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.

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.
Recommended: ME 373 or ME 373H or ECE 353 or CS 331

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.

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.

ROB 538. AUTONOMOUS AGENTS AND MULTI-AGENT SYSTEMS. (4 Credits)
Provides an introduction to autonomous agents and multi-agent systems. In particular, it focuses on how to use agents as building blocks for different autonomous systems. Covered topics include reinforcement learning, game theory, swarms, auctions, and collectives. Because this course covers a constantly evolving field, there will be a significant paper reading component in addition to the regular lectures. Students are expected to spend at least three hours a week reading, discussing and critiquing assigned papers.

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 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.