Turbines Pre: 3014	3
AOE 4604	Booster Design, Fabrication, and Operation Pre: 2074, 3124, 3154, 3164	3
AOE 4814	Special Topics in Propulsion Pre: 3164 or 3264	3
AOE 5135* (ME 5135)	Vehicle Propulsion	3
AOE 5144*	Boundary Layer Theory and Heat Transfer Pre: 5104	3
ME 4204	Internal Combustion Engines Pre: 3124, 3404	3

*Graduate School policy: seniors with ≥ 3.0 GPA may take graduate course with instructor's permission.

SPACE ENGINEERING TRACK

Space Engineering is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of the space environment, space payloads, and/or space mission design and operations is critical to the design, analysis, and functioning of those space vehicles and payloads. The Space Engineering Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Choose a minimum of 9 credit hours from the following courses.

Course	Title	CH
AOE 2664 (ECE 2164)	Exploration of the Space Environment	3
AOE 4174 (ME 4174)	Spacecraft Propulsion	3
	Pre: 3164 or 4234 or ME 4234	
AOE 4454	Spacecraft Position/Navigation/Timing and Orbit Determination	3
	Pre: 3154	
AOE 4604	Booster Design, Fabrication, and Operation	3
	Pre: 2074, 3124, 3154, 3164	
AOE 4654 (ECE 4154)	Space Weather: The Solar Wind and Magnetosphere	3
	Pre: 3105 or 3014	
AOE 4674	Upper Atmosphere Space Weather	3
	Pre: 3014 or ECE 3105	
AOE 4864	Special Topics in Space Engineering	3
	Pre: 3154	
AOE 5135* (ME 5135)	Vehicle Propulsion	3
AOE 5174* (ECE 5174)	Introduction to Plasma Science	3
AOE 5234*	Orbital Mechanics	3
ECE 3104	Introduction to Space Systems and Technologies	3
	Pre: 3105	
ECE 3154	Space Systems—Design and Validation	2
	Pre: 3105. Co: 3104	
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	4
	Pre: (3105, 2014) or AOE 4134	
ECE 4194	Engineering Principles of Remote Sensing	3
	Pre: 3106	
PHYS 3655	Introduction to Astrophysics	3
	Pre: 2306	
PHYS 3656	Introduction to Astrophysics	3
	Pre: 2306	

*Graduate School policy: seniors with ≥ 3.0 GPA may take graduate course with instructor's permission.

STRUCTURES AND MATERIALS TRACK

Structures and Materials is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of structural analysis and materials selection for aerospace and ocean vehicles is critical to the design of those vehicles. The Structures and Materials Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Required:

Course	Title	CH
AOE 4324	Energy Methods for Structures <small>Pre: 2024, (3124 or 3224)</small>	3

Choose a minimum of 6 credit hours from the following courses

Course	Title	CH
AOE 4024 (ESM 4734)	An Introduction to the Finite Element Method <small>Pre: (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) or (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)</small>	3
AOE 4054 (ESM 4444)	Stability of Structures <small>Pre: 2024 or 3024 or CEE 3404</small>	3
AOE 4274	Intermediate Ship Structural Analysis <small>Pre: 3224</small>	3
AOE 5024*	Vehicle Structures	3
AOE 5034* (ESM 5304)	Mechanical and Structural Vibrations	3
AOE 5074*	Advanced Ship Structural Analysis <small>Pre: 5024</small>	3
ESM 3054 (MSE 3054)	Mechanical Behavior of Materials <small>Pre: 2204, (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684)</small>	3
ESM 4024	Advanced Mechanical Behavior of Materials <small>Pre: 3054 or MSE 3054</small>	3
ESM 4044 (CEE 4610)	Mechanics of Composite Materials <small>Pre: 2204 or AOE 2024</small>	3
ME 4624	Finite Element Practice in Mechanical Design <small>Pre: 3614</small>	3
MSE 2034	Elements of Materials Engineering <small>Pre: CHEM 1035. Co: PHYS 2305</small>	3
MSE 3094 (AOE 3094)	Materials & Manufacturing for Aero & Ocean Engineers <small>Pre: CHEM 1035. Co: ESM 2204, PHYS 2305</small>	3

*Graduate School policy: seniors with ≥ 3.0 GPA may take graduate course with instructor's permission.

VEHICLE AND SYSTEM DESIGN TRACK

Vehicle and System Design is a core discipline in both Aerospace and Ocean Engineering. Its focus is on imparting specific skills required to understand the nature, scope, and challenges of designing innovative vehicles and systems by synthesizing foundational knowledge from other courses. The Vehicle and System Design Track will allow students with a particular interest in design and operation of aircraft, spacecraft, and ocean vehicles to focus their technical electives. This Track is available to all Aerospace and Ocean Engineering majors.

Required:

Course	Title	CH
AOE 4084 (ESM 4084)	Engineering Design Optimization Pre: (MATH 2224 or MATH 2204 or MATH 2204H)	3

Choose a minimum of 6 credit hours from the following courses.

Course	Title	CH
AOE 3354	Avionics Systems Pre: (AOE 2054 or ECE 2054), (AOE 3034 or ME 3534 or ME 4505)	3
AOE 3804	Special Topics in Aircraft Systems (HAW) Pre: 2104	3
AOE 4124	Configuration Aerodynamics Pre: 3014, 3114	3
AOE 4244	Naval and Marine Engineering Systems Design Pre: 2054, 2204, 3264, 4264	3
AOE 4264	Principles of Naval Engineering Pre: 2204, (MATH 2224 or MATH 2204 or MATH 2204H), PHYS 2306	3
AOE 4604	Booster Design, Fabrication, and Operation Pre: 2074, 3124, 3154, 3164	3
AOE 4814	Special Topics in Propulsion Pre: 3164 or 3264	3
CEE 5614	Analysis of Air Transportation Systems	3
ME 4644	Introduction to Rapid Prototyping	3
MGT 3304	Management Theory and Leadership Pre: Sophomore standing	3

TABLE of AOE UG Courses in TRACKS
(See Track Descriptions for Specific Conditions/Requirements)

	Tracks	Structures & Materials	Aero/Hydro Dynamics	Dynamics, Control, and Estimation	Vehicle & System Design	Naval Engineering	Space Engineering	Propulsion	Energy and the Environment
Foundational Track	Foundational Courses	AOE 4324 Energy Methods for Structures	AOE 3044: Boundary Layer & Heat Transfer	AOE 4004 State-Space Control	AOE 4084 (ESM 4084) Engineering Design Optimization	AOE 4264 Principles of Naval Engineering			
	Track Courses	AOE 4054 (ESM 4444) Stability of Structures	AOE 4064 Fluid Flows in Nature	AOE 3134** Air Vehicle Dynamics	AOE 3354 Avionics Systems	AOE 4244 Naval and Marine Engineering Systems Design	AOE 2664 (ECE 2164) Exploration of Space Environment	AOE 4174 (ME 4174) Spacecraft Propulsion	AOE 4064 Fluid Flows in Nature
		AOE 4024 (ESM 4734) Intro to the Finite Element Method	AOE 4114 Applied Computational Aerodynamics	AOE 3144** Space Vehicle Dynamics	AOE 3804 Special Topics in Aircraft Systems (HAW)	AOE 4274 Intermediate Ship Structural Analysis	AOE 4174 (ME 4174) Spacecraft Propulsion	AOE 4234 (ME 4234) Aerospace Propulsion Systems	AOE 4474 Propellers & Turbines
		AOE 4274 Intermediate Ship Structural Analysis	AOE 4124 Configuration Aerodynamics	AOE 3234** Ocean Vehicle Dynamics	AOE 4124 Configuration Aerodynamics	AOE 4344 Dynamics of High Speed Marine Craft	AOE 4454 Spacecraft PNT & Orbit Determination	AOE 4474 Propellers & Turbines	AOE 4624 Foundations of Aero/Hydroacoustics
		AOE 5024* Vehicle Structures	AOE 4434 Introduction to Computational Fluid Dynamics	AOE 4344 Dynamics of High Speed Marine Craft	AOE 4244 Naval and Marine Engineering Systems Design	AOE 4474 Propellers & Turbines	AOE 4604 Booster Design, Fabrication, and Operation	AOE 4604 Booster Design, Fabrication, and Operation	AOE 4634 Wind Turbine Tech & Aerodynamics
		AOE 5034 (ESM 4304)* Vehicle Structural Dynamics	AOE 4474 Propellers & Turbines	AOE 4454 Spacecraft PNT & Orbit Determination	AOE 4264 Principles of Naval Engineering	AOE 5074* Advanced Ship Structural Analysis	AOE 4654 (ECE 4154) Intro to Space Weather	AOE 4814 Sp Topics in Propulsion	AOE 4824 Sp Topics in Energy & Environment
		AOE 5074* Advanced Ship Structural Analysis	AOE 4624 Foundations of Aero/hydroacoustics	AOE 4514 Nonlinear Dynamics & Chaos	AOE 4604 Booster Design, Fabrication, and Operation	AOE 5334* Advanced Ship Dynamics	AOE 4674 Upper Atmosphere Space Weather	AOE 5135 (ME 5135)* Vehicle Propulsion	ECE 4364 Alternate Energy Systems
		ESM 3054 (MSE 3054) Mechanical Behavior of Materials	AOE 5104* Advanced Aero and Hydrodynamics	AOE 4804 Sp Topics in DCE	AOE 4814 Sp Topics in Propulsion	AOE 5444* Advanced Dynamics of High Speed Marine Craft	AOE 4864 Special Topics in Space Engineering	AOE 5144 * Boundary Layer Theory & Heat Transfer	ENGR 3124 Intro to Green Engineering
		ESM 4024 Advanced Mechanical Behavior of Materials	AOE 5114* High Speed Aerodynamics	AOE 5204* Vehicle Dynamics & Control	CEE 5614 Analysis of Air Transportation Systems	ECE 4164 Global Navigation Satellite	AOE 5135 (ME 5135)* Vehicle Propulsion	ME 4204 Internal Combustion Engines	ESM 4194 (ME 4194) Sustainable Energy Solution for a Global Society
		ESM 4044 (CEE 4610) Mechanics of Composite Materials	AOE 5144 * Boundary Layer Theory & Heat Transfer	AOE 5234* Orbital Mechanics	ME 4644 Intro to Rapid Prototyping	ECE 4364 Alt Energy Systems	AOE 5174 (ECE 5174)* Introduction to Plasma Science		
		ME 4624 Finite Element Practice in Mechanical Design		AOE 5334* Advanced Ship Dynamics	MGT 3304 Mgt Theory & Leadership		AOE 5234* Orbital Mechanics		
		MSE 2034 Elements of Materials Engineering		AOE 5744* Linear Systems Theory			ECE 3104 Intro to Space Systems & Technologies		
		MSE 3094 (AOE 3094) Materials & Manufacturing for Aero & Ocean Engineers		AOE 5754* Applied Linear Systems			ECE 3154 Space Systems Design and Validation		
				AOE 5764* Applied Linear Control			ECE 4164 Intro to GPS		
				AOE 5774* Nonlinear Systems Theory			ECE 4194 Eng Principles of Remote Sensing		
				ECE 3714 Introduction to Control Systems			PHYS 3655 Intro to Astrophysics		
				ECE 4624 Digital Signal Processing & Filter Design			PHYS 3656 Intro to Astrophysics		
				ESM 4114 Nonlinear Dynamics & Chaos					
				ME 4534 Land Vehicle Dynamics					

* Must be in the UG/G Accelerated Master's Program; or a senior with a 3.0 GPA or above and instructor permission

** Cannot be taken as both a major requirement & a track elective