SYSTEMS MODELING AND ANALYSIS, DOCTOR OF PHILOSOPHY (PH.D.) WITH A CONCENTRATION IN APPLIED MATHEMATICS

Program goal

The Ph.D. in Systems Modeling and Analysis is offered jointly by the Department of Statistical Sciences and Operations Research and the Department of Mathematics and Applied Mathematics. The program focuses on the development of the mathematical and computational skills used to conceptualize and analyze real-world systems. Faculty and students will engage and collaborate to contribute to the knowledge base used in the fields of science, medicine, business and engineering. The continued development of applied mathematics, discrete mathematics, operations research and statistics is critical to scientific advancement in the 21st century. The curriculum enables students to expand the frontiers of knowledge through original, relevant research involving quantitative and qualitative complex systems derived from real, contemporary problems facing our world.

Student learning outcomes

Systems modeling and analysis core outcomes

1. Theory and application of statistics and data science: Students will have a solid foundation in collection, modeling and analysis of data using statistical methods, including determination and application of appropriate procedures.
2. Theory and application of applied mathematics: Students will have a solid foundation in applied mathematics techniques and their use in analysis of biological and related systems.
3. Theory and application of discrete mathematics: Students will have a solid foundation in the theory, techniques, and tools of discrete mathematics as well as their applications.
4. Theory and application of mathematical sciences: Students will have a solid foundation in the theory, techniques and tools of a mathematical sciences subfield, including determination and application of appropriate procedures.
5. Modeling of systems: Students will be able to identify situations in which mathematics or statistics can be applied and model the situation.
6. Use of software used in applications: Students will be able to solve a wide variety of mathematics or statistics problems using the software commonly used in industry.
7. Programming for research: Students will be able to write code using appropriate research programming environments to implement their research ideas.
8. Interpretation of model analysis: Students will be able to interpret analyses from mathematical or statistical models to draw meaningful conclusions about the systems they are studying.
9. Written communication: Students will be able to successfully communicate their research ideas through their writing.
10. Oral communication: Students will be able to successfully communicate their research ideas through presentations.
11. Independent research: Students will be required to participate in research under the guidance of the faculty.

Applied mathematics concentration-specific outcome

1. Additional theory and application of applied mathematics: Students will demonstrate an advanced understand of applied mathematics techniques and their use in analysis of biological and related systems.

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** 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.

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.

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.

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

Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
Ph.D.	Fall	Feb 1	
	Spring	Nov 1	
	Summer	Jul 1	

Note: Assistantships are only available starting in the fall semester. Spring and summer semester admission deadlines are only for students not seeking an assistantship.

In addition to general admission requirements of the VCU Graduate School (https://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements/), the following requirements represent the minimum acceptable standards for admission: have completed an undergraduate degree with at least 30 credit hours of undergraduate-level mathematics, including calculus I and II, multivariate calculus, linear algebra, probability and statistics. Applicants also must have completed at least one upper-level mathematics class that includes mathematical reasoning, such as abstract algebra, combinatorics, graph theory, real analysis or topology. The GRE General exam is optional. Applicants must provide three letters of recommendation, a statement of purpose and a resume/CV.

Degree requirements

In addition to general VCU Graduate School graduation requirements (https://bulletin.vcu.edu/academic-regs/grad/graduation-info/), students are required to complete course work in core and elective courses and to conduct significant research.

1. Credit hour requirements: Students in the systems modeling and analysis Ph.D. program are required to earn a minimum of 57 graduate-level credit hours beyond the baccalaureate. At least one-half of the credit hours presented for graduation must be at the 600 level or higher.
2. Qualifying exam: Students must pass a qualifying exam covering material from each of the first three core courses they take after admission to the program. Two attempts are allowed for each exam. This requirement must be fulfilled by the end of the semester following completion of 18 graduate credit hours. Students are exempt from a qualifying exam if they earned an A in the corresponding core course or if they took an equivalent course at another university, as determined by the Ph.D. steering committee.
3. Doctoral candidacy: Admission to candidacy is made by evaluation of a qualifying portfolio, including exams and project work from courses, research products and statements from faculty advisers and instructors. The portfolio can be submitted after all course work has been completed, as well as any additional preparatory course work required at admission. Students must present their research in a department-sponsored seminar. The candidacy committee will evaluate the student's readiness to begin their dissertation work. Supplementary examination may be required by the committee.
4. Dissertation proposal: After admission to candidacy and the completion of all course work, the student will prepare a written and oral proposal of the intended dissertation research area, including a complete literature review. A successful proposal must be completed at least three months prior to the dissertation defense.
5. Dissertation defense: The student must complete 18 credit hours in SYSM 798 or HUMS 701 resulting in a publishable dissertation and a successful oral defense. The student also must have submitted at least one paper to a refereed academic journal.

Curriculum requirements

Course	Title	Hours
Program core		
MATH 535	Introduction to Dynamical Systems (Program Core)	3
MATH 556	Graph Theory	3
STAT 513	Mathematical Statistics I	3
SYSM 681	Research Exploration	1
Concentration courses		
MATH 507	Bridge to Modern Analysis	3
MATH 515	Numerical Analysis	3
MATH 615	Iterative Numerical Methods	3
or MATH 632	Ordinary Differential Equations I	
or MATH 633	Partial Differential Equations	
or MATH 715	Numerical Solutions for Differential Equations	
MATH 640	Mathematical Biology I	3
or MATH 769	Topics in Applied Mathematics: ____	
or SYSM 780	Stochastic Methods in Mathematical Biology	
Select courses from the applied mathematics electives list below. [1]		6
Research requirements		
SYSM 697	Systems Research [2]	2
SYSM 798	Dissertation Research	18
or HUMS 701	Post-candidacy Doctoral Research	
Electives		
Select 500-, 600- or 700-level MATH, OPER, STAT or SYSM courses with the exception of those in the list below. [1]		9
Total Hours		**57**

1 Students must complete at least six credit hours at the 700-level. Electives will be determined based on a student's research interests and in consultation with their advisers and the graduate program director.

2 Students are required to take SYSM 697 with a faculty adviser before admission to candidacy.

The minimum total of graduate credit hours required for this degree is 57.

Applied mathematics electives

Course	Title	Hours
MATH 610	Advanced Linear Algebra	3
MATH 615	Iterative Numerical Methods	3
MATH 632	Ordinary Differential Equations I	3

MATH 633	Partial Differential Equations	3
MATH 640	Mathematical Biology I	3
MATH 715	Numerical Solutions for Differential Equations	3
MATH 732	Ordinary Differential Equations II	3
MATH 769	Topics in Applied Mathematics: ____	3
SYSM 780	Stochastic Methods in Mathematical Biology	3

Elective exceptions

These courses may not count as electives for this program.

Course	Title	Hours
MATH 505	Modern Geometry	3
MATH 592	Teaching and Communicating Mathematics	1
MATH 593	Internship in Mathematical Sciences	3,6
MATH 661	Number and Operations	3
MATH 662	Geometry and Measurement	3
MATH 663	Functions and Algebra	3
MATH 664	Statistics and Probability	3
MATH 665	Rational Numbers and Proportional Reasoning	3
MATH 667	Functions and Algebra II	3
MATH 668	Modeling With Mathematics	3
MATH 690	Research Seminar	2
MATH 697	Directed Research	1-3
MATH 698	Thesis	1-3
OPER 696	Applied Project	1-3
OPER 697	Directed Research	1-3
OPER 698	Thesis	1-3
STAT 508	Introduction to Social Statistics	3
STAT 543	Statistical Methods I	3
STAT 608	Statistics for Social Research	3
STAT 696	Applied Project	1-3
STAT 697	Directed Research	1-3
STAT 698	Thesis	1-3
SYSM 697	Systems Research	2
SYSM 798	Dissertation Research	1-12

Contact
H. Reed Ogrosky, Ph.D.
Associate professor and Ph.D. program director
hogrosky@vcu.edu (areynolds2@vcu.edu)
Phone: (804) 828-1301

Program website: sysm.vcu.edu (http://sysm.vcu.edu/)