MS IN SYSTEMS & CONTROL ENGINEERING
Online Curriculum

To complete the online program in two years, students typically take two courses per semester, each lasting 14 weeks. There are four core classes and five technical electives that may be chosen from the list below.

The curriculum is organized as follows:

CORE COURSES

EECS 401: Digital Signal Processing

Characterization of discrete-time signals and systems. Fourier analysis: the Discrete-time Fourier Transform, the Discrete-time Fourier series, the Discrete Fourier Transform and the Fast Fourier Transform. Continuous-time signal sampling and signal reconstruction. Digital filter design: infinite impulse response filters, finite impulse response filters, filter realization and quantization effects. Random signals: discrete correlation sequences and power density spectra, response of linear systems. Recommended preparation: undergraduate signals and systems course or EECS 313.

EECS 407: Engineering Economics & Financial Analysis

Engineering economics provides a set of tools to aid in deciding which course of economic action is most desirable to take in an engineering project. In this course, money and profit are the critical measures of performance in engineering design. Topics: Introduction to capital allocation problems; The time value of money; Application of economic equivalence to engineering design problems; Economic criteria for comparing projects; Depreciation and taxation; Retirement and replacement; Effects of inflation and escalation on economic evaluations; Use of optimization methods to evaluate many alternatives; Decision Analysis: the effect of risk and attitudes; and Accounting fundamentals: income and balance sheets.

EECS 408: Introduction to Linear Systems

Analysis and design of linear feedback systems using state-space techniques. Review of matrix theory, linearization, transition maps and variations of constants formula, structural properties of state-space models, controllability and observability, realization theory, pole assignment and stabilization, linear quadratic regulator problems, observers, and the separation theorem. Recommended preparation: undergraduate control course or EECS 304.

EECS 416: Convex Optimization for Engineering

This course will focus on the development of a working knowledge and skills to recognize, formulate and solve convex optimization problems that are so prevalent in engineering. Applications in control systems; parameter and state estimation; signal processing; communications and networks; circuit design; data modeling and analysis; data mining including clustering and classification; and combinatorial and global optimization will be highlighted. New reliable and efficient methods, particularly those based on interior-point methods and other special methods to solve convex optimization problems will be emphasized. Implementation issues will also be underscored.
Recommended preparation: discrete math (MATH 201 or equivalent).

TECHNICAL ELECTIVES

EECS 404: Digital Control Systems

Data acquisition (theory and practice), digital control of sampled data systems, stability tests, system simulation digital filter structure, finite word length effects, limit cycles, state-variable feedback and state estimation. Design.
Recommended preparation: undergraduate control course.

EECS 411: Applied Engineering Statistics

This course deals with the collection, classification, analysis, and interpretation of numerical data and allows decision-makers, analysts, managers, engineers, scientists, and researchers to understand phenomena subject to variation and to predict or control them effectively. Lectures, demonstrations, case studies and numerous individual and group problems provide an intensive introduction to the fundamental concepts, applications, and practice of contemporary statistics. Topics: Treatment of Data, Basic Probability, Probability Distributions and Densities, Sampling Distributions, Statistical Inferences — means, variances, and proportions, Nonparametric Tests, Analysis of Variance and Design of Experiments.

EECS 413: Nonlinear Systems I

This course will provide an introduction to techniques used for the analysis of nonlinear dynamic systems. Topics will include existence and uniqueness of solutions, phase plane analysis of two-dimensional systems including Poincaré-Bendixson, describing functions for single-input single-output systems, averaging methods, bifurcation theory, stability, and an introduction to the study of complicated dynamics and chaos.
Recommended preparation: EECS 408.

EECS 421: Optimization of Power Systems

Fundamentals of dynamic optimization with applications to control. Variational treatment of control problems and the Maximum Principle. Structures of optimal systems; regulators, terminal controllers, and time-optimal controllers. Sufficient conditions for optimality. Singular controls. Computational aspects. Selected applications.
Recommended preparation: EECS 408.

EECS 468: Power System Analysis I

This course introduces the steady-state modeling and analysis of electric power systems. The course discusses the modeling of essential power system network components such as transformers and transmission lines. The course also discusses important steady-state analysis of three-phase power system network, such as the power flow and economic operation studies. Through the use of PowerWorld Simulator education software, further understanding and knowledge can be gained on the operational characteristics of AC power systems. Special topics concerning new grid technologies will be discussed towards the semester's end. Prerequisite requirements include the concepts and computational techniques of Alternative Current (AC) circuit and electromagnetic field. The course is co-offered with undergraduate course EECS 367.
Prerequisite: EECS 245 Electronic Circuits or equivalent.

EMAE 450: Advanced Engineering Analysis

This course aims to equip students with tools for solving mathematical problems commonly encountered in mechanical engineering. The goals are to enable the student to properly categorize the problem in a variety of ways, to identify appropriate approaches to solving the problem and to choose effective numerical solution methods. The course covers analytical and computational approaches to linear and nonlinear problems in both discrete and continuous systems. Computational approaches include direct methods such as finite difference methods and approximation methods based on a variational approach, such as finite elements. The course is built around specific examples from solid mechanics, dynamics, vibrations, heat transfer and fluid mechanics, represented by initial value problems, eigenvalue problems and boundary value problems.

TECHNICAL ELECTIVES (CONT.)

EMAE 481: Advanced Dynamics I

Particle and rigid-body kinematics and dynamics. Inertia tensor, coordinate transformations and rotating reference frames. Application to rotors and gyroscopes. Theory of orbital motion with application to earth satellites. Impact dynamics. Lagrange equations with applications to multi-degree of freedom systems. Theory of small vibrations.
Prerequisite: EMAE 181 or equivalent.

EMAE 487: Vibration Problems in Engineering

Free and forced-vibration problems in single and multi-degree of freedom damped and undamped linear systems. Vibration isolation and absorbers. Modal analysis and approximate solutions. Introduction to vibration of continuous media. Noise problems. Laboratory projects to illustrate theoretical concepts and applications.
Prerequisite: MATH 224 and EMAE 181.

EMAE 494: Energy Systems

This is a cutting-edge, interdisciplinary, graduate-level course focused at the nexus of advanced energy and innovation. The energy market is dynamic, complex and a system of sub-systems with multiple paths to market. Key technology developments are influencing progress towards a drastically different energy future. The high cost of capital associated with bringing a new technology to market increases perceived risks. To successfully embed advanced energy technology, you have to be able to effectively navigate the market and reduce the risks associated with adopting a new technology. This course helps close the gap between energy research and industry by providing students a process for managing innovation, an understanding of the complex and dynamic energy market and "hands-on" experience building a business through the creation of E-teams who ultimately pitch their business ideas to investors.

EBME 410: Medical Imaging Fundamentals (Imaging)

Physical principles of medical imaging. Imaging devices for x-ray, ultrasound, magnetic resonance, etc. Image quality descriptions. Patient risk.