Department of Modeling, Simulation and Visualization Engineering

1300 Engineering and Computational Sciences Building
757-683-3720
www.eng.odu.edu/msve

Frederic (Rick) D. McKenzie, Chair
Yuzhong Shen, Graduate Program Director

Degree Programs:
The department offers the following graduate degrees:

- Ph.D. in Modeling and Simulation
- Doctor of Engineering in Modeling and Simulation
- Master of Science in Modeling and Simulation
- Master of Engineering in Modeling and Simulation
- Graduate Certificate in Modeling and Simulation Engineering

Description of Master’s Degree
The master’s degree in modeling and simulation (M&S) emphasizes a strong, common subject core while providing the student with the flexibility to design a plan of study to meet each individual’s study objectives and needs. The purpose of the program’s subject core is to provide a common academic foundation for all simulation students. Thus, all students in this program will have grounding in the same methods, principles, and philosophy of simulation. This provides the mechanisms for the simulationist to work across disciplines and domains while maintaining a common frame of reference for communication, technical specialization, and advanced study and research. The master’s degree is available as a thesis option (MS) or non-thesis option (ME); both require 30 hours of graduate credit. The Master of Science (MS) in Modeling and Simulation requires six hours of thesis credit and 24 hours of course credit. The Master of Engineering (ME) in Modeling and Simulation requires 30 hours of course credit. The MS program is directed primarily at full-time students who are preparing for a career in advanced M&S research and/or academic positions, while the ME program is focused on developing the practical skills and knowledge needed to solve problems requiring applications of modeling and simulation.

The program’s subject core consists of:

1. an overview of modeling and simulation;
2. an in-depth exploration of specific simulation methodological approaches;
3. simulation system modeling principles and techniques;
4. an introduction to computer visualization and visual simulation; and,
5. principles of stochastic analysis.

Most courses are offered in distance learning format. They are delivered to Old Dominion University’s higher education centers and are available synchronously using video teleconferencing software. Additionally, the MSVE department is offering a Master of Engineering Online program.

A significant resource to the program is the Virginia Modeling, Analysis and Simulation Center (VMASC). The primary purposes of VMASC include the advancement of state-of-the-art modeling and simulation through research and development and the transfer of modeling and simulation technology to industry, education, and government. Constituent interest in this center is shared by numerous industrial partners as well as local Department of Defense organizations.

Master’s Admission Requirements
The Master’s Degree in Modeling and Simulation is designed for students having bachelor’s degrees in Engineering, Science or Mathematics, although students from other educational backgrounds may apply with appropriate leveling courses. Prerequisites for admission include: mathematics – two courses in differential and integral calculus and one course in calculus-based probability and statistics; and computer science – algorithmic problem solving using a high-level object-oriented programming language such as C++.

A minimum GPA of 2.80 overall and a minimum GPA of 3.0 in the undergraduate major are required. Students with notable deficiencies may be considered for provisional admission and will be required to complete prerequisite course requirements in addition to the graduate degree requirements. Job experience and training may be considered in evaluating prerequisite requirements.

Applicants should plan to submit a completed application form, transcripts from all colleges and universities attended, GRE scores (verbal, quantitative, and analytical writing), a resume and personal statement of objectives, two letters of recommendation from former university instructors, and TOEFL scores if an international applicant.

Potential prerequisite courses for the master’s degrees in modeling and simulation include the following:

1. Introductory differential and integral calculus equivalent to MATH 211 (Calculus I) and MATH 212 (Calculus II).
2. Calculus-based probability and statistics; this material is available for graduate credit in ENMA 520, PSYC 727, or PSYC 728.
3. Computer science fundamentals including an object-oriented programming language such as C++, algorithmic problem solving, and data structures.

Master of Science Degree Requirements
The Master of Science program requires 12 hours of course credit in modeling and simulation foundation courses. These foundation courses include:

- MSIM 741 Principles of Visualization 3
- MSIM 551 Analysis for Modeling and Simulation 3
- or MSIM 751 Advanced Analysis for Modeling and Simulation

Advanced Modeling Course Example (see list below)

Advanced Simulation Course Example (see list below)

Advanced Modeling Course Examples (3 credits)

- MSIM 607 Machine Learning I
- MSIM 660 System Architecture and Modeling
- MSIM 702 Methods of Rational Decision Making
- MSIM 730 Simulation Formalisms
- MSIM 772 Modeling Global Events
- MSIM 774 Transportation Network Flow Models

Advanced Simulation Course Examples (3 credits)

- MSIM 711 Finite Element Analysis
- MSIM 722 Cluster Parallel Computing
- MSIM 725 Principles of Combat Modeling and Simulation
- MSIM 742 Synthetic Environments
- MSIM 776 Simulation Modeling in Transportation Networks

Other courses with graduate program director’s approval.

The remaining course credits (12 credits) are elective course credits. These courses are selected to achieve one or more program objectives or themes and must be approved by the student’s advisor and/or graduate program director. Elective courses outside the MSVE Department must be approved by the graduate program director. The program concludes with 6 credit hours of thesis credit (MSIM 699) and a thesis defense.
Certain students will need to take pre-requisite leveling courses that will count towards the 12 credit hour elective course requirement. These courses are: MSIM 510 Model Engineering; MSIM 541 Computer Graphics and Visualization; MSIM 602 Simulation Fundamentals; and, MSIM 603 Simulation Design.

Master of Engineering Degree Requirements
The Master of Engineering program requires completion of 10 three-credit courses; four core courses and six elective courses are required to complete the degree program.

- MSIM 741 Principles of Visualization 3
- MSIM 551 Analysis for Modeling and Simulation 3 or MSIM 751 Advanced Analysis for Modeling and Simulation
- Advanced Modeling Course (see list below) 3
- Advanced Simulation Course (see list below) 3

Advanced Modeling Course Examples (3 credits)
- MSIM 607 Machine Learning I
- MSIM 660 System Architecture and Modeling
- MSIM 702 Methods of Rational Decision Making
- MSIM 730 Simulation Formalisms
- MSIM 772 Modeling Global Events
- MSIM 774 Transportation Network Flow Models

Students must take six electives, 3 credit hours each, in addition to the core courses. Several electives are available covering topics such as system dynamics, social networks, graduate level statistics, and combat modeling. Other courses must be approved by the graduate program director.

Certain students will need to take pre-requisite leveling courses that will count towards the six elective course requirement. These courses are: MSIM 510 Model Engineering; MSIM 541 Computer Graphics and Visualization; MSIM 602 Simulation Fundamentals; and, MSIM 603 Simulation Design.

Master of Engineering Online Program
The MSVE department also offers an ME online degree in Modeling and Simulation via the Blackboard Academic Suite that provides online lectures, homework submissions, examinations, discussion boards, wikis, video/audio collaboration sessions and grading. Students having access to reliable high speed internet service can connect and participate in engaging discussion and distributed asynchronous learning with the instructor and other students. All course materials are distributed and collected electronically. Students located in the Hampton Roads region may utilize live courses to fulfill the elective course requirement with approval from the MSVE graduate program director.

Master of Engineering Online Admission Requirements
Most students in this program would have limited or no knowledge of modeling and simulation before starting the program. Their objective would be to develop knowledge and credentials needed for employment or advancement in a modeling and simulation company or organization. The Master of Engineering degree program offers courses that develop the practical skills and knowledge needed to solve problems requiring the application of modeling and simulation. Applicants are expected to have earned a bachelor’s degree and have successfully taken previous courses in calculus and statistics, and programming skills in C++.

The GPA in the student’s undergraduate major, student’s performance in prerequisite courses, and GRE scores (verbal, quantitative, and analytical) are used to determine eligibility for admission into the program. Job experience and training may also be considered in evaluating prerequisite requirements.

Description of Doctor of Philosophy Degree
The Ph.D. in Modeling and Simulation program focuses on developing the necessary skills and knowledge to enable the graduate to conduct and evaluate independent, original research in an area of modeling and simulation. The goal of the program is to prepare students for careers in teaching and research at academic institutions, as well as the conduct of leadership of research and development in public and private organizations.

Doctor of Philosophy Admission Requirements
Admission to the Ph.D. in M&S program is made in accordance with Old Dominion University and Batten College of Engineering and Technology requirements for doctoral programs as specified in this Catalog. Specific requirements for the modeling and simulation degree include the following:

1. Completion of a master’s degree in an appropriate and closely related field is expected. However, students who have completed 24 credits of graduate courses in an appropriate field from an accredited institution may apply.

2. A minimum GPA in graduate course work of 3.50 (out of 4.0) is required of most students. A student with a GPA greater than 3.25 and with evidence of a high level of professional capability in the field of modeling and simulation may be eligible for admission to the program upon submission of a petition to the graduate program director.

3. Recent scores (typically, not more than five years old) on the Graduate Record Examination’s (GRE) verbal, quantitative, and analytical writing sections must be submitted by all applicants.

4. Three letters of recommendation (typically at least two of which are from faculty in the highest degree program completed when the application is within five years of graduation from that degree program) are required.

5. The applicant must submit a statement of purpose, goals, and objectives related to the program and a resume.

Applicants are expected to have the following foundation knowledge:


2. Computer science fundamentals including an object-oriented programming language such as C++, algorithmic problem solving, and data structures.

3. Knowledge of the content of the foundation courses required in the Modeling and Simulation Master’s Program.

Doctor of Philosophy Degree Requirements
The Ph.D. in modeling and simulation is offered in accordance with the general requirements for doctoral degrees as specified in the Requirements for Graduate Degrees Section of this Catalog. Specific program of study requirements for the concentration in modeling and simulation include the following:

1. Completion of a minimum of 24 credits of course work beyond the master’s degree; and a minimum of 24 credits of dissertation research.

2. Successful completion of a written diagnostic examination before completion of nine credits of advanced course work.

3. Successful completion of a written and oral qualifying (candidacy) examination near the completion of the course work.

4. Successful presentation of a dissertation research proposal at the beginning of the dissertation research.
5. The successful completion and public defense of a dissertation representing independent, original research worthy of publication in a peer-reviewed scholarly journal.

The program of study for the Ph.D. in M&SS program is developed with the approval of the graduate program director and the student’s advisor. The program shall include a minimum of 24 credit hours of course work beyond the master’s degree distributed as follows.

**Common Core**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>Advanced Simulation Course (see the list below)</td>
<td>3</td>
</tr>
<tr>
<td>MSIM 830 Simulation Formalisms</td>
<td>3</td>
</tr>
<tr>
<td>MSIM 842 Synthetic Environments</td>
<td>3</td>
</tr>
<tr>
<td>MSIM 851 Advanced Analysis for Modeling and Simulation</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours** 12

**Advanced Simulation Course Examples (3 credits)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSIM 811 Finite Element Analysis</td>
<td></td>
</tr>
<tr>
<td>MSIM 822 Cluster Parallel Computing</td>
<td></td>
</tr>
<tr>
<td>MSIM 825 Principles of Combat Modeling and Simulation</td>
<td></td>
</tr>
<tr>
<td>MSIM 876 Simulation Modeling in Transportation Networks</td>
<td></td>
</tr>
</tbody>
</table>

Other courses with graduate program director’s approval.

**Electives** - Minimum of 12 credits of elective courses that provide a basis for dissertation research. No more than six credits from course work satisfying foundation knowledge requirements may be included in the program of study for elective credit. At least three-fifths (15 credits) of non-dissertation course work must be at the 800-level. Elective courses outside the MSVE Department must be approved by the graduate program director.

Certain students entering the program will be required to complete additional pre-requisite leveling courses. These courses are: MSIM 510 Model Engineering; MSIM 541 Computer Graphics and Visualization; MSIM 602 Simulation Fundamentals; and, MSIM 603 Simulation Design.

**Description of Doctor of Engineering Degree**

The D. Eng. in Modeling and Simulation program focuses on developing the advanced skills and knowledge to enable the graduate to conduct and lead advanced technical M&S projects in an engineering environment. It affords engineering practitioners the opportunity to achieve advanced graduate education beyond the master’s degree.

**Doctor of Engineering Admission Requirements**

Admission to the D. Eng. Program with a concentration in modeling and simulation is made in accordance with Old Dominion University and Batten College of Engineering and Technology requirements for doctoral programs as specified in this catalog. Specific admission requirements are identical to the admission requirements for the Doctor of Philosophy program with a concentration in modeling and simulation.

**Doctor of Engineering Degree Requirements**

The D. Eng. in modeling and simulation is offered in accordance with the D. Eng. degree requirements as specified for the Batten College of Engineering and Technology in this catalog. Specific program of study requirements for the concentration in modeling and simulation include the following.

1. Completion of a minimum of 18 credits of core professional courses; a minimum of 18 credits of core and elective technical courses; and a minimum of 12 credits of applied doctoral project.
2. Successful completion of a written diagnostic examination before completion of nine credits of advanced course work.
3. Successful completion of a written and oral qualifying (candidacy) examination near the completion of the course work.
4. Successful presentation of a project concept proposal.
5. Successful presentation and public defense of the completed project. The project should be worthy of publication in a peer-reviewed scholarly journal.

The program of study for the D.Eng. in M&S program is developed with the approval of the graduate program director and the student’s advisor. The program shall include a minimum of 18 credits of professional course work and 18 credits of technical core course work beyond the master’s degree distributed as follows:

**Professional Core Courses** 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ENMA 604 Project Management</td>
<td></td>
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<td>ENGN 611 Financial Engineering</td>
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<tr>
<td>ENGN 612 Analysis of Organizational Systems</td>
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<tr>
<td>ENGN 811 Methodologies for Advanced Engineering Projects</td>
<td></td>
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<tr>
<td>ENGN 812 Engineering Leadership</td>
<td></td>
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<tr>
<td>ENGN 813 Engineering Ethics</td>
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</tbody>
</table>

**Technical Core Courses** 18

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Simulation Course from the list below</td>
<td></td>
</tr>
<tr>
<td>MSIM 830 Simulation Formalisms</td>
<td></td>
</tr>
<tr>
<td>MSIM 842 Synthetic Environments</td>
<td></td>
</tr>
<tr>
<td>MSIM 851 Advanced Analysis for Modeling and Simulation</td>
<td></td>
</tr>
</tbody>
</table>

Two approved technical elective courses - 6 credits

**Total Hours** 36

**Advanced Simulation Course Examples (3 credits)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSIM 811 Finite Element Analysis</td>
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<td></td>
</tr>
<tr>
<td>MSIM 876 Simulation Modeling in Transportation Networks</td>
<td></td>
</tr>
</tbody>
</table>

Other courses with graduate program director’s approval.

No more than three credits from course work satisfying foundation knowledge requirements may be included in the program of study for technical elective credit. At least three-fifths of the non-project coursework must be at the 800-level.

Certain students entering the program will be required to complete additional pre-requisite leveling courses. These courses are: MSIM 510 Model Engineering; MSIM 541 Computer Graphics and Visualization; MSIM 602 Simulation Fundamentals; and, MSIM 603 Simulation Design.

**Graduate Certificate in Modeling and Simulation Engineering**

The Graduate Certificate in Modeling and Simulation Engineering is designed for those who meet the admission requirements of the modeling and simulation master’s program and wish to broaden their knowledge of modeling and simulation related principles and practices without pursuing a graduate degree. This is a 12 credit hour non-degree program offered by the Department of Modeling Simulation and Visualization Engineering. The certificate program is open to both degree-seeking and non-degree-seeking graduate students. Certain courses taken for the certificate program may later be applied to the master’s degree in modeling and simulation.

**Graduate Certificate Admission Requirements**

Students should have either an undergraduate degree from a regionally accredited institution and should have a mathematical background through calculus, along with a calculus based probability and statistics course. Students should submit a graduate non-degree application through the Office of Admissions, and then submit a departmental application with copies of unofficial transcripts from all previous coursework to the MSVE Department of Modeling and Simulation Engineering.

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Department. Departmental applications are available online on the MSVE Department’s website – http://eng.odu.edu/msve - and should be sent to:

Academic Advisor and Program Manager
MSVE Department
Old Dominion University
1300 Engineering and Computational Sciences Building
Norfolk, VA 23529

Graduate Certificate Requirements

The Graduate Certificate in Modeling and Simulation Engineering requires the completion of 12 credit hours at the graduate level. The course requirements are:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSIM 601</td>
<td>Introduction to Modeling and Simulation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(required of all students)</td>
<td></td>
</tr>
<tr>
<td>MSIM 602</td>
<td>Simulation Fundamentals</td>
<td>3</td>
</tr>
<tr>
<td>One course from the following below:</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MSIM 510</td>
<td>Model Engineering</td>
<td></td>
</tr>
<tr>
<td>MSIM 541</td>
<td>Computer Graphics and Visualization</td>
<td></td>
</tr>
<tr>
<td>MSIM 551</td>
<td>Analysis for Modeling and Simulation</td>
<td></td>
</tr>
<tr>
<td>MSIM 603</td>
<td>Simulation Design</td>
<td></td>
</tr>
<tr>
<td>MSIM ELE - MSIM Elective *</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours 12

* A graduate level elective approved by the graduate program director. This elective may be an MSIM course or from another discipline outside of modeling and simulation. It is possible that this course may be outside the discipline of modeling and simulation, but approved because it complements the field of M&S and the student’s interests.

An overall GPA of 3.00 or better is required to earn the graduate certificate in modeling and simulation engineering.