Modeling and Simulation, Ph.D.

**Program Coordinator:** Mikel D. Petty, Director, Center for Modeling Simulation and Analysis

Technology Hall N300G  
301 Sparkman Drive, Huntsville, AL 35899  
Ph: 256.824.4368

**Degree**  
Doctor of Philosophy

**Mission**  
The Modeling and Simulation (M&S) Graduate Program is an interdisciplinary program of the University of Alabama in Huntsville committed to research in and advancement of this rapidly expanding field. The program's focus is on graduate level education leading to the Master of Science and Doctor of Philosophy degrees.

M&S has become increasingly important in the modern technological world, with nearly all aspects of engineering and the physical sciences making use of, or depending on, M&S. Additionally, use of M&S has steadily increased in economics, politics, and the social sciences. M&S is not a singular area of study but has rather emerged as a distinct, cross-cutting, inter-disciplinary academic discipline. As an inter-disciplinary program, the majority of the courses associated with the M&S degree program will come from existing University of Alabama in Huntsville programs. Students seeking M&S degrees will primarily be taking courses offered by the Industrial and Systems Engineering and Engineering Management, Computer Science, Physics, Mathematics, and Psychology departments.

The objectives of the M&S degree programs are to prepare graduates to make significant contributions in:

1. M&S practitioner positions in industrial and government organizations.
2. Research staff positions in industry, government, and research laboratories focused on M&S.
3. Teaching and research careers at academic institutions.
4. Expanding the university’s research activities in M&S.

**Distance Learning**  
Courses in both the Master of Science and Doctor of Philosophy programs in Modeling & Simulation are available as part of the UAH Distance Learning (DL) program. The UAH DL program provides course access over high speed internet or via mailed CDs. All registered DL students are welcome to attend the live class when possible.

**Doctor of Philosophy in Modeling and Simulation**  
The Doctor of Philosophy Degree Program in Modeling and Simulation 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 or leadership of research and development in public and private organizations.

**Admission Requirements**  
1. Admission to the Ph.D. Program in Modeling and Simulation (M&S) is granted in accordance with University of Alabama in Huntsville requirements for doctoral programs, as specified in the Graduate Catalog. Specific additional requirements for the Modeling and Simulation Program include the following:
   a. Completion of a
      i. Bachelor's degree in computer science, engineering, mathematics, or the physical or life sciences or
      ii. Master's degree in computer science, engineering, mathematics, or the physical or life sciences.  
         Applicants with other than the above degrees may still be admitted and may be required to complete additional coursework as determined by the admissions committee.
   b. A minimum grade-point-average of 3.5/4.0. A student having a graduate coursework grade-point-average, greater than 3.3/4.0 and with evidence of a high level of professional capability may be eligible for admission upon submission of a petition to the graduate program coordinator.
   c. A minimum total score of 1000 on the verbal plus quantitative portions of the Graduate Record Examination (GRE) and a minimum score of 3.0 on the analytical writing portion.
2. Applicants are expected to have the following foundation knowledge for admission to the Ph.D. Program in M&S:
   a. Mathematics fundamentals including differential and integral calculus, probability and statistics, and elementary differential equations.
   b. Computer Science fundamentals including the algorithmic approach to problem solving, proficiency in an object-oriented programming language such as C++ or Java, and familiarity with standard data structures.

Students who do not meet the above requirements may petition the School of Graduate Studies and the Program Coordinator for conditional admission.

Degree Requirements
A minimum of 54 semester hours of graduate courses and 18 semester hours of dissertation research are required for the Ph.D. degree in M&S, and must be included in the student's Program of Study. Transfer credit from a master's degree program is subject to approval by the admissions committee and the School of Graduate Studies. The Program of Study must be formally approved by the graduate dean, the graduate program coordinator and the student's dissertation supervisory committee.

Preliminary Examination
The Preliminary Exam is used to assess the student's ability to pursue the Ph.D. in M&S. Students should plan on taking the exam when they have completed the M&S prerequisite foundation courses, and before completing 9 semester hours of doctoral courses. Successful completion of six of the following seven exam topic areas is required: M&S fundamentals; discrete event simulation; probability and statistics; computer graphics; artificial intelligence; systems engineering; and software engineering. This exam may only be repeated once.

Qualifying Examination and Dissertation
The Qualifying Exam is designed to assess the student's preparation to successfully conduct dissertation research. It is normally taken at the completion of the course work in the Program of Study, and is conducted in two distinct stages. The first stage is a demonstration, through written and oral examination, that the student is proficient in the subject matter in the Program of Study. This stage may be attempted no more than twice and must be passed before progressing to the second stage. The second stage of the Qualifying Exam is the dissertation proposal, where the student prepares a written report and makes a subsequent oral presentation describing the proposed dissertation research. Both the dissertation topic and the expected approach to the problem solution must be clearly delineated to the committee's satisfaction in order for a pass to be granted. The dissertation proposal may be attempted no more than twice. Upon completion and approval of the dissertation by the supervisory committee, the student must present and defend it in a public forum. The qualifying exam must be successfully completed in order to be admitted to candidacy.

Ph.D. Residency Requirements
According to The School of Graduate Studies policy, residency may be established by

1. being enrolled as a full-time student (at least 9 graduate semester hours) either for one continuous academic year, or for Spring and Fall semesters in the same calendar year, or
2. being enrolled in at least 6 semester hours of graduate course work in at least three of four consecutive semesters.

Other Requirements for the Ph.D. Degree
The program must be completed within five years after admission to candidacy. MOD 799 is required each semester a student is receiving direction on the doctoral dissertation.

Core M&S Courses

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<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MOD 501</td>
<td>SVY MODELING &amp; SIMULATION</td>
<td>3</td>
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<tr>
<td>CS 545</td>
<td>INTRO COMPUTER GRAPHICS</td>
<td>3</td>
</tr>
<tr>
<td>ISE 547</td>
<td>INTRO TO SYSTEMS SIMULATION</td>
<td>3</td>
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<tr>
<td>MA 565</td>
<td>INTERM MATH MODELING</td>
<td>3</td>
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<tr>
<td>ISE 627</td>
<td>ENGINEERING SYSTEMS</td>
<td>3</td>
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<tr>
<td>CS 630</td>
<td>ARTIFICIAL INTELLIGENCE I</td>
<td>3</td>
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<tr>
<td>ISE 690</td>
<td>STATISTICAL METHODS FOR ENGR</td>
<td>3</td>
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Required Doctoral Core Courses M&S

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<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>CS 582</td>
<td>MODELING &amp; SIMULATION II</td>
<td>3</td>
</tr>
<tr>
<td>ISE 647</td>
<td>ADVANCED SYSTEM SIMULATION</td>
<td>3</td>
</tr>
<tr>
<td>CS 548</td>
<td>HUMAN-COMPUTER INTERACTION</td>
<td>3</td>
</tr>
<tr>
<td>or CS 546</td>
<td>COMPUTER GRAPHICS</td>
<td>3</td>
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<tr>
<td>ISE 637</td>
<td>SYSTEMS MODELING &amp; ANALYSIS</td>
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<tr>
<td>ISE 726</td>
<td>SYSTEMS MODELING</td>
</tr>
<tr>
<td>CS 655</td>
<td>FORMAL METHODS IN SOFTWARE ENG</td>
</tr>
<tr>
<td>ISE 734</td>
<td>DECISION ANALYSIS</td>
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<tr>
<td>or ISE 790</td>
<td>ADV STATISTICAL APPLICATIONS</td>
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**Elective Doctoral Courses**

Select a minimum of 15 semester hours of elective graduate courses  

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<th>Course Code</th>
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<td>MOD 799</td>
<td>DOCTORAL DISSERTATION</td>
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**Dissertation**

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<th>Course Title</th>
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<tr>
<td>MOD 799</td>
<td>DOCTORAL DISSERTATION</td>
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**Total Semester Hours**

72

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Students with approved transfer courses or documented proficiency in above areas may substitute elective courses.

These courses are selected to expand the background knowledge for the dissertation research and must be formally approved by the graduate program coordinator.

**Graduate Courses in Modeling and Simulation (MOD)**

Due to its interdisciplinary nature, nearly all of the courses that make up the M&S program are offered through various departments at the university. The list of M&S specific courses follows.

**MOD 501 - SVY MODELING & SIMULATION**

Semester Hours: 3

Broad-based introductory survey of Modeling & Simulation intended to provide an overview that exposes entering Modeling & Simulation students to a full range of teh discipline. Surveyed items include indentification, categorization and comparison of modeling methods, applications, architectures, and environments. Appropriate applications for different simulation paradigms and relative advantages and disadvantages of each. Model testing and validation approaches, distributed simulated, graphics and visualization, and other topics are introduced. Case studies of Modeling & Simulation applications.

**MOD 591 - M & S INTEGRATED PRODUCT DEV**

Semester Hours: 3

Introduction to the development of models and simulation in support of Integrated Product Team (IPT) projects. Development and use of models within the context of engineering projects and the systems engineering process. Topics address phases from model requirements through model verification. Offered and taught concurrently with MAE 491 Mechanical Engineering Design.

**MOD 595 - INDEPENDENT STUDY**

Semester Hours: 3

Individual directed study under the supervision of an instructor. Prerequisites: Approval of Instructor.

**MOD 596 - SELECTED TOPICS M & S**

Semester Hours: 3

Course offered by an instructor in a specialized are of Modeling and Simulation. Prerequisites: Approval of Instructor.

**MOD 620 - M & S TEST & EVALUATION**

Semester Hours: 3

Use of modeling and simulation as a complement to physical testing during systems evaluation. Opportunities for simulation throughout the acquisition life-cycle, including test planning, test execution, and systems analysis, are described, characterized, and illustrated through case studies. Strategies to optimize the use of scarce resources in executing test and evaluation programs are explored. Prerequisites: MOD 501.

**MOD 695 - INDEPENDENT STUDY**

Semester Hours: 3

Individual directed study under the supervision of an instructor: Prerequisites: Approval of Instructor.
MOD 696 - SELECTED TOPICS M & S  
Semester Hours: 3  
Course offered by an instructor in a specialized area of modeling and simulation. Prerequisites: Approval of Instructor.

MOD 699 - MASTER'S THESIS  
Semester Hours: 3-6  
Required each semester student is working and receiving direction on master's thesis. Prerequisites: Approval of Instructor.

MOD 795 - INDEPENDENT STUDY  
Semester Hours: 3  
Individual directed study under the supervision of an instructor. Prerequisites: Approval of Instructor.

MOD 796 - SELECTED TOPICS M & S  
Semester Hours: 3  
Course offered by an instructor in a specialized area of modeling and simulation. Prerequisite: Approval of Instructor.

MOD 799 - DOCTORAL DISSERTATION  
Semester Hours: 3-9  
Required each semester student is working and receiving direction on doctoral dissertation. Prerequisites: Approval of Instructor.