

SYSTEMS ENGINEERING, BACHELOR OF SCIENCE

Many of the challenges facing modern society require not only new technological solutions, but also efficient, effective, and equitable implementations of these technologies to ensure the betterment of society. Venturing beyond the confines of traditional engineering coursework, the Bachelor of Science degree in Systems Engineering is trans-disciplinary and collaborative, connecting mathematics, engineering, social and physical sciences, and medicine.

The program provides students with knowledge of theory, computational methods, and research in the fundamental frameworks of optimization, network theory, data analysis, and uncertainty quantification, providing the tools required to envision solutions to big-picture problems in a range of applications. Examples include monitoring and modeling the COVID-19 outbreak, optimizing hospital resource allocation, optimizing equitable access to food, and designing infrastructure, energy systems, and smart cities that are interconnected, resilient to hazards, and equitable.

Students will gain significant experience in collaborative problem solving that will serve them well in a broad range of careers, including those related to future energy infrastructure, smart cities, decision-making in healthcare, and data mining and decision making.

Combined Bachelor's/Master's Programs

The Department of Civil and Systems Engineering offers two options for earning a combined bachelor's/master's degree.

One option combines a **B.S. in Systems Engineering** with a **Master of Science in Engineering (M.S.E.) in Civil or Systems Engineering**. For students who are admitted to this program, the two degrees typically require five years total to complete. Students who enroll in the combined Bachelor's/Master's program or pursue a master's degree after having earned a the B.S. in Civil or Systems Engineering at Hopkins may double-count one advanced course (400-level or higher) towards both the bachelor's and master's degrees with the permission of the master's faculty advisor. More detail on double-counting courses can be found here (<https://engineering.jhu.edu/education/graduate-studies/graduate-academic-policies-procedures/>).

The other option combines a **B.S. in Systems Engineering** with a **Master of Science in Engineering Management (M.S.E.M.)** (<http://mseme.engineering.jhu.edu/>). Students are required to submit a formal application through the M.S.E.M. Program (<http://mseme.engineering.jhu.edu/>).

Students enrolled in either the B.S./M.S.E. or B.S./M.S.E.M program are awarded a Dean's Master's Fellowship, covering half their tuition, after they have completed eight semesters of undergraduate study. More information about these programs can be found here (<https://engineering.jhu.edu/education/combined-degrees/combined-bachelors-masters-program/>).

The information below describes the academic requirements for students entering JHU as degree-seeking students in Fall 2025. Students who entered JHU as degree-seeking students prior to Fall 2025 should view the appropriate archived catalogue (<https://e-catalogue.jhu.edu/archive/>).

Students must meet the University requirements and the Whiting School of Engineering requirements (see Requirements for a Bachelor's Degree

(<https://e-catalogue.jhu.edu/ksas-wse/undergraduate-policies/academic-policies/requirements-bachelors-degree/>) in this catalogue), as well as the departmental major requirements, to complete a bachelor's degree.

- The Bachelor of Science in Systems Engineering requires 125 credits.
- The CaSE department recognizes students with exemplary academic records by awarding Departmental Honors to students with a Grade Point Average of 3.75 GPA or higher in Core Requirements. Students with either a primary major or an additional major in systems engineering are evaluated for departmental honors.

UNIVERSITY REQUIREMENTS

These requirements are described in this section of the catalogue (<https://e-catalogue.jhu.edu/ksas-wse/undergraduate-policies/academic-policies/requirements-bachelors-degree/>).

WSE SCHOOL REQUIREMENTS

FIRST-YEAR SEMINAR OR DESIGN CORNERSTONE REQUIREMENT

All WSE primary majors are required to complete a First-Year Seminar (FYS) or a Design Cornerstone class with a grade of Satisfactory (S).

The first-year seminar requirement is waived for students who transfer into the university after the first year. These students must still complete the minimum number of required credits to graduate.

Code	Title	Credits
	One FYS or Design Cornerstone course.	2-3
Total Credits		2-3

FOUNDATIONAL ABILITIES REQUIREMENTS

All students with a primary major within the Whiting School of Engineering must complete the Foundational Abilities (<https://e-catalogue.jhu.edu/ksas-wse/undergraduate-policies/academic-policies/requirements-bachelors-degree/#writingtext>) (FA) in six designated areas. Grades of C- or higher are required. No Satisfactory/Unsatisfactory (S/U) grades will be accepted, except in cases where a course is offered on an S/U basis only, such as the Bootcamp Computing courses. For Foundational Abilities that require the submission of ePortfolio assignments in an engineering discipline, students must achieve a minimum assessment of "Proficient".

FA1 WRITING AND COMMUNICATION

This Foundational Abilities requirement has four parts:

1. Foundational Course in Writing: All WSE students are required to successfully complete one foundational course in writing. Courses that will satisfy the writing course requirement are listed below:

Code	Title	Credits
Choose one from the following:		
AS.004.101	Reintroduction to Writing	3
EN.661.110	Professional Writing and Ethics	3

2. Writing ePortfolio Assignment: All WSE students must be assessed as at least proficient in one or more writing ePortfolio assignments. Courses that include at least one assignment eligible for the writing ePortfolio assignment requirement can be identified in SIS (<https://sis.jhu.edu/sswf/>) by searching for the specific tag listed below:

Code	Title	Credits
EN Foundational Ability tag FA1.1eP		

3. Foundational Course in Oral Communication: All WSE students are required to successfully complete one foundational course in oral communication. The course that will satisfy the oral communication course requirement is listed below:

Code	Title	Credits
EN.661.250	Oral Presentations	3

4. Oral Communication ePortfolio Assignment: All WSE students must be assessed as at least proficient in one or more oral communication ePortfolio assignments. Courses that include at least one assignment applicable to the oral communication ePortfolio assignment requirement can be identified in SIS (<https://sis.jhu.edu/sswf/>) by searching for the specific tag listed below:

Code	Title	Credits
EN Foundational Ability tag FA1.2eP		

FA2 SCIENTIFIC AND QUANTITATIVE REASONING

This Foundational Abilities requirement has five parts. The CaSE department has specified the courses below that will satisfy the requirements.

1. Calculus I: Calculus I applies to both the FA2 requirement and the Systems Engineering Mathematics requirement.

Code	Title	Credits
AS.110.108	Calculus I (Physical Sciences & Engineering)	4

2. Calculus II: Calculus II applies to both the FA2 requirement and the Systems Engineering Mathematics requirement.

Code	Title	Credits
AS.110.109	Calculus II (For Physical Sciences and Engineering)	4

3. Probability and Statistics: The Probability and Statistics course applies to both the FA2 requirement and the Systems Engineering Core requirement.

Code	Title	Credits
EN.560.240	Uncertainty, Reliability and Decision-making	3

4. Computing and Data Science: The computing course applies to both the FA2 requirement and the Systems Engineering computing requirement.

Code	Title	Credits
Choose one from the following:		

EN.500.113 & EN.500.132	Gateway Computing: Python and Bootcamp: Java	4
EN.500.112 & EN.500.133	Gateway Computing: JAVA and Bootcamp: Python	4

5. Natural Science and Laboratory: One natural science lecture and its associated laboratory will apply to both the FA2 requirement and the Systems Engineering Basic Sciences requirement. Additional natural science lectures and labs are required for the major; see the Major Requirements section for details.

Code	Title	Credits
Choose one from the following:		

AS.030.101 & AS.030.105	Introductory Chemistry I and Introductory Chemistry Laboratory I	4
AS.171.101 & AS.173.111	General Physics: Physical Science Major I and General Physics Laboratory I	5
AS.171.107 & AS.173.111	General Physics for Physical Sciences Majors (AL) and General Physics Laboratory I	5

FA3 CREATIVE EXPRESSION

A minimum of 12 credits of coursework in creative expression (FA3) and engagement with society (FA4) is required. At least three of these credits must be earned through a course tagged FA3. Courses with the FA3 tag can be identified in SIS (<https://sis.jhu.edu/sswf/>) by searching the tag listed below:

Code	Title	Credits
EN Foundational Ability tag FA3		3

In addition to the required FA3 and FA4 courses, students must complete six additional credits from any combination of FA3 or FA4 courses, for a total of 12 credits in FA3 and FA4.

FA4 ENGAGEMENT WITH SOCIETY

A minimum of 12 credits of coursework in creative expression (FA3) and engagement with society (FA4) is required. At least three of these credits must be earned through a course tagged FA4. Courses with the FA4 tag can be identified in SIS (<https://sis.jhu.edu/sswf/>) by searching for the specific tag listed below:

Code	Title	Credits
EN Foundational Ability tag FA4		3

In addition to the required FA3 and FA4 courses, students must complete six additional credits from any combination of FA3 or FA4 courses, for a total of 12 credits in FA3 and FA4.

FA5 ETHICAL REFLECTION

This Foundational Abilities requirement has two parts. The CaSE department has specified the courses below that will satisfy the requirements.

1. Foundational Course in Ethical Reflection: All WSE students are required to successfully complete one foundational course in ethical reflection. The CaSE department has specified the courses below that will satisfy the FA5 Foundational Course in Ethical Reflection requirement and the Core requirement.

Code	Title	Credits
EN.660.463	Engineering Management & Leadership	3

2. Ethical Reflection ePortfolio Assignment: All WSE students must be assessed as at least proficient in one or more ethical reflection ePortfolio assignments. Courses that include at least one assignment eligible for the conceiving of and realizing projects ePortfolio assignment requirement can be identified in SIS (<https://sis.jhu.edu/sswf/>) by searching for the specific tag listed below:

Code	Title	Credits
EN Foundational Ability FA5eP		

FA6 CONCEIVING OF AND REALIZING PROJECTS

All WSE students must be assessed as at least proficient in two or more conceiving of and realizing projects ePortfolio assignments. Courses that include at least one assignment eligible for the conceiving of and realizing projects ePortfolio assignment requirement can be identified in SIS (<https://sis.jhu.edu/sswf/>) by searching for the specific tag listed below:

Code	Title	Credits
EN.Foundational Ability FA6eP		

MAJOR REQUIREMENTS

MATHEMATICS

A total of 16 credits in mathematics is required. If a student receives a waiver for Calculus I and/or II or transfers in courses with fewer credits than the corresponding JHU course credits, they must make up the difference by completing additional mathematics coursework.

Grades of C- or higher are required for courses fulfilling FA2 requirements; otherwise, grades of D or higher are required. No Satisfactory/Unsatisfactory (S/U) grades will be accepted.

Code	Title	Credits
AS.110.108	Calculus I (Physical Sciences & Engineering) (FA2 Requirement)	4
AS.110.109	Calculus II (For Physical Sciences and Engineering) (FA2 Requirement)	4
AS.110.202	Calculus III	4
or AS.110.211	Honors Multivariable Calculus	
EN.553.291	Linear Algebra and Differential Equations ¹	4-8
or AS.110.201	Linear Algebra	
& AS.110.302	and Differential Equations and Applications	
or AS.110.212	Honors Linear Algebra	
& AS.110.302	and Differential Equations and Applications	
or EN.553.295	Linear Algebra for Data Science	
& AS.110.302	and Differential Equations and Applications	
Total Credits		16-20

¹ Students may fulfil the requirement by taking either a combined course or two separate courses in Linear Algebra and Differential Equations.

BASIC SCIENCES

A total of 13 credits in basic science courses is required. One natural science lecture and its associated laboratory will apply to both the FA2 requirement and the Systems Engineering Basic Sciences requirement. Students who receive exam credit for Physics I are waived from the corresponding lab courses, but will not receive credit for the lab. This reduces the total basic science credit requirement by 1 credit. To fulfill the 13-credit requirement, students MUST still take either AS.173.111 General Physics Laboratory I or another 1-credit laboratory course designated as Natural Science (N).

Grades of C- or higher are required for courses fulfilling FA2 requirements; otherwise, grades of D or higher are required. No Satisfactory/Unsatisfactory (S/U) grades will be accepted.

Code	Title	Credits
AS.030.101	Introductory Chemistry I	3
AS.030.105	Introductory Chemistry Laboratory I	1

AS.171.101	General Physics: Physical Science Major I	4
or AS.171.107	General Physics for Physical Sciences Majors (AL)	
AS.173.111	General Physics Laboratory I	1
EN.560.312	Electromagnetism & Sensors Lab	1
Basic Science Elective. Recommended courses: ¹		3
AS.171.102	General Physics: Physical Science Major II	
AS.270.305	Energy Resources in the Modern World	
Total Credits		13

¹ Students may take the recommended course or with permission from the Director of Undergraduate Studies, another course with the Natural Science (N) area designation.

COMPUTING REQUIREMENT

A grade of C- or higher in the Gateway Computing course and a grade of S in the Bootcamp course are required to apply toward the FA2 requirement and to the computing requirement in the major.

Code	Title	Credits
Choose one of the following:		
EN.500.113	Gateway Computing: Python	4
& EN.500.132	and Bootcamp: Java	
EN.500.112	Gateway Computing: JAVA	4
& EN.500.133	and Bootcamp: Python	
Total Credits		4

CORE REQUIREMENTS

Grades of C- or higher are required. Excluding courses that fulfill the FA course requirements, a maximum of two D grades may be applied toward the Core Requirements, which include CaSE Fundamentals, Systems Engineering Fundamentals, Systems Engineering Electives, CaSE Professional Practice, and CaSE Technical Electives. No Satisfactory/Unsatisfactory (S/U) grades will be accepted.

CaSE FUNDAMENTALS

Code	Title	Credits
EN.560.100	Civilization Engineered: Structures and Systems	3
EN.560.101	Civilization Engineered: Data-driven Solutions for Communities (FA1.2eP)	3
EN.560.192	CaSE Cornerstone Design Project (FA6eP - Project 1)	1
EN.560.201	Statics & Mechanics of Materials	3
EN.560.211	Statics and Mechanics of Materials Laboratory	1
EN.560.240	Uncertainty, Reliability and Decision-making	3
EN.560.250	Intro to Mathematical Decision Making	3
EN.560.355	Dynamical Systems	3
EN.560.458	Natural Disaster Risk Modeling	3
Total Credits		23

SYSTEMS ENGINEERING FUNDAMENTALS

Code	Title	Credits
EN.500.215	Principles of Data Science	3
EN.560.315	Data Science for Systems Engineers	3
EN.560.342	(Smart Cities)	3

EN.560.350	(Optimization for Systems Engineers) ¹	3
Total Credits		12

¹ EN.560.450 Operations Research is an acceptable replacement for this course.

SYSTEMS ENGINEERING ELECTIVES

Complete three systems engineering elective courses selected from the Data Analytics Electives and the Optimization & Modeling Electives. Approved courses are listed in the two drop-down menus below.

Code	Title	Credits
Data Analytics or Optimization & Modeling Elective 1 (e.g. Energy Systems)		3
Data Analytics or Optimization & Modeling Elective 2 (e.g. Systems Dynamics)		3
Data Analytics or Optimization & Modeling Elective 3 (e.g. Intro to Network Modeling)		3
Total Credits		9

Data & Analytics Electives

Code	Title	Credits
EN.553.413	Applied Statistics & Data Analysis I	4
EN.553.414	Applied Statistics and Data Analysis II	3
EN.553.432	Bayesian Statistics	3
EN.553.436	Introduction to Data Science	4
EN.553.439	Time Series Analysis	3
EN.560.450	Operations Research	3
EN.560.457	System Dynamics	3
EN.560.459	Production Systems Analysis	3
EN.601.226	Data Structures	4
EN.601.433	Intro Algorithms	3
EN.601.475	Machine Learning	3
EN.601.477	Causal Inference	3
EN.601.482	Machine Learning: Deep Learning	4
EN.601.484	Explainable AI Design & Human-AI Interaction	3
EN.601.486	Machine Learning: Artificial Intelligence System Design & Development	3

Optimization & Modeling Electives

Code	Title	Credits
EN.553.171	Discrete Mathematics	4
EN.553.361	Introduction to Optimization I	4
EN.553.362	Introduction to Optimization II	4
EN.553.385	Introduction to Computational Mathematics	4
EN.553.391		4
EN.553.453	Mathematical Game Theory	4
EN.553.463	Network Models in Operations Research	4
EN.553.465		4
EN.553.471	Combinatorial Analysis	4
EN.560.449	Energy Systems	3
EN.560.450	Operations Research	3
EN.560.453	An Introduction to Network Modeling	3
EN.560.459	Production Systems Analysis	3

CaSE PROFESSIONAL PRACTICE

In preparation for CaSE Professional Practice, students must also take the Fundamentals of Engineering (FE) exam in the spring of their graduating year.

Code	Title	Credits
EN.560.391	CaSE Careers I (FA1.1eP, FA5eP)	0.5
EN.560.392	CaSE Careers II	0.5
EN.560.401	Design Theory and Practice (Must take both EN.560.401 and EN.560.402 to satisfy FA6eP - Project 2)	3
EN.560.402	CaSE Capstone Design Project (Must take both EN.560.401 and EN.560.402 to satisfy FA6eP - Project 2)	3
EN.660.463	Engineering Management & Leadership (FA5 Foundational Course in Ethical Reflection)	3
EN.661.110	Professional Writing and Ethics (FA1 Foundational Course in Writing)	3
Total Credits		13

CaSE TECHNICAL ELECTIVES

Technical electives are designed to provide students with opportunities to explore the field of systems engineering in greater depth. These courses must be at the 300-level or higher and carry an E area distribution. Courses at the 300-level or higher with an N or Q distribution may be allowed with approval from the Director of Undergraduate Studies.

Courses may be taken as Satisfactory/Unsatisfactory (S/U) grades only with approval from the Director of Undergraduate Studies.

Code	Title	Credits
Two Technical Elective Courses		
Total Credits		6

FREE ELECTIVES

Grades of D or higher are required. Satisfactory (S) grades will be accepted.

Code	Title	Credits
Elective courses to reach 125 credits		

Sample Program

This sample illustrates the general sequence of courses; individual programs may vary as a result of exam credits. For more information, visit the Civil and Systems Engineering website (<https://engineering.jhu.edu/case/>).

First Year		
Fall	Credits Spring	Credits
AS.030.101 ¹	3 AS.110.109 (FA2 Calculus II Requirement)	4
AS.030.105 ¹	1 AS.171.101 ¹	4
AS.110.108 (FA2 Calculus I Requirement)	4 AS.173.111 ¹	1
EN.500.113 (FA2 Computing and Data Science Requirement)	3 EN.560.101 (FA1.2eP)	3

EN.560.100	3 EN.560.192 (FA6eP - Project 1)	1
FYS or Design Cornerstone	2-3 EN.661.110 or AS.004 101 (FA1 Foundational Course in Writing)	3
Optional HEART course	0-1	

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Second Year

Fall	Credits Spring	Credits
EN.500.132 (FA2 Computing and Data Science Requirement)	1 AS.110.202	4
EN.553.291	4 EN.500.215	3
EN.560.201	3 EN.560.250	3
EN.560.211	1 EN.661.250 (FA1 Foundational Course in Oral Communication)	3
EN.560.240 (FA2 Probability and Statistics Requirement)	3 Course with EN Foundational Ability tag FA4 (Engagement with Society)	3
Course with EN Foundational Ability tag FA3 (Creative Expression)	3	

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Third Year

Fall	Credits Spring	Credits
EN.560.315	3 EN.560.312	1
EN.560.350 (Optimization for Systems Engineers)	3 EN.560.342 (Smart Cities)	3
EN.560.355	3 EN.560.392	0.5
EN.560.391 (FA1.1eP, FA5eP)	0.5 Basic Science Elective	3
Course with EN Foundational Ability tag FA3 or FA4	3 Analytics or Optimization Elective	3
Free Elective	3 Course with EN Foundational Ability tag FA3 or FA4	3
	Free Elective	3

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Fourth Year

Fall	Credits Spring	Credits
EN.560.401 (Must take both EN.560.401 and EN.560.402 to satisfy FA6eP - Project 2)	3 EN.560.402 (Must take both EN.560.401 and EN.560.402 to satisfy FA6eP - Project 2)	3
EN.660.463 (FA5 Foundational Course in Ethical Reflection)	3 EN.560.458	3
Analytics or Optimization Elective	3 Analytics or Optimization Elective	3
CaSE Technical Elective	3 CaSE Technical Elective	3
Free Elective	3 Free Elective	3

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Total Credits 125-127

¹ One of the natural science courses with its associated laboratory will satisfy the FA2 requirement. The other natural science courses with their associated laboratories will satisfy the Basic Sciences requirement for the major.

Sample Program with Hopkins Semester

This sample illustrates a possible sequence of courses for students wishing to pursue a Hopkins Semester in the spring of their junior year; the sequence may vary as a result of exam credits or pursuit of a minor in another department. Students may explore additional options with their professional academic advisor if their desired Hopkins Semester experience varies from what is presented here.

First Year

Fall	Credits Spring	Credits
AS.030.101 ¹	3 AS.110.109 (FA2 Calculus II Requirement)	4
AS.030.105 ¹	1 AS.171.101 ¹	4
AS.110.108 (FA2 Calculus I Requirement)	4 AS.173.111 ¹	1
EN.500.113 (FA2 Computing and Data Science Requirement)	3 EN.560.192 (FA6eP - Project 1)	1
EN.560.100	3 EN.560.101 (FA1.2eP)	3
FYS or Design Cornerstone	2-3 EN.661.110 or AS.004 101 (FA1 Foundational Course in Writing)	3
Optional HEART course	0-1	

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Second Year

Fall	Credits Spring	Credits
EN.500.132 (FA2 Computing and Data Science)	1 AS.110.202	4
EN.553.291	4 EN.500.215	3
EN.560.201	3 EN.560.250	3
EN.560.211	1 EN.560.392	0.5
EN.560.240 (FA2 Probability and Statistics Requirement)	3 EN.661.250 (FA1 Foundational Course in Oral Communication)	3
EN.560.391 (FA1.1eP, FA5eP)	0.5 Course with EN Foundational Ability tag FA4 (Engagement with Society)	3
Course with EN Foundational Ability tag FA3 (Creative Expression)	3	

15.5 16.5

Third Year

Fall	Credits Spring	Credits
EN.560.315	3 Hopkins Semester	
EN.560.350 (Optimization for Systems Engineers)	3 Free Elective	3
EN.560.355	3 Free Elective	3
Analytics or Optimization Elective	3 Free Elective	3
Basic Science Elective	3 Free Elective	3

Course with EN Foundational Ability tag FA3 or FA4	3	
	18	12
Fourth Year		
Fall	Credits Spring	Credits
EN.560.401 (Must take both EN.560.401 and EN.560.402 to satisfy FA6eP - Project 2)	3 EN.560.312	1
Analytics or Optimization Elective	3 EN.560.342 (Smart Cities, FA6eP)	3
CaSE Technical Elective	3 EN.560.402 (Must take both EN.560.401 and EN.560.402 to satisfy FA6eP - Project 2)	3
EN.660.463 (FA5 Foundational Course in Ethical Reflection)	3 EN.560.458	3
Course with EN Foundational Ability tag FA3 or FA4	3 Analytics or Optimization Elective	3
	CaSE Technical Elective	3
	15	16

Total Credits 125-127

¹ One of the natural science courses with its associated laboratory will satisfy the FA2 requirement. The other natural science courses with their associated laboratories will satisfy the Basic Sciences requirement for the major.

Accreditation

The Bachelor of Science in Systems Engineering plans to seek ABET accreditation in 2029.