ROBOTICS (ROB)

ROB 421, APPLIED ROBOTICS, 4 Credits

Multidisciplinary teams of students design, build, and demonstrate a robotic system, including all sensing, computation, and actuation. The specific task, such as checkers-playing robots, changes each year, and is designed to be challenging for ambitious students. Robots will compete in a friendly competition at the end of the term. Lec/lab.
Prerequisite: ME 430 with C or better
Equivalent to: ENGR 421

ROB 456, INTELLIGENT ROBOTS, 4 Credits

Foundations of probabilistic reasoning for robotics. Topics include state estimation, robot motion, perception, localization and decision making under uncertainty.
Prerequisite: ST 314 with C or better
Equivalent to: ME 456
Recommended: CS 331, CS 361, ECE 353, or other programming experience

ROB 501, RESEARCH, 1-16 Credits

Graded P/N.
This course is repeatable for 99 credits.

ROB 503, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

ROB 505, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

ROB 506, PROJECTS, 1-16 Credits

Graded P/N.
This course is repeatable for 16 credits.

ROB 507, SEMINAR, 1-16 Credits

Graded P/N.
This course is repeatable for 16 credits.

ROB 514, INTRODUCTION TO ROBOTICS, 4 Credits

A broad introduction to the field of robotics, and to the graduate Robotics program. The goal of the class is to take students with different backgrounds (mechanical engineering, computer science, electrical engineering, physics, etc.) and give them a common base in the fundamentals of robotics. A secondary goal is to introduce students to the Robotics program, and to give them some of the skills that will make them successful, both in the program and as a professional roboticist.

ROB 521, RESEARCH ROBOTICS, 4 Credits

Multidisciplinary teams of students will use the backdrop of a robotics competition to generate a research question, then design, build, and demonstrate a robotic system that is used to answer this research question. An example may be a Jenga-playing robot, where students try a new computer vision algorithm, or test a theory on force control. This directly parallels graduate research in robotics, where systems-building is necessary, and toy problems can illustrate research results, but the important focus is a core research question. The specific competition task changes each year, and robots will compete at the end of the term. Lec/lab.
Equivalent to: ENGR 521

ROB 534, SEQUENTIAL DECISION MAKING IN ROBOTICS, 4 Credits

Examines sequential decision making in robotics with a focus on motion planning and related optimization problems applied to fielded systems in marine, aerial, and ground domains. Discussions regarding both fundamental background material as well as cutting edge research in the following areas: discrete planning, sampling-based planning, planning under uncertainty, multi-robot systems, optimization, and performance guarantees.

ROB 537, LEARNING-BASED CONTROL, 4 Credits

Provides an introduction to learning systems and their application to the control of nonlinear systems. Covered topics include neural networks, reinforcement learning, and evolutionary algorithms. Includes project component in which students write a technical paper and give a conference style presentation based on their project.
Equivalent to: ME 537

ROB 538, MULTIAGENT SYSTEMS, 4 Credits

Provides an introduction to multiagent systems. In particular, it focuses on how to coordinate agents using different approaches. Covered topics include multiagent learning, game theory, swarms, social choice, and auctions. Includes significant reading and critiquing of assigned papers.
Equivalent to: ME 538

ROB 541, GEOMETRIC MECHANICS, 4 Credits

An introduction to geometric methods in the analysis of dynamic systems. Using the kinematics of simple robotic systems as a motivating example, we explore topics such as manifolds and Lie groups, representations of velocity, holonomic and nonholonomic constraints, constraint curvature and response to cyclic inputs, distance metrics.
Recommended: Prior exposure to linear algebra and differential equations

ROB 542, ACTUATOR DYNAMICS, 4 Credits

Focuses on how inertia, spring compliance, and other passive dynamics affect highly dynamic, software-controlled systems. Examples include robotic manipulation tasks, robot-human interaction, CNC machines, or legged locomotion. Lec/lab.
Recommended: Prior courses on dynamics and control such as ME 531, ME 533, ME 535

ROB 545, ROBOTIC MANIPULATION, 4 Credits

Introduction to the mechanical processes governing manipulation with a focus on the kinematics, statics, and dynamics of interacting rigid bodies. Topics include numerical inverse kinematics, dynamics of open chains, and interaction control. Some manipulation problems considered include grasping, picking and placing, and assembly.

ROB 562, HUMAN CONTROL SYSTEMS, 4 Credits

Covers mechanisms of human motor systems and control of the neuromusculoskeletal anatomy followed by functional analysis of these system components. Then all the components are integrated to study feedback control dynamics. Covers classic to modern theories of motor control, adaptation, cognitive involvement, and rehabilitation techniques.
Equivalent to: ME 539
Recommended: Basic feedback control systems, linear algebra, differential equations

ROB 564, SOFT ROBOTICS, 4 Credits

Soft robotics researchers propose building intelligent machines purely out of stretchable compressible soft materials. The course is centered on term-long projects that will result in real soft robots with the goal of presenting to the international community. The topics covered include rapid digital manufacturing, soft actuators, soft sensors, soft logic, soft energy, applications of soft robotics, and modeling soft mechanics.

ROB 567, HUMAN ROBOT INTERACTION, 4 Credits

The field of human-robot interaction brings together research and application of methodology from robotics, human factors, human-computer interaction, interaction design, cognitive psychology, education and other fields to enable robots to have more natural and more rewarding interactions with humans throughout their spheres of functioning.
Recommended: Background in one of human factors, usability/hci, programming experience, design

ROB 568, SOCIAL ROBOTICS, 4 Credits

In-depth exploration of the leading research, design principles, and challenges in Human-Robot Interaction (HRI), with an emphasis on socially interactive robots. Topics include social embodiment, multi-modal communication, human-robot teamwork, social learning, aspects of social psychology and cognition, as well as applications and evaluation with human subjects. Requires participation, lightning talks, student-led lectures, written critiques of class readings, and a group project involving a hypothetical social robotics project.

ROB 599, SPECIAL TOPICS, 0-16 Credits

This course is repeatable for 32 credits.

ROB 601, RESEARCH, 1-16 Credits

Graded P/N.
This course is repeatable for 99 credits.

ROB 603, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

ROB 605, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.