MODELING AND SIMULATION Courses

MSIM 506. Introduction to Distributed Simulation. 3 Credits.
Lecture, 3 hours. 3 credits. An introduction to distributed simulation. Topics include motivation for using distributed simulation, distributed simulation architectures, time management issues, and distributed simulation approaches. Current standards for distributed simulation are presented.

MSIM 595. Topics in Modeling and Simulation. 3 Credits.
3 hours lecture; 3 credits. Special topics of interest with emphasis placed on recent developments in modeling and simulation engineering.

MSIM 601. Introduction to Modeling and Simulation. 3 Credits.
Lecture 3 hours; 3 credits. First course for modeling and simulation graduate students. Modeling and simulation discipline surveyed at an overview level of detail. Definitions, paradigms, applications, and sub-disciplines are introduced. Orient students to Modeling and Simulation Graduate Program, and provides a general conceptual framework for further modeling and simulation studies.

MSIM 603. Discrete Event Simulation. 3 Credits.
Lecture, 3 hours; 3 credits. Prerequisite: undergraduate course in probability and statistics; computer literacy. An introduction to the fundamentals of discrete event simulation (DES). Topics include discrete event simulation methodology, development of simulation models, simulation verification and validation, and the design of simulation experiments. Important statistical concepts, including selection of input probability distribution and output data analysis are developed and applied. A DES tool will be used to create, simulate and analyze self-defined projects.

MSIM 605. Engineering Systems Modeling. 3 Credits.
Lecture 3 hours; 3 credits. Prerequisites: differential equations and one course on probability and statistics. An overview of various modeling approaches and methods representing both continuous and discrete event systems. Course addresses topics such as concept graphs, Bayesian nets, Markov models, Petri nets, system dynamics, bond graphs, cellular automata, and L systems. The Unified Modeling Language is introduced as a means of communicating system descriptions. A student project is required. (Cross listed with ECE 605).

MSIM 607. Machine Learning I. 3 Credits.
Lecture 3 hours; 3 credits. Course provides a practical treatment of design, analysis, implementation and applications of algorithms. Topics include multiple learning models: linear models, neural networks, support vector machines, instance-based learning, Bayesian learning, genetic algorithms, ensemble learning, reinforcement learning, unsupervised learning, etc. (cross listed with ECE 607).

MSIM 608. Introduction to Game Development. 3 Credits.
Lecture 3 hours; 3 credits. Introduction to Game Development is an introductory course focused on game development theory and practices using Microsoft XNA Game Studio with emphasis on educational game development. Topics covered in this course include game architecture, computer graphics theory, user interaction, audio, high level shading language, animation, physics and artificial intelligence.

MSIM 611. Modeling and Simulation Fundamentals I. 3 Credits.
Lecture 3 hours; 3 credits. Prerequisites: MATH 102M or MATH 162M or equivalent; CS 101D or equivalent; and graduate standing. Introduction to the discipline of modeling and simulation for students not in engineering or sciences. Topics include: basic terminology and concepts; M&S paradigms including Monte Carlo, continuous, and discreet event simulation; and important concepts from supporting disciplines including probability and statistics, systems modeling, analysis and operations research, and computer visualization.

MSIM 612. Modeling and Simulation Fundamentals II. 3 Credits.
Lecture 3 hours; 3 credits. Prerequisites: MSIM 611. Topics include: concepts from supporting disciplines including human factors and project management; M&S methodologies including modeling approaches, verification and validation, distributed simulation, and interoperability and integration. Overview of M&S applications in engineering, science, education, health science, business, and arts & letters.

MSIM 635. Modeling in Musculoskeletal Biomechanics. 3 Credits.

**MSIM 641. Visualization I. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisites: [CS 150](#) or equivalent. A course examining the theories and techniques of computer graphics and visualization for various modeling and simulation applications. Computer graphics fundamentals, including mathematical foundations, rendering pipeline, geometrical transformations, 3D viewing and projections, lighting and shading, texture mapping, and curves and surfaces are explored. Course covers 3D graphics programming in detail and several commonly used visualization software packages. Specific visualization areas, such as scientific visualization, terrain visualization, and mobile visualization, are also discussed.

**MSIM 651. Analysis I. 3 Credits.**

Lecture 3 hours; 3 credits. An introduction to mathematical and statistical analysis techniques required for the conduct of modeling and simulation studies. Topics include random number generation, input data modeling, measures of effectiveness, output data analysis, variance reduction techniques, and experimental design. Methods for verification and validation are introduced. Course concepts are applied to real systems and data.

**MSIM 660. System Architecture and Modeling. 3 Credits.**

Lecture 3 hours; 3 credits. Students will learn the essential aspects of the system architecture paradigm through environment and analysis of multiple architecture framework and enterprise engineering, such as IDEF0, TOGAF, DODAF and OPM. Emphasis on system modeling and enterprise engineering. (Cross listed with ENMA 660).

**MSIM 667. Cooperative Education. 1-3 Credits.**

1-3 credits. Available for pass/fail grading only. Student participation for credit based on academic relevance of the work experience, criteria, and evaluation procedures as formally determined by the program and the Cooperative Education/Career Management program prior to the semester in which the work experience is to take place.

**MSIM 669. Practicum. 1-3 Credits.**

1-3 credits. Academic requirements will be established by the graduate program director and will vary with the amount of credit desired. Allows students an opportunity to gain short-duration career related experience. Student is usually employed--this is an additional project beyond the duties of the student's employment.

**MSIM 695. Topics in Modeling and Simulation. 3 Credits.**

Lecture 3 hours; 3 credits. Special topics of interest with emphasis placed on recent developments in modeling and simulation.

**MSIM 697. Independent Study in Modeling and Simulation. 3 Credits.**

3 credits. Prerequisite: permission of instructor or graduate program director. Individual study selected by the student. Supervised and approved by a faculty member with the approval of the graduate program director.

**MSIM 699. Thesis. 1-6 Credits.**

1-6 credits. Prerequisite: permission of instructor and graduate program director. Research leading to the Master of Science thesis.

**MSIM 702. Methods of Rational Decision Making. 3 Credits.**

Lecture 3 hours; 3 credits. Covers advanced methods in Operation Research and Optimization. Focus will be on developing models and their application in different domains including manufacturing and services. (Cross listed with ENMA 702/802).

**MSIM 711. Finite Element Analysis. 3 Credits.**

Lecture, 3 hours; 3 credits. Prerequisite: permission of the instructor. The purpose of the course is to provide an understanding of the finite element method (FEM) as derived from an integral formulation perspective. The course will demonstrate the solutions of (1-D and 2-D) continuum mechanics problems such as solid mechanics, fluid mechanics and heat transfer.

**MSIM 720. Foundations for Continuous and Real-Time Simulation. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisites: calculus-based physics and ordinary differential equations. Introduction to the fundamentals of modeling and simulating continuous-state, time-driven systems. Topics include use of physics laws to...
develop differential equation representation of systems and formulation of input/output and state variable equations for systems. Linearization, numerical integration, and techniques for computer based solutions of differential equations are covered. Application domains include mechanical, rotational, electrical, hydraulic, and thermal systems.

**MSIM 722. Cluster Parallel Computing. 3 Credits.**

Lecture, 3 hours; 3 credits. This course provides detailed numerical step-by-step procedures to exploit parallel and sparse computation under MPI (Message, Passing, Interface) computer environments. Large-scale engineering/science applications are emphasized. Simultaneous linear equations are discussed.

**MSIM 725. Principles of Combat Modeling and Simulation. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisites: **MSIM 601** and **MSIM 603**. Principles of combat modeling and simulation. Introduction including history, basic definitions, and best practice. Algorithms for modeling movement, sensing effects and behavior. Overview of modern combat models. Interoperability and integration into operational environments.

**MSIM 730. Simulation Formalisms. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisite: **MSIM 601** or equivalent. The focus of the course is on identification and investigation of mathematical and logical structures that form the foundation for computational simulation. Topics include: foundations of simulation theory in logic, discrete mathematics, and computability; simulation formalisms, including DEVS; interoperability protocols; and computational complexity.

**MSIM 742. Visualization II. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisite: **MSIM 641** or permission of instructor. Course discusses a variety of topics in advanced visualization theory and applications. Topics included visualization, level of detail techniques, animation, terrain visualization, flow and ocean visualization, and cal imaging and visualization.

**MSIM 752. Analysis II. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisite: **MSIM 603** or equivalent. This course will expand the student’s capabilities in areas of stochastic analysis and data analysis. Course will include the theoretical underpinnings of stochastic processes commonly encountered in the application of operations research, and it will examine the literature of applied stochastic methods.

**MSIM 763. Distributed Simulation. 3 Credits.**

Lecture, 3 hours. 3 credits. An introduction to parallel and distributed simulation. Topics include motivation for using distributed simulation, computing models for distributed simulation, causality and time advance issues, and strategies for implementing distributed simulations. Current standards for distributed simulation are presented. Course is only open to students admitted to the online ME program in modeling and simulation.

**MSIM 772. Modeling Global Events. 3 Credits.**

Lecture 3 hours; 3 credits. Modeling Global Events introduces modeling and simulation as a tool for expanding our understanding of events that have shaped the global environment of the 21st century. Students will review real-world case studies and then analyze these case studies via system dynamics, agent-based, social network, and game theory modeling paradigms. This course is designed to develop empirical research skills, conceptual modeling expertise, and model construction. Students will understand how to analyze, verify, and validate a model.

**MSIM 774. Transportation Network Equilibrium. 3 Credits.**

Lecture, 3 hours: 3 credits. This course provides a rigorous introduction to transportation network modeling, with special emphasis on network equilibrium problems. Topics include: elementary graph theory, shortest path problem nonlinear optimization, optimization of univariate functions, deterministic and stochastic user equilibrium.

**MSIM 776. Simulation Modeling in Transportation Networks. 3 Credits.**

Lecture 3 hours; 3 credits. Principles of simulation modeling, microscopic, mesoscopic, and macroscopic traffic simulation models. Course explores diver behavior in networks, calibration and validation of traffic simulation models, and use of traffic simulation software.

**MSIM 781. Imaging Technologies for Homeland Security. 3 Credits.**

Lecture 3 hours; 3 credits. Prerequisites: Calculus and Linear Algebra. This course introduces the fundamentals of various imaging technologies that are used in Homeland Security applications, including Visible, Infrared, Ultrasound, X-ray, and Terahertz. Models for the different technologies will be discussed vis-à-vis their application to homeland security. Visible imagery will be examined in detail for reconnaissance and surveillance. Joint use of data for image and information fusion or security applications will also be examined. (Cross listed with ECE 781).
MSIM 795. Topics in Modeling and Simulation. 3 Credits.
Lecture 3 hours; 3 credits. Special topics of interest with emphasis placed on recent developments in modeling and simulation.

MSIM 797. Independent Study in Modeling and Simulation. 3 Credits.
3 credits. Prerequisite: permission of instructor or graduate program director. Individual study selected by the student. Supervised and approved by a faculty member with the approval of the graduate program director.

MSIM 802. Methods of Rational Decision Making. 3 Credits.
Lecture 3 hours; 3 credits. Covers advanced methods in Operation Research and Optimization. Focus will be on developing models and their application in different domains including manufacturing and services. (Cross listed with ENMA 702/802).

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Lecture 3 hours; 3 credits. Principles of simulation modeling, microscopic, mesoscopic, and macroscopic traffic simulation models. Course explores diver behavior in networks, calibration and validation of traffic simulation models, and use of traffic simulation software.

MSIM 892. Doctor of Engineering Project. 1-9 Credits.
1-9 credits. Directed individual study applying advanced level technical knowledge to identify, formulate and solve a complex, novel problem in Modeling and Simulation.

MSIM 895. Topics in Modeling and Simulation. 3 Credits.
Lecture 3 hours; 3 credits. Special topics of interest with emphasis placed on recent developments in modeling and simulation.

MSIM 897. Independent Study in Modeling and Simulation. 1-3 Credits.
3 credits. Prerequisite: permission of instructor or graduate program director. Individual study selected by the student. Supervised and approved by a faculty member with the approval of the graduate program director.

MSIM 898. Research in Modeling and Simulation. 1-12 Credits.
1-12 credits. Prerequisite: permission of instructor and graduate program director. Supervised research prior to passing Ph.D. candidacy exam.

MSIM 899. Research in Modeling and Simulation. 1-12 Credits.
1-12 credits. Prerequisite: permission of instructor and graduate program director. Directed research for the doctoral dissertation.

MSIM 999. Modeling and Simulation 999. 1 Credit.
1 credit. A one-hour pass/fail registration required of all graduate students to maintain active status during the final semester prior to graduation. After successfully achieving "candidate" status, all doctoral students are required to be registered for at least one graduate credit each term until the degree is complete.