Systems Engineering (SE)

cse.uconn.edu

5000. Introduction to Systems Engineering

Three credits.

Introduction to the hard and soft skills that are required of good systems engineers. Lectures follow the competency models for systems engineers and include topics such as systems thinking, needs identification, requirements formulation, architecture definition, technical management, design integration, as well as verification and validation of designs. Some of the key systems engineering (SE) standards will be covered and the roles of organizations in enabling engineers to develop systems will be explored. Applications of SE concepts and tools in various settings will be discussed through examples and case studies. Students will learn to apply the SE methodologies in modern complex system development environments such as aerospace and defense, transportation, energy, communications, and modern software-intensive systems.

5001. Model-Based Systems Engineering

Three credits. Prerequisite: Undergraduate degree in engineering or science.

Provides students with the foundations of model-based systems engineering. Students will develop skills in the areas of fundamental logical, behavioral, and physical representations of engineered cyberphysical systems. Topics include software and systems requirements engineering, interface design and modeling, system architecting, system verification and testing, and system simulation. Emphasis is placed on modeling cyberphysical systems using modern MBSE principles, methods, and tools. Examples include a water distiller, a residential security system, an automobile, an elevator, and a geospatial library for the demonstration of the theoretical and practical aspects of systems modeling. Designed for all graduate students pursuing graduate certificates and degrees in an engineering discipline.

5095. Special Topics

Variable (1-3) credits. May be repeated for credit.

General topics in systems engineering.

5101. Foundations of Physical Systems Modeling

Three credits. Recommended preparation: undergraduate degree in Mechanical Engineering, Chemical Engineering, and Modelica Software.

Provides students with the foundations of physical systems modeling and computational methods for performance analysis. Students will develop skills in the areas of fundamental physical and mathematical representations of fluid dynamics, thermodynamics, heat transfer, and electro-mechanics. Introduction to concepts on how systems can be architected and designed with the aid of models. Topics include system and component requirements specification, creation of system models for design and control analysis of physical systems. Emphasis is placed on the modeling of such systems in the equation oriented programming environment of the Modelica language, and the utilization of these system models within the Functional Mockup Interface for co-simulation and Model Exchange. Examples of Aircraft Environmental Control, Chiller Systems and Plants, Engine Fuel Systems, Variable Frequency Drives and Electric Machines are used for the demonstration of the theoretical and modeling aspects of physical system modeling.

5102. Uncertainty Analysis, Robust Design, and Optimization

Three credits. Prerequisite: SE 5101.

Provides students with a thorough understanding of platform-based and model-driven methods for uncertainty analysis and robust design of cyber-physical systems. Topics include modeling of uncertainties, sensitivity analysis, robust design analysis methodologies (DFSS, IDOV), and critical parameter management (CPM).

5201. Embedded/Networked Systems Modeling Abstractions

Three credits. Recommended preparation: background in hardware and/or software design.

Familiarizes students with design flows for designing, implementing and verifying embedded systems, and to provide skills necessary to specify requirements and perform platform-based design, analysis and modeling of embedded and networked systems. These models will be motivated by applications which demonstrate embedded systems design challenges of satisfying time-critical, event-driven, and data-centric requirements. Students will be cognizant of the role of embedded controllers and devices in the system design process, as they relate to event-driven and data-driven systems, and supervisory control of hybrid (continuous and discrete-time) systems. This will include exposure to platform-based design principles with an emphasis on requirements capture and refinement to platform architecture mapping, analysis and verification. Students will learn the technical aspects of modeling principles relevant to embedded systems, specifically modeling system architecture, system functions, computation, software, real-time systems, and distributed systems.

5202. Foundations of Control

Three credits. Prerequisite: SE 5101. Recommended preparation: undergraduate course in systems analysis.

Familiarizes students with system design flows used for designing, implementing and verifying control systems and to provide skills necessary to design and analyze practical regulatory controllers for Cyber-Physical systems. Successful students will be cognizant of the role of controls in the system design process and will be proficient in specifying control system requirements, especially as they relate to attenuation of load disturbances, robustness to dynamic system model uncertainty, actuator nonlinearities, and measurement noise; knowledgeable of the distinctions between modeling systems for control and understanding the fundamental limits of regulatory control systems; knowledgeable of the role of control architectures for regulatory controllers, including sensor selection and sizing of actuators; aware of practical control design methods focusing on PID controllers; controller implementation, validation, testing, diagnostics and tuning. Use of computer-aided engineering tools (Dymola, MATLAB/Simulink) in the design flows for control of cyber-physical systems is emphasized.

5302. Formal Methods

Three credits. Prerequisite: SE 5301.

Introduction to formal methods as a framework for the specification, design, and verification of software-intensive embedded systems. Topics include automata theory, model checking, theorem proving, and system specification. Examples are driven by cyber-physical systems.

5402. Architecture of IoT

Three credits. Prerequisite: SE 5001 or 5101 or 5102.

Provides students with a thorough understanding of the design, verification, and validation of embedded/network systems and software-intensive systems. The student will develop skills in specifying requirements for embedded software systems, model based architecture and design, and verification and validation of embedded systems. Special emphasis will be placed on distributed embedded systems and real-time systems. The platform-based design (PBD) flow will be used as the common thread through the course. Examples are driven by cyber-physical systems.

5502. Capstone Projects for Systems Engineering

Three credits. Prerequisite: SE 5001 or 5101 or 5102.

This project course is designed to provide students with a thorough understanding of cyber-physical systems modeling and design through a comprehensive capstone project. These projects will be practical and relevant to industry needs. Students submit a Project Proposal before registering for the course, and develop the proposal with feedback from a faculty member. The graduate student is expected to spend the same amount of time for the project course as any other graduate three-credit course in systems engineering.

5702. Data Science for Materials and Manufacturing

(Also offered as ME 5702.) Three credits. Prerequisite: Undergraduate degree in engineering or computer science, departmental or unit consent required. Recommended preparation: knowledge or coursework in probability and statistics.

This course will provide students with data analytics skills for knowledge discovery and product design optimization. The students will also learn how to apply data mining and machine learning techniques to tackle the challenges in manufacturing and computational materials engineering. Topics include uncertainty quantification, design of experiment and data collection, data visualization, gradient/non-gradient-based optimization, supervised/unsupervised learning methods, and applications of data analytics in manufacturing and computational materials engineering problems.