Special Topics Courses

RBE 595 Special Topics courses are arranged by individual faculty with special expertise, these courses survey fundamentals in areas that are not covered by the regular Robotics Engineering course offerings. Courses are not always offered each semester.

RBE 595 courses offered in Spring 2021:

Humanoid Robotics

This is a graduate-level course in humanoid robotics: the principles and methods of making human-shaped robots interact with their environment. Topics include: manipulation, perception, locomotion, balance, coordination, control, interfaces, and human-robot interaction. Recommended background is advanced graduate standing in Robotics Engineering. Familiarity with ROS and a recursive programming language is assumed.

Optimal Control

Optimal control deals with problems of finding control laws for given dynamic systems such that the costs are minimized, or the rewards are maximized. It is becoming increasingly important for improving the performance of modem physical, cyber-physical, social and economic systems. The first half of the course will focus on optimal control methods for continuous-time dynamic systems, and the second half will focus on methods commonly used for discrete-time dynamic systems. The topics to be covered include calculus of variations, Pontryagin's Minimum Principle, linear quadratic regulators, dynamic programming, and reinforcement learning. In this course, all the methodologies will be introduced from the point of view of optimal control. Some of them, such as dynamic programming and reinforcement learning, may be applied to certain general control and decision making problems beyond optimal control.

Swarm Intelligence

This course will cover a wide range of topics in swarm intelligence, including mathematical, computational, and biological aspects. The course is organized in four parts. In the first part, the students will learn about complex systems and the basic concepts of self-organization, such as positive and negative feedback, symmetry breaking, and emergence. The second part concerns several types of network models, such as information cascades, epidemics and voting. The instructor will illustrate a diverse collection of self-organized systems in nature, finance, and technology that concretize these concepts. The third part is dedicated to swarm robotics, and will cover common swarm algorithms for task allocation, collective motion, and collective decision-making. The fourth and final part covers optimization algorithms inspired by swarm intelligence, namely ant colony optimization and particle swarm optimization. The course will blend theory and practice, challenging the students to learn by implementing the algorithms discussed in class. The final project will involve working on a research problem in swarm robotics, and the final deliverable will include a demo and a research paper.

WR 593: Topics in Writing and Communication
Robot Futures: Design, Ethics, Communication

Engineers and other technologists are increasingly more aware of the ethical, legal, and social impacts of robotics and artificial intelligence. Some of them actively contribute to the creation and communication of new sets of ethical standards, such as the work done by IEEE's Global Initiative on Ethics of Autonomous and Intelligent Systems. What are the ethical principles that underpin these new ethical standards? Should these standards be voluntary or enforced by a regulatory body? Since robots and AI systems are designed to work with or alongside humans, do people have a right to understand what autonomous systems are doing and why? How can robotics and AI designers ensure that these systems are transparent and explainable? These are only a few of the questions raised by our society's increasing technological capabilities. Highlighting connections between design ethics and technical communication, this seminar will help students incorporate humanistic and social scientific insights into the study of potentially disruptive technologies.

**WR 593 can satisfy your "Engineering Context" category graduation requirement with this course. For that you will need to send a petition to rbe-gpc@wpi.edu, but it will be auto-approved and the registrar will be notified accordingly.*