

MATHEMATICAL SCIENCES, MASTER OF SCIENCE (M.S.) WITH A CONCENTRATION IN OPERATIONS RESEARCH

Program goal

The Department of Mathematics and Applied Mathematics and the Department of Statistical Sciences and Operations Research jointly offer the M.S. in Mathematical Sciences.

The mission of the Department of Statistical Sciences and Operations Research is to offer a strong undergraduate and graduate education, with an increasing focus on the development of cross-disciplinary efforts that will prepare students for real-world applications and stimulating employment and career opportunities.

The program offers maximum flexibility by allowing students, in consultation with their graduate committees, to design a course of study that will best develop competence in those areas most relevant to their scholarly and professional objectives. Students may obtain a designation on their transcripts indicating that their graduate study has emphasized the mathematics concentration by completing the requirements that are listed here. A student who has not satisfied the requirements for one of the program concentrations offered, but who has otherwise fulfilled all the requirements for a master's degree, will be awarded a degree of Master of Science in Mathematical Sciences without any specialization.

Student learning outcomes

1. **Theory and application of mathematical programming**
Students will demonstrate a solid foundation in the theory and application of mathematical programming and a comprehensive understanding of basic mathematical programming methods.
2. **Theory and application of stochastic models**
Students will demonstrate a comprehensive understanding of the theory and application of stochastic models and decision analysis.
3. **Obtain, analyze and interpret data**
Students will be able to obtain, analyze and interpret the data necessary to perform operations research projects.
4. **Use of software commonly used in industry**
Students will be able to solve a wide variety of operations research problems employing the software commonly used in industry.
5. **Modeling of operations research problems**
Students will identify and model situations in which operations research can be applied.
6. **Mathematical knowledge**
Students will demonstrate proficiency in the mathematics required to perform operations research methods.
7. **Written communication of technical information**
Students will clearly and concisely present technical information in writing.
8. **Oral communication of technical information**
Students will clearly and concisely present technical information through oral presentations.

VCU Graduate Bulletin, VCU Graduate School and general academic policies and regulations for all graduate students in all graduate programs

The VCU Graduate Bulletin website documents the official admission and academic rules and regulations that govern graduate education for all graduate programs at the university. These policies are established by the graduate faculty of the university through their elected representatives to the University Graduate Council.

It is the responsibility of all graduate students, both on- and off-campus, to be familiar with the VCU Graduate Bulletin as well as the Graduate School website (<http://www.graduate.vcu.edu/>) and academic regulations in individual school and department publications and on program websites. However, in all cases, the official policies and procedures of the University Graduate Council, as published on the VCU Graduate Bulletin and Graduate School websites, take precedence over individual program policies and guidelines.

Visit the academic regulations section for additional information on academic regulations for graduate students. (<http://bulletin.vcu.edu/academic-regs/>)

Degree candidacy requirements

A graduate student admitted to a program or concentration requiring a final research project, work of art, thesis or dissertation, must qualify for continuing master's or doctoral status according to the degree candidacy requirements of the student's graduate program. Admission to degree candidacy, if applicable, is a formal statement by the graduate student's faculty regarding the student's academic achievements and the student's readiness to proceed to the final research phase of the degree program.

Graduate students and program directors should refer to the following degree candidacy policy as published in the VCU Graduate Bulletin for complete information and instructions.

Visit the academic regulations section for additional information on degree candidacy requirements. (<http://bulletin.vcu.edu/academic-regs/grad/candidacy/>)

Graduation requirements

As graduate students approach the end of their academic programs and the final semester of matriculation, they must make formal application to graduate. No degrees will be conferred until the application to graduate has been finalized.

Graduate students and program directors should refer to the following graduation requirements as published in the Graduate Bulletin for a complete list of instructions and a graduation checklist.

Visit the academic regulations section for additional information on graduation requirements. (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info/>)

Apply online today. (<https://www.vcu.edu/admissions/apply/graduate/>)

Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
M.S.	Fall	Mar 1	GRE-General
	Spring	Oct 1	TOEFL (International students only)

In addition to the general admission requirements of the VCU Graduate School (<http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements/>), the following requirements represent the minimum acceptable standards for admission:

- Thirty credit hours in undergraduate mathematical sciences, computer science or related areas of which at least 18 credit hours must represent upper-level courses
- Three letters of recommendation pertaining to the student's potential ability as a graduate student in mathematical sciences

Provisional admission may be granted when deficiencies exist. These deficiencies must be removed by the end of the first year of residence, or its part-time equivalent, when the student's application will be re-examined. Courses that are remedial or designed to remove deficiencies will not be accepted for credit hours toward the fulfillment of the course requirements for the master's degree.

Degree requirements

In addition to the VCU Graduate School graduation requirements (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info/>), students are required to complete course work in core and elective courses and to meet the following requirements.

- Credit hour requirements: Students in the M.S. in Mathematical Sciences program are required to earn a minimum of 30 graduate-level credit hours. At least one-half of the credit hours presented for graduation must be at the 600 level or higher.
- Other requirements: All students must pass two comprehensive examinations: foundations of operations research, covering OPER 527 and OPER 528 and methods of operations research, covering OPER 639, OPER 643 and STAT 613. All students will be given two attempts to pass each exam. Students who receive a minimum grade of B on both OPER 527 and OPER 528 and a grade of A on at least one of the two courses will not need to take the foundations of operations research exam. Students who receive a minimum grade of B on each of OPER 639, OPER 643 and STAT 613 and a grade of A on at least one of the three courses will not need to take the methods of operations research exam.

Curriculum requirements

Course	Title	Hours
Concentration core courses		
OPER 527	Optimization I ¹	3
OPER 528	Stochastic Simulation ¹	3
OPER 639	Practical Optimization	3
OPER 643	Decision and Risk Analysis	3
SSOR 690	Research and Communications Seminar	3
STAT 613	Stochastic Processes	3
Additional courses		

Operations research electives (Choose courses from list one below)	6
Operations research and allied field electives (Choose courses from list two below)	6
Total Hours	30

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If a student previously received credit hours for OPER 527 and/or OPER 528 or their equivalents, then one or two other operations research courses must be taken in their place.

The minimum total of graduate credit hours required for this degree is 30.

List one: Recommended electives in operations research

Course	Title	Hours
OPER 627	Optimization II	3
OPER 635	Network Models and Graph Theory	3
OPER/STAT 636	Machine Learning Algorithms	3
OPER 641	Stochastic Simulation and Monte Carlo Methods	3
OPER 645	Queuing Theory	3
OPER 647	Multiobjective Decision Analysis	3
OPER 648	Systems Reliability Analysis	3
OPER 649	Statistical Quality Control	3
OPER 691	Special Topics in Operations Research	1-3
OPER 696	Applied Project	1-3
OPER 697	Directed Research	1-3
OPER 698	Thesis	1-3
OPER 731	Discrete Optimization	3
OPER 732	Optimization Under Uncertainty	3
OPER/STAT 736	Mathematics of Knowledge and Search Engines	3
OPER 741	Advanced Stochastic Simulation	3
OPER 743	Decision Analysis II	3
OPER 791	Special Topics in Operations Research	1-3

List two: Recommended electives in operations research and allied fields

Course	Title	Hours
Any 500-, 600- or 700-level MATH, OPER or STAT course except the following		
MATH 505	Modern Geometry	
MATH 592	Teaching and Communicating Mathematics	
MATH 593	Internship in Mathematical Sciences	
MATH 661	Number and Operations	
MATH 662	Geometry and Measurement	
MATH 663	Functions and Algebra	
MATH 664	Statistics and Probability	
MATH 665	Rational Numbers and Proportional Reasoning	
MATH 667	Functions and Algebra II	
MATH 668	Modeling With Mathematics	
MATH 698	Thesis	
STAT 508	Introduction to Social Statistics	
STAT 543	Statistical Methods I	

STAT 608	Statistics for Social Research
STAT 696	Applied Project
STAT 698	Thesis

Accelerated opportunities

The department offers opportunities for qualified undergraduate students to earn both an undergraduate and graduate degree in a minimum of five years by completing approved graduate courses during the senior year of their undergraduate program. **See the program page in the Undergraduate Bulletin** for details.

Contact

David J. Edwards, Ph.D.
Professor, Department of Statistical Sciences and Operations Research,
and graduate program director
dedwards7@vcu.edu
(804) 828-2936

Additional contact

QiQi Lu, Ph.D.
Graduate admissions
qlu2@vcu.edu
(804) 828-1304

Program website: ssor.vcu.edu (<http://ssor.vcu.edu>)