

# OPERATIONS RESEARCH, MS

Banner Code: VS-MS-OPRS

## Academic Advising

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Fairfax Campus

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The MS prepares students for research and professional practice associated with the formulation and analysis of mathematical models for decision making and their computer implementation. Major components include optimization, queuing and network modeling, computer simulation and modeling, applied and computational probability, and application of these components to realistic and relevant operational analysis problems. Students are expected to become proficient in these areas, as well as in supporting areas of information technology necessary to implement operations research methods.

The program includes core courses and electives selected by the student with the aid of a faculty advisor. To obtain the MS degree, students complete an approved plan of study that contains a minimum of 30 graduate credits. Students may take courses through the Commonwealth Graduate Engineering Program. Appropriate courses may be transferred, with advisor approval, into this Mason degree program.

## Admissions & Policies

### Admissions

To be admitted to the program, students must hold a baccalaureate degree from an accredited institution in engineering, mathematics, computer science, physical sciences, economics, or a related field. They also must have completed courses in:

Code	Title	Credits
<b>Calculus</b>		
MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
MATH 114	Analytic Geometry and Calculus II	4
MATH 213	Analytic Geometry and Calculus III	3
<b>Matrix Algebra</b>		
MATH 203	Linear Algebra	3
<b>Differential Equations</b>		
MATH 214	Elementary Differential Equations	3
<b>Applied Probability and Statistics</b>		
STAT 346	Probability for Engineers	3
<b>Scientific Programming Language</b>		
CS 112	Introduction to Computer Programming (Mason Core)	4

Specific application deadlines and requirements ([https://admissions.gmu.edu/grad/application-deadlines-and-requirements/?academicUnit=VS&\\_ga=1.107632321.273102085.1480697294](https://admissions.gmu.edu/grad/application-deadlines-and-requirements/?academicUnit=VS&_ga=1.107632321.273102085.1480697294)) are available through the Office of Graduate Admissions.

## Requirements

### Degree Requirements

Total credits: 30

Students must complete four core courses and the project (15 credits). The remaining 15 credits are electives subject to the requirements below, and can be taken in one of five concentration areas or in an individual plan approved by the student's advisor.

### Required Core Courses

Code	Title	Credits
OR 541	Operations Research: Deterministic Models	3
OR 542	Operations Research: Stochastic Models	3
OR 568	Applied Predictive Analytics	3
OR 635	Discrete System Simulation	3
Total Credits		12

### Project

Code	Title	Credits
OR 699	Masters Project	3
Total Credits		3

### Methods Courses

Code	Title	Credits
Select at least one deterministic methods and one stochastic methods course:		6
<b>Deterministic Methods Courses:</b>		
OR 641	Linear Programming	
OR 642	Integer Programming	
OR 643	Network Modeling	
OR 644	Nonlinear Programming	
OR 670	Metaheuristics for Optimization	
<b>Stochastic Methods Courses:</b>		
OR 645	Stochastic Processes	
OR 647	Queuing Theory	
OR 674	Dynamic Programming	
OR 675	Reliability Analysis	
SYST 664	Bayesian Inference and Decision Theory	
Total Credits		6

### Additional Electives

Code	Title	Credits
Select up to three additional electives from the list of allowable electives with written concurrence of the advisor <sup>1</sup>		9
Total Credits		9

<sup>1</sup> At least two of these electives must be taken from SEOR course offerings, and one of these must be OR 600-level or higher. The remaining course should be taken in an area appropriate to the student's interests, such as operations research, systems engineering, computer science, information systems, statistics, data analytics, electrical and computer engineering, economics, mathematics or supply chain management.

The allowable elective for MS students includes:

A. Within VSE:

- o Any OR course  $\geq 600$
- o Any SYST course  $> 500$
- o Any STAT course  $\geq 554$
- o Any CS course  $\geq 500$
- o Any ECE course  $\geq 500$  but not 528
- o Any CEIE course  $> 500$  but not 601

B. External to VSE (subject to approval by the Department Chair):

- o Any MATH course  $> 601$  and permitted for Math majors;
- o Any CSI course  $> 610$
- o Any ECON course  $\geq 611$

## Concentrations

Students may construct concentration areas by choosing electives from among special groupings. The six concentrations available are data analytics, decision analysis, financial engineering, military operations research, optimization, and stochastic modeling. In addition to the required core courses (12 credits) and project course (3 credits), the remaining 15 credit hours consist of methods and elective courses associated with the concentration areas as outlined below. Students can also devise their own grouping of electives subject to prior approval of their advisor.

### Available Concentrations

- Concentration in Data Analytics (DNIC)
- Concentration in Decision Analysis (DA)
- Concentration in Financial Engineering (FNNE)
- Concentration in Military Operations Research (MOR)
- Concentration in Optimization (OPT)
- Concentration in Stochastic Models (STM)

### Concentration in Data Analytics (DNIC)

Code	Title	Credits
CS 504	Principles of Data Management and Mining	3
	One deterministic methods course	3
	One stochastic methods course	3
	and two courses from the following list:	6
OR 604	Practical Optimization	
OR 670	Metaheuristics for Optimization	
STAT 663	Statistical Graphics and Data Exploration I	
SYST 664	Bayesian Inference and Decision Theory	
Total Credits		15

### Concentration in Decision Analysis (DA)

Code	Title	Credits
OR 671	Judgment and Choice Processing and Decision Making	3
OR 681	Decision and Risk Analysis	3
SYST 664	Bayesian Inference and Decision Theory	3
	Select one deterministic methods course	3
	Select one stochastic methods course	3
Total Credits		15

### Concentration in Financial Engineering (FNNE)

Code	Title	Credits
OR 588	Financial Systems Engineering I: Introduction to Options, Futures, and Derivatives	3
OR 688	Financial Systems Engineering II: Derivative Products and Risk Management	3
	Select one from the following:	3
OR 538	Analytics for Financial Engineering and Econometrics	
OR 645	Stochastic Processes	
OR 671	Judgment and Choice Processing and Decision Making	
OR 681	Decision and Risk Analysis	
OR 682	Computational Methods in Engineering and Statistics	
	Students must also complete:	6
	One deterministic methods course	
	One stochastic methods course <sup>1</sup>	
Total Credits		15

<sup>1</sup> If the student has already taken OR 645 Stochastic Processes this can be substituted for an elective course with written concurrence of the student's advisor

### Concentration in Military Operations Research (MOR)

Code	Title	Credits
OR 651	Military Operations Research I: Cost Analysis	3
OR 652	Military Operations Research Modeling II: Effectiveness Analysis	3
SYST 683	Modeling, Simulation, and Gaming	3
	One deterministic methods course	3
	One stochastic methods course	3
Total Credits		15

### Concentration in Optimization (OPT)

Code	Title	Credits
	Select three courses from the following:	9
OR 604	Practical Optimization	
OR 641	Linear Programming	
OR 642	Integer Programming	
OR 643	Network Modeling	
OR 644	Nonlinear Programming	
OR 646	Stochastic Optimization	

OR 670	Metaheuristics for Optimization	
OR 682	Computational Methods in Engineering and Statistics	
Students must also complete:		6
One stochastic methods course		
One elective course with written concurrence of the student's advisor		
Total Credits		15

### Concentration in Stochastic Models (STM)

Code	Title	Credits
Select three courses from the following:		
OR 645	Stochastic Processes	
OR 647	Queuing Theory	
OR 674	Dynamic Programming	
OR 719	Graphical Models for Inference and Decision Making	
SYST 664	Bayesian Inference and Decision Theory	
STAT 554	Applied Statistics I	
	or STAT 663 Statistical Graphics and Data Exploration I	
Select must also complete:		6
One deterministic methods course		
One elective course with written concurrence of the student's advisor		
Total Credits		15

STAT 652	Statistical Inference	3
STAT 654	Applied Statistics II	3
Total Credits		27

### Elective Credits in OR Courses

Code	Title	Credits
Select 12 elective credits in OR courses at the 600 level, including at least one deterministic methods course and at least one stochastic methods course:		12

Deterministic Methods Courses:		
OR 641	Linear Programming	
OR 642	Integer Programming	
OR 643	Network Modeling	
OR 644	Nonlinear Programming	
Stochastic Methods Courses:		
OR 645	Stochastic Processes	
OR 647	Queuing Theory	
OR 674	Dynamic Programming	
OR 675	Reliability Analysis	
SYST 664	Bayesian Inference and Decision Theory	
Total Credits		12

### Elective Credits in STAT Courses

Code	Title	Credits
Select 9 elective credits from any STAT courses numbered 540-775		9
Total Credits		9

## Dual Degree Options

## Operations Research and Statistical Science Dual-Degree MS

This program allows students to earn an MS in Operations Research and an MS in Statistical Science by completing 48 credits of coursework in both areas instead of the 60 that would be required if the degrees were sought independently.

### Admission Requirements

Applicants must satisfy admission requirements for the MS in Operations Research Program and the MS in Statistical Science Program. A joint faculty committee from the Statistics and Systems Engineering and Operations Research Departments make final admission decisions into the dual-degree program.

### MS-OPRS/STAT Dual Degree Requirements

Total credits: 48

#### Required Courses

Code	Title	Credits
OR 541	Operations Research: Deterministic Models	3
OR 542	Operations Research: Stochastic Models	3
OR 635	Discrete System Simulation	3
OR 699	Masters Project	3
STAT 544	Applied Probability	3
STAT 554	Applied Statistics I	3
STAT 634	Case Studies in Data Analysis	3

### Notes

- Students currently enrolled in one of the MS programs must declare pursuit of the dual MS within one year of matriculation into the first MS program.
- A maximum of 6 credits across the two disciplines may be in independent research (thesis). The requirements for independent research are the same as detailed for the associated MS program.
- Students in either the BS (selected)/Operations Research, Accelerated MS program or the BS (selected)/Statistical Science, Accelerated MS program cannot get a reduction of 6 credits toward this dual degree. Students who want to proceed to a PhD degree will only be able to waive the number of credits specified in the associated PhD degree requirements, even though they will have 48 credits at the MS level.
- If a student decides not to complete the required 48 credits, a single MS degree will not be granted unless the student fulfills the requirements for the MS in Operations Research or the MS in Statistical Science.
- Once a student receives one of the MS degrees from either department, the student will no longer be eligible for the reduction in credit (i.e., will need to complete 30 credits) if the student later decides to earn the other MS degree.

## Accelerated Master's

### Bioengineering, BS/Operations Research, Accelerated MS

#### Overview

Highly-qualified students in the Bioengineering, BS have the option of obtaining an accelerated Operations Research, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

#### Admission Requirements

Mason undergraduate students majoring in Bioengineering, 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 Operations Research, 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 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 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/Operations Research, Accelerated MS

#### Overview

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

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 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 Operations Research, MS program.

Students must additionally complete MATH 203 Linear Algebra prior to applying for the graduate 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 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 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/Operations Research, Accelerated MS

#### Overview

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

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 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 Operations Research, 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.

## Mechanical Engineering, BS/Operations Research, Accelerated MS

### Overview

Highly-qualified students in the Mechanical Engineering, BS have the option of obtaining an accelerated Operations Research, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### Admission Requirements

Mason undergraduate students majoring in Mechanical 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 Operations Research, MS program.

Students must additionally complete MATH 203 Linear Algebra prior to applying for the graduate 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 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 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.

## Statistics, BS/Operations Research, Accelerated MS

### Overview

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

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 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.

Criteria for admission are identical to criteria for admission to the Operations Research, 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.

## Systems Engineering BS/Operations Research, 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 Operations Research.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 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 Operations Research, 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 Operations Research, MS.

Undergraduate	Graduate	
SYST 420	SYST 521/OR 643	Credit may not be received for both courses.
SYST 473	SYST 573	Credit may not be received for both courses.

OR 441	OR 541	Credit may not be received for both courses.
OR 442	OR 542	Credit may not be received for both courses.
SYST 438	SYST 538	These courses apply only to certain concentrations in the graduate program; credit may not be received for both courses.
SYST 468	SYST 568	These courses apply only to certain concentrations in the graduate program; credit may not be received for both courses.
SYST 488	SYST 588	These courses apply only to certain concentrations in the graduate program; credit may not be received for both courses.

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)/Operations Research, Accelerated MS

### Overview

Highly-qualified students in BS programs have the option of obtaining an accelerated Operations Research, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### Admission Requirements

Mason undergraduate students majoring in both engineering and non-engineering disciplines may apply to this option if 1) such an accelerated Operations Research, MS pathway is allowable from the student's BS program, which will be determined by the academic advisors of both the BS and MS programs and by the SEOR department chair, 2) they have earned 90 undergraduate credits with an overall GPA of at least 3.30, and 3) they have completed all MATH and PHYS requirements. Criteria

for admission are identical to criteria for admission to the Operations Research, MS program.

Students must additionally complete MATH 203 prior to applying for the graduate program.

### Accelerated Option Requirements

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 the BS and MS programs and by the SEOR department chair.

For the BS programs that allow undergraduate electives from the department of systems 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.