SYSTEMS ENGINEERING, MS

Banner Code: VS-MS-SYST

Academic Advising
2100 Nguyen Engineering Building
Fairfax Campus
Phone: 703-993-1670
Email: seor@gmu.edu
Website: https://seor.gmu.edu/

Systems Engineering is concerned with analysis of needs and requirements, design, production, deployment, operation, maintenance, refinement, and retirement of reliable systems considering various system constraints. Systems Engineering comprises product, process, and resource management and focuses on architecture, human factors, decision support, performance and evaluation, and management.

System engineers are the visionaries who take a global perspective of the system. Whereas discipline-specific engineers deal with system components, the systems engineer is concerned with the integration of these components and the overall success of the system throughout its life cycle. Our educational and research program reflects the systems engineer’s unique perspective on the system life cycle.

Mason’s graduate program in Systems Engineering recognizes the importance of balancing an education in quantitative models and engineering tools with a proper understanding of the systems perspective. Concentration areas include Advanced Transportation Systems (ATS), Architecture-Based Systems Integration (ABSI), Command, Control, Communications, Computing, and Intelligence (C4I), Energy Systems (NRGS), Financial Systems Engineering (FNSE), Systems Engineering and Data Analytics (SEDA), Systems Engineering of Software-Intensive Systems (SES1) and Systems Management (SMG).

The graduate program leading to the Master of Science in Systems Engineering (MSSE) emphasizes both analytical and practical aspects of engineering complex systems. Students are expected to demonstrate proficiency in using qualitative and quantitative tools relevant to systems engineering practice. The program also prepares students for careers in research and development and for pursuing advanced graduate study leading to the Ph.D. degree in Systems Engineering and Operations Research.

Admissions & Policies

Admissions

Foundation and Admission Requirements
Each applicant for the MS program should meet the following entrance requirements:

1. Have a baccalaureate degree from an accredited institution in engineering, mathematics, computer science, physical sciences, economics, or a related field.
2. Have completed courses in multivariate calculus, matrix algebra, differential equations, applied probability and statistics, and a computer language.

3. Provide evidence of satisfactory educational achievement in at least one of the following forms: a GPA of at least 3.00 as an undergraduate or an acceptable GPA in graduate courses. International students must also achieve satisfactory scores on the Graduate Record Examination (GRE).
4. Have achieved a satisfactory score on the TOEFL examination for non-native English speakers.
5. Have two letters of recommendation submitted by former professors or supervisors.

Students who enter the program must have a working background in engineering mathematics and computer systems. A student lacking these foundations may apply for admission to the program, but may be required to take one or more foundation courses. The department offers SYST 500 Quantitative Foundations for Systems Engineering as an intensive review of undergraduate engineering mathematics, including matrix algebra, calculus, differential equations, probability and statistics. Students who have not completed a two-semester calculus sequence and matrix algebra will be required to complete these courses prior to taking SYST 500 Quantitative Foundations for Systems Engineering. Upon acceptance, each student will be required to take a foundation qualification test a week or two before school starts, unless waived by the department chair or graduate coordinator. Students who fail the test will be required to take SYST 500 Quantitative Foundations for Systems Engineering or other foundation courses. A sample test is available from the department.

Familiarity with analytical modeling software, such as spreadsheets or math packages, is also expected. Students should acquaint themselves with these software packages before beginning classes.

Policies

Advising & Plan of Study
All entering systems engineering students must attend an orientation meeting. Each student is assigned a faculty advisor upon acceptance. Students must meet with their advisors during their first semester and design an approved plan of study. Students are encouraged to seek out their advisor when questions arise and when their plan of study needs to be revised. Any changes to the plan of study must be approved by the faculty advisor. A copy of the plan of study must remain on file with the department.

Requirements

Degree Requirements
Total credits: 30-33

To obtain the Master of Science degree, students must complete a minimum of 30 semester hours of graduate level courses that consists of five core courses, three concentration courses, an elective, and a systems engineering project.

Approved basic methods and concentration courses for the eight concentration areas are listed below. Students are expected to select a set of concentration courses that constitute a clearly defined focus. These courses must be approved by the student’s advisor. Each student
is required to have a current plan of study on file with the Systems Engineering and Operations Research Department.

Candidates for the MS must have a minimum GPA of 3.00 in course work applied to the degree, which may include no more than 6 credits of C. The GPA calculation excludes all transfer courses and Mason nondegree studies credits not formally approved for the degree.

### Core Courses

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 505</td>
<td>Systems Engineering Principles ¹</td>
<td>3</td>
</tr>
<tr>
<td>SYST 510</td>
<td>Systems Definition and Cost Modeling</td>
<td>3</td>
</tr>
<tr>
<td>SYST 520</td>
<td>System Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>SYST 530</td>
<td>Systems Engineering Management I</td>
<td>3</td>
</tr>
<tr>
<td>SYST 611</td>
<td>System Methodology and Modeling</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits:** 15

¹ SYST 505 Systems Engineering Principles may be replaced by an approved elective for students who have work experience in systems engineering or who have been enrolled in the undergraduate BSSE program at Mason. SYST 505, if taken, must be taken in the first semester of enrollment in the MSSE program.

### Basic Methods Course

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR 531</td>
<td>Analytics and Decision Analysis</td>
<td>3</td>
</tr>
<tr>
<td>OR 541</td>
<td>Operations Research: Deterministic Models</td>
<td>3</td>
</tr>
<tr>
<td>OR 542</td>
<td>Operations Research: Stochastic Models</td>
<td>3</td>
</tr>
<tr>
<td>ECE 528</td>
<td>Introduction to Random Processes in Electrical and Computer Engineering</td>
<td>3</td>
</tr>
<tr>
<td>SYST 563</td>
<td>Evidence-Based Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>SYST 568 or OR 568</td>
<td>Applied Predictive Analytics</td>
<td>3</td>
</tr>
<tr>
<td>SYST 573</td>
<td>Decision and Risk Analysis</td>
<td>3</td>
</tr>
<tr>
<td>SYST 620</td>
<td>Discrete Event Systems</td>
<td>3</td>
</tr>
<tr>
<td>SYST 664</td>
<td>Bayesian Inference and Decision Theory</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits:** 12

¹ Students must complete one basic methods course. The choice of basic methods course may depend on the student's concentration and must be selected from the list above.

### Concentrations

Students must complete 3 courses (9 credits) from their area of emphasis. Students may select one of the following eight areas of concentration, or may create their own emphasis area with the approval of their advisor and the Department Chair.

#### Concentration in Advanced Transportation Systems (ATS)

The air transportation system is among the most complex networked systems. This concentration is designed to provide students with the skills to address the next generation of challenges of the air transportation system. Topics addressed include congestion and safety of the national air space, economic and human factors, impact of technology innovation, and public policy. The program emphasizes design, modeling, and analysis to support decision making for government and the aviation industry.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 560</td>
<td>Introduction to Air Traffic Control</td>
<td>3</td>
</tr>
<tr>
<td>SYST 660</td>
<td>Air Transportation Systems Modeling</td>
<td>3</td>
</tr>
<tr>
<td>ECE 528</td>
<td>Introduction to Random Processes in Electrical and Computer Engineering</td>
<td>3</td>
</tr>
<tr>
<td>OR 531</td>
<td>Analytics and Decision Analysis</td>
<td>3</td>
</tr>
<tr>
<td>OR 541</td>
<td>Operations Research: Deterministic Models</td>
<td>3</td>
</tr>
<tr>
<td>OR 542</td>
<td>Operations Research: Stochastic Models</td>
<td>3</td>
</tr>
<tr>
<td>OR 568</td>
<td>Applied Predictive Analytics</td>
<td>3</td>
</tr>
<tr>
<td>SYST 563</td>
<td>Evidence-Based Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>SYST 573</td>
<td>Decision and Risk Analysis</td>
<td>3</td>
</tr>
<tr>
<td>SYST 620</td>
<td>Discrete Event Systems</td>
<td>3</td>
</tr>
<tr>
<td>SYST 664</td>
<td>Bayesian Inference and Decision Theory</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits:** 15

#### Concentration in Architecture-Based Systems Integration (ABSI)

There is much interest today in the engineering of systems that comprise other component systems, where each of the component systems serves organizational and human purposes. These systems families are often categorized as systems of systems, federations of systems, or coalitions of systems. The design of architectures is a major ingredient in the design of systems families. Furthermore, it provides the conceptual basis for achieving system integration. This concentration covers the formulation of the system integration problem, definition of architecture frameworks, use of structured analysis and object-oriented methodologies for the design of architectures, modeling and simulation for the evaluation of architectures, and approaches to integration. Both defense and industrial applications are considered.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 620</td>
<td>Discrete Event Systems</td>
<td>3</td>
</tr>
<tr>
<td>SYST 618</td>
<td>Model-based Systems Engineering</td>
<td>3</td>
</tr>
<tr>
<td>SYST 621</td>
<td>Systems Architecture Design</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits:** 12

#### Concentration in Command, Control, Communications, Computing, and Intelligence (C4I)

C4I systems are concerned with gathering, retrieving, analyzing, and disseminating time-sensitive information to achieve mission-critical objectives. These systems support military operations across the spectrum of conflict, intelligence operations, transportation monitoring, emergency response, drug interdiction, and law enforcement, among others. C4I systems include the equipment, people, and procedures necessary to accomplish the mission. The equipment may include a
variety of sensors, communications systems, and information processing and decision-support systems.

The program focuses on the analysis, design, development, and management of C4I systems. Topics addressed include C4I architectures and software, communications, decision support, modeling and simulation, and sensor data fusion.

### Code | Title | Credits
---|---|---
OR 542 | Operations Research: Stochastic Models | 3
or ECE 528 | Introduction to Random Processes in Electrical and Computer Engineering | 3

**Required Coursework**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 680</td>
<td>Principles of Command, Control, Communications, Computing, and Intelligence (C4I)</td>
<td>3</td>
</tr>
<tr>
<td>or ECE 670</td>
<td>Principles of Command, Control, Communications, Computing, and Intelligence (C4I)</td>
<td>3</td>
</tr>
<tr>
<td>SYST 584</td>
<td>Heterogeneous Data Fusion</td>
<td>3</td>
</tr>
<tr>
<td>One free elective, chosen under advisement</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits** 12

### Concentration in Energy Systems (NRGS)

With the rising economic and environmental costs to power homes, businesses and the transportation systems that move people and goods from place to place, innovative solutions are required to meet the world’s expanding energy needs. Students completing the energy systems concentration will build upon a foundation in systems engineering design by incorporating physical principles of thermal fluid energy transfer into system models. Students will develop the tools to model and analyze generation, transmission, and utilization systems in steady and dynamic operation. Students will optimize these systems by considering physical principles, economics, local policy and security concerns. Graduates will be able to apply their expertise to work with: traditional power generation facilities; renewable energy integration; national, local, and smart grids; mechanical and electrical energy storage systems; utilization of energy in building and transportation systems.

### Code | Title | Credits
---|---|---
ME 521 | Energy Transfer | 3
ME 531 | Energy Transmission | 3
ME 541 | Power Generation | 3
One free elective, chosen under advisement | | 3

**Total Credits** 12

### Concentration in Financial Systems Engineering (FNSE)

Financial engineering is a cross-disciplinary field which relies on mathematical finance, numerical methods, and computer simulations to make trading, hedging, and investment decisions, as well as facilitating the risk management of those decisions. While mathematics is indispensable in financial engineering, the concentration will try best to focus on the concepts and ideas of finance, while limiting the math within a scope acceptable to most students in engineering.

### Code | Title | Credits
---|---|---
OR 542 | Decision Support Systems Engineering | 3
SYST 618 | Model-based Systems Engineering | 3
One from the following: | | 3
| ECE 528 | Introduction to Random Processes in Electrical and Computer Engineering | 3
| OR 531 | Analytics and Decision Analysis | 3
| OR 541 | Operations Research: Deterministic Models | 3
| OR 542 | Operations Research: Stochastic Models | 3
| OR 568 | Applied Predictive Analytics | 3
or SYST 568 | Applied Predictive Analytics | 3
| SYST 563 | Evidence-Based Systems Engineering | 3

### Concentration in Systems Engineering and Data Analytics (SEDA)

Systems engineers must address a broad range of issues relevant to the design, implementation, analysis, and management of systems. This concentration provides methodological tools that can be applied to the systems engineering process. Areas of focus include decision support systems, distributed intelligent systems, knowledge-based planning systems, network systems, probabilistic reasoning systems, sensor fusion systems, and optimization methods.

### Code | Title | Credits
---|---|---
OR 531 | Analytics and Decision Analysis | 3
SYST 568 | Applied Predictive Analytics | 3
SYST 573 | Decision and Risk Analysis | 3
One free elective, chosen under advisement | | 3

**Total Credits** 12

### Concentration in Systems Engineering of Software-Intensive Systems (SESI)

This concentration addresses the software component of the systems engineering life cycle. It specifically covers the allocation of system requirements to software. Practitioners are concerned with the theoretical and practical aspects of technology, cost, and the social effect of computer systems that are reliable, maintainable, secure, efficient, and cost effective. The program emphasizes the integration of hardware, software, and firmware, and the management of these complex computer systems over their life cycle through systems engineering methods, tools, and processes.

### Code | Title | Credits
---|---|---
SYST 542 | Decision Support Systems Engineering | 3
SYST 618 | Model-based Systems Engineering | 3
SYST 563 | Evidence-Based Systems Engineering | 3
Accelerated Options Requirement

Students must complete all credits that satisfy requirements for both the BS and MS programs. Up to two courses (6 credits) of approved master’s level courses taken as part of the undergraduate degree may be applied to the graduate degree. The courses selected for this purpose must be approved by the academic advisors of both BS and MS programs and by the SEOR department chair. For the BS programs that allow undergraduate electives from the department of system engineering and operations research, the students may choose the graduate version of such elective courses to replace the corresponding undergraduate courses.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student’s final undergraduate semester, students must complete a Bachelor’s/Accelerated Master’s Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master’s degree is conferred.

Civil and Infrastructure Engineering, BS/Systems Engineering, Accelerated MS

Overview

Highly-qualified students in the Civil and Infrastructure Engineering, BS have the option of obtaining an accelerated Systems Engineering, MS.

For more detailed information, see AP6.7 Bachelor’s/Accelerated Master’s Degrees. For policies governing all graduate degrees, see AP6 Graduate Policies.

Admission Requirements

Mason undergraduate students majoring in Civil and Infrastructure Engineering, BS may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Systems Engineering, MS program.

Accelerated Options Requirement

Students must complete all credits that satisfy requirements for both the BS and MS programs. Up to two courses (6 credits) of approved master’s level courses taken as part of the undergraduate degree may be applied to the graduate degree. The courses selected for this purpose must be approved by the academic advisors of both BS and MS programs and by the SEOR department chair. For the BS programs that allow undergraduate electives from the department of system engineering and operations research, the students may choose the graduate version of such elective courses to replace the corresponding undergraduate courses.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the
beginning of the student’s final undergraduate semester, students must complete a Bachelor’s/Accelerated Master’s Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master’s degree is conferred.

**Cyber Security Engineering, BS/Systems Engineering, Accelerated MS**

**Overview**

Highly-qualified students in the Cyber Security Engineering, BS have the option of obtaining an accelerated Systems Engineering, MS.

For more detailed information, see AP.6.7 Bachelor’s/Accelerated Master’s Degrees. For policies governing all graduate degrees, see AP6 Graduate Policies.

**Admission Requirements**

Mason undergraduate students majoring in Cyber Security Engineering, BS may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Systems Engineering, MS program.

**Accelerated Options Requirement**

Students must complete all credits that satisfy requirements for both the BS and MS programs. Up to two courses (6 credit hours) of approved master’s level courses taken as part of the undergraduate degree may be applied to the graduate degree. The courses selected for this purpose must be approved by the academic advisors of both the BS and MS programs and by the SEOR department chair. For the BS programs that allow undergraduate electives from the department of system engineering and operations research, the students may choose the graduate version of such electives to replace the corresponding undergraduate courses.

**Degree Conferral**

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student’s final undergraduate semester, students must complete a Bachelor’s/Accelerated Master’s Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master’s degree is conferred.

**Statistics, BS/Systems Engineering, Accelerated MS**

**Overview**

Highly-qualified students in the Statistics, BS have the option of obtaining an accelerated Systems Engineering, MS.

For more detailed information, see AP.6.7 Bachelor’s/Accelerated Master’s Degrees. For policies governing all graduate degrees, see AP6 Graduate Policies.

**Admission Requirements**

Mason undergraduate students majoring in Statistics, BS may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements.

**Accelerated Options Requirement**

Students must complete all credits that satisfy requirements for both the BS and MS programs. Up to two courses (6 credit hours) of approved master’s level courses taken as part of the undergraduate degree may be applied to the graduate degree. The courses selected for this purpose must be approved by the academic advisors of both the BS and MS programs and by the SEOR department chair. For the BS programs that allow undergraduate electives from the department of system engineering and operations research, the students may choose the graduate version of such electives to replace the corresponding undergraduate courses.

**Systems Engineering BS/Systems Engineering, Accelerated MS**

**Overview**

Qualified undergraduate students may apply for a five-year accelerated BS/MS program leading to a Bachelor of Science in Systems Engineering and an MS degree in Systems Engineering.

For more detailed information, see AP.6.7 Bachelor’s/Accelerated Master’s Degrees. For policies governing all graduate degrees, see AP6 Graduate Policies.

**Admission Requirements**

Mason undergraduate students majoring in systems engineering may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Systems Engineering, MS program.

**Accelerated Option Requirements**

Up to two courses (six credit hours) of master’s level courses may be applied to both the undergraduate and the graduate degrees. These two courses may be chosen from the list of graduate courses in the following table. For Systems Engineering, BS students, these graduate courses replace the corresponding undergraduate courses listed in the table. The undergraduate version of these courses may not be applied toward the Systems Engineering, MS.

<table>
<thead>
<tr>
<th>Undergraduate</th>
<th>Graduate</th>
<th>Credit may not be received for both courses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 420</td>
<td>SYST 521/OR 643</td>
<td></td>
</tr>
<tr>
<td>SYST 473</td>
<td>SYST 573</td>
<td></td>
</tr>
</tbody>
</table>
Accelerated Option Requirements

Up to two courses (6 credits) of approved master's level courses taken as part of the undergraduate degree may be applied to the graduate degree. These two courses may be chosen from the graduate courses in the following table.

For BS candidates, these graduate courses replace the corresponding undergraduate courses listed. The undergraduate version of these courses may not be applied toward the MS degree.

<table>
<thead>
<tr>
<th>Undergraduate</th>
<th>Graduate</th>
<th>Credit may not be received for both courses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYST 420</td>
<td>SYST 521</td>
<td></td>
</tr>
<tr>
<td>SYST 473</td>
<td>SYST 573</td>
<td></td>
</tr>
<tr>
<td>OR 441</td>
<td>OR 541</td>
<td></td>
</tr>
<tr>
<td>OR 442</td>
<td>OR 542</td>
<td></td>
</tr>
</tbody>
</table>

Any other 500-level course may be applied to both the undergraduate and graduate degrees with approval of the advisor and SEOR department chair.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and Graduate Recruitment and Enrollment Services. At the completion of MS requirements, a master's degree is conferred.

BS (selected)/Systems Engineering, Accelerated MS

Overview

Highly-qualified students in selected BS programs (see below) have the option of obtaining an accelerated Systems Engineering, MS.

For more detailed information, see AP6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP6 Graduate Policies.

Admission Requirements

Mason undergraduate students majoring in computer engineering, computer science, or electrical engineering may apply to this option if they have earned 90 undergraduate credits with an overall GPA of at least 3.30 and completed all MATH and PHYS requirements. Criteria for admission are identical to criteria for admission to the Systems Engineering, MS program.