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 Fall 2021:

Advanced Surgical Robotics (In-Person)

In RBE 595 - Advanced Topics in Surgical Robotics you will learn about some of the most recent advances in surgical robotics research, and how these advances enable new treatment options for medical conditions that are currently considered inoperable. Topics covered in the course include (time permitting):

- Taxonomy of surgical robots: CAD/CAM systems, surgical extenders, and autonomous systems
- Kinematics and statics of continuum manipulators and examples of applications in surgery
- Automatic mechanism synthesis with applications in the design of surgical instruments
- Overview of Common Medical Imaging modalities
- The development cycle for surgical technology, and the “Clinical pull/Technology push” duality

Deep Learning for Advanced Robotic Perception (Online)

This course will cover deep learning and its applications to perception in many modalities, focusing on those relevant for robotics (images (RGB and RGB-D), videos, and audio). Deep learning is a sub-field of machine learning that deals with learning hierarchical features representations in a data-driven manner, representing the input data in increasing levels of abstraction.

The course will cover the fundamental theory behind these techniques, with topics ranging from sparse coding/filtering, autoencoders, convolutional neural networks, deep belief nets, and Deep reinforcement networks. We will cover both supervised and unsupervised variants of these algorithms, and we will work with real-world examples in perception-related tasks, including robot perception (object recognition/classification, activity recognition, loop closure, etc.), robot behavior (obstacle avoidance, grasping, navigation, etc.), and more.

The course will involve a project where students will be able to take relevant research problems in their particular field, apply the techniques and principles learned in the course to develop an approach, and implement it to investigate how these techniques are applicable.

Haptic and Robotic Interaction (In-Person)

The course is focused on studying how to detect and simulate physical interaction between two entities (for example, between a robot and an object, or between two objects) in a virtual environment, motivated by applications in haptics, where a human operator interacts with virtual objects via a haptic display device. Applications range from virtual training for a wide range of tasks that require physical interaction with objects, such as dental and surgical operations, to teleoperation of robotic manipulation tasks through haptics, and dynamic simulation. Multi-region collisions and contacts involve both rigid and deformable objects will be addressed.

Sensor Fusion and Perception for Autonomous Vehicles (Online)

This course focuses in Sensor Fusion, Image Processing and Computer Vision techniques for Autonomous Vehicles. The class covers four topics: Image Processing (Image Enhancement, Filtering, Advanced Edge and Texture), 2D/3D Vision (3D Geometry from Multiple view geometry, Motion Processing and Stereo) Sensor fusion (homogeneous fusion, heterogeneous fusion and sensor integration) and Image Segmentation and Object Recognition. Students will be introduced to several existing software toolboxes from Vision and Robotics, and will implement a number of smaller projects

Moreover, this course presents a variety of tools and approaches for solving fundamental problems involving sensor fusion and perception. Topics to be covered include the mathematical formulation of fusion algorithms, the use of sensor fusion to solve visual perception degeneratives, time domain discrepancies, and accurate reconstruction, and the design and implementation of heterogeneous sensor fusion approaches. Prerequisite: RBE 500.

Space and Planetary Robotics (In-Person)

Space and Planetary Robotics course provides historical overview, addresses state of the art and discusses potential future directions of robotics applied to orbiting and voyaging spacecraft technologies and instrumentation, planetary landers and rovers, service, construction and industrial, autonomous and semi-autonomous, conventional and possibly self-replicating robotic systems within non-Earth based settlements, as well as human augmentation systems in the context of space and planetary exploration. This course is intended for graduate students and advanced undergraduate students. This is term long course. There is no prerequisite for this course. However, it is recommended that this course is taken in conjunction with either courses within minor in Astrophysics, or courses within minor in Aerospace Engineering, or select courses in Engineering Science and Aerospace Engineering such as: ES2501 Introduction to Static Systems, ES2503 Introduction to Dynamic Systems, AE2713 Astronautics, AE4713 Spacecraft Dynamics and Control, or select courses in Robotics such as RBE1001 Introduction to Robotics, the four course series RBE2001, 2002, 3001 and 3002.

Robotic Materials (In-Person)

Robots are typically comprised of discrete components including sensors, actuators, electronics, and power supplies and are housed inside a chassis. Although such robots are typically self-sufficient (untethered) and capable of increasingly autonomous behaviors, they possess a low degree of integration, standing in explicit contrast to biological systems. For example, humans possess 100s of skeletal muscles (robots possess 10s of actuators), a vasculature (vs. centralized power), a nervous system (vs. centralized control), and are grown (vs. assembled). In robotic materials research, we develop composites that combine sensing, actuation, computation, and power. Robotic materials do not only differ from traditional robots in their degree of integration, but also their compliance. Robotic materials are typically flexible allowing for new types of robotic applications including wearables for healthcare, foldable structures for aerospace, and expandable structures for aquatic environments. In this course, students will be introduced to the fabrication techniques, the characterization, and control of robotic materials. We will focus on fluidically and electromagnetically driven robotic materials.

WR 593: Robot/AI Ethics and Future of Work (In-Person)

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.