Syllabus/Course Units Description

Robotics II

REC Unit 7: Overview

Unit 7 introduces students to both the theory behind and the practice of basic electronics, one of the major facets of Robotics Engineering. Assuming no prior knowledge of electronics, the unit begins with a basic review of safety around electronics, the concepts of voltage, current and resistance, as well as how to read and create electronics diagrams. Students use real components and their own breadboard to create increasingly complex circuits.

Additional topics in Unit 7 include a discussion of Ohm's law, series and parallel circuits as well as more complex components like transistors, potentiometers, photoresistors, timers and logical gates. In the unit project, students incorporate programming on the Vex Controller with an electrical circuit on a breadboard to control a bank of LEDs.

Students will learn:

Basic electronic components

Understand how to draw and work with schematics

Learn how to assemble basic circuits using a breadboard

Understand how to use a digital multimeter to measure current, voltage, and resistance

Understand Ohm's Law

Learn how electronic components and circuitry are used in feedback control systems

Understand how circuitry (hardware) interfaces with software and provides feedback

REC Unit 8: Overview

Unit 8 reintroduces the student to working directly with Vex. Students first learn about chain and sprockets with the new chain and sprocket kit, available in the REC 2 pack. They then build a fast, durable, four-wheel drive robot called the "Tumblebot”.

After building the robot, students learn about some of the advanced features of easyC V4, such as the Switch and Case function blocks, support for more sensors, and robot mapping. Students learn to write their own C functions and even type the code by hand into the new text editor. Students will finally learn how to program their robots for autonomous robotics competitions.

The capstone project for Unit 8 is a freeze tag competition where all of the students compete to see who can program and control their robot the best, while using everything they have learned in Units 7 and 8.

Students will learn:

How and when to effectively use chain and sprocket.

The important advantages and shortcomings of various robotic drive trains.

Use advanced features in easyC to create more complex programs.

Understand how the easyC text editor functions to write C programs in text.

Understand what a state machine is and program robotic state machine to play freeze tag

Learn how to use the easyC competition templates.

Write multiple autonomous programs and select the most appropriate for competition.

Continue to implement concepts learned in previous units for actual robotic competition.

REC Unit 9: Overview

Unit 9 reviews a number of advanced programming concepts that are applicable to both C and other programming languages. The first three Cores and Activities are dedicated to teaching the students PID (Proportional, Integral and Derivative) control. Students learn both the theory behind PID and practice using their Tumblebots equipped with a front mounted ultrasonic sensor. Students then learn other advanced programming techniques, such as filtering out erroneous data retrieved from a sensor, using arrays, behavioral robotics, encoders, and creating their own random number generator.

The final project in Unit 9 is a free design and programming activity where the students design, build and program their own "vacuuming" robot. All of the programming techniques taught in Unit 9 are designed to be both relevant to robotics, as well as other real life applications such as process control and manufacturing.

Students will learn:

Re-examine sensor usage and sensor feedback processes.

Learn the advanced programming concepts involved in PID control.

Understand and make use of the proportional (P) control algorithm.

Understand and make use of the differential (D) control algorithm.

Understand and make use of the integral (I) control algorithm.

Learn about digital filtering and processing sensor data.

Learn about arrays and matrices and their uses in processing sensor data.

Understand the need for randomness and how to generate random data.

Make use of user functions in programming hierarchical robot behaviors.

Understand programming and robotics in a real-world application.

REC Unit 10: Overview

Unit 10 combines elements of Units 8 and 9 in the study of industrial robotic arms. Students first learn about the different types and uses of robotic arms and robotic systems in industry. The students then work system by system to create a fully functional three axis robotic arm using Vex mechanical parts and sensors, including the new potentiometer available in the REC 2 bundle.

After learning about the various ways to move a robotic arm, students combine a motor and potentiometer to simulate the operation of a servo. In the final project, students add conveyor belts to their robots and work together to pass an object from one robot to another, mimicking a real manufacturing environment.

Students will learn:

The uses of industrial robots found in manufacturing environments.

Understand how servos operate, as well as the concept of a hard limit.

Understand how a 3-axis robotic arm works as they construct and program their own.

Learn how industrial robots use the method of homing to determine their position.

Learn about a robot's work envelope and the need for software limits and hard limits.

Understand a variety of coordinate systems commonly used in industrial robots.

Understand concepts of mass production and Computer Integrated Manufacturing (CIM).

Learn the components of a typical CIM cell and how robots communicate with each other as they work together on the production floor.

Program multiple Vex controllers to work together as robots work together to complete a common task using the 3-axis robotic arms.

REC Unit 11: Overview

In Unit 11, students learn about various advanced mechanical systems. In the first Core and Activity, students learn about and create a chain driven lift mechanism and use a spring scale to measure the force delivered by their lift. The next section discuses different types of gears, such as worm, bevel, and helical gears as well as rack and pinion systems, differentials and transmissions.

In the activity, students build two sets of rack and pinion lifts and test them to see how much each can lift. Students also learn about the uses for collectors and roller systems in both robotics and industry. With all of these advanced mechanics under their belt, students are now ready to complete the REC 2 project.

Students will learn:

About a variety of advanced mechanical systems.

Understand how a simple chain and sprocket driven lift works.

Discover and understand how different gear trains function.

Understand how a rack and pinion gear system works.

Understand how transmissions work.

Learn how a differential gear systems works.

Learn how harvesters and other collection systems work.

Understand that combinations of systems can result in a very competitive robot.

REC Unit 12: Overview

This is a two-week project that reinforces the programming and engineering concepts covered during REC 1 and 2. The student must design and build a robot that can compete in Bucket Battle, a game developed especially for REC 2 and intended to simulate the experience of real robotics competitions. Students must present a preliminary design to their teacher before building, and end the project with a critical design review, in which they present their various design considerations, strategies and mathematical calculations. In Bucket Battle, the team with the fewest balls at the end of the match wins. Each team or alliance must frantically collect balls from their side, and dump them over the wall onto their opponent's side in order to keep their score low. The game begins with a 15-second autonomous period, during which robots can drop special balls into a large bucket to secure points.

This game was designed to incorporate all mechanical, electrical and programming aspects taught to the students throughout the year in an exciting and competitive environment.

Students will learn:

Understand the parameters and rules of a robotics competition.

Use competition templates.

Program the robot to operate autonomously, as well as under operator control.

Design and program a robot with a fully functional locomotive system.

Design and program a fully functional collection system.

Design and program a fully functional delivery system.