The STEM Institute at The City College of New York
Summer 2013

Introduction to Robotics

Course Description and Syllabus

Introduction

The objective of this course is to introduce students to the field of Robotics and stimulate their interests in science and engineering through the participation of the entire engineering design process. This course covers a variety of multidisciplinary topics necessary to understand the fundamentals of designing, building, and programming robots. Each topic is presented in the format of one hour lectures immediately followed by a two hour laboratory where students will apply the concepts discussed during the lecture. During this course, students will be required to gradually complete the design and construction of a robot using the Vex Robotic System kit and following the constrains and objectives for competing on the final project demonstration.

This class is hosted by the STEM institute at The City College of New York and sponsored by the office of the Dean of the Grove School of Enginnering and the Army Educational Outreach Program (UNITE).

Instructor

Sebastian Pendola - spendol00@ccny.cuny.edu

Grading Policy

The final grade for this course will be calculated using the following formula:

a) Attendance and Participation: 10%

b) In class quizzes: 30%

c) Midterm presentation: 20%

d) Final project demonstration : 40%

Attendance is mandatory and is strictly controlled by the office of the STEM institute at The City College of New York.

Final Project

The entire syllabus of the class is complemented by the construction of a robot capable of participating on a competition where different robotic skills are necessary. Each team will be graded independently based on the performance of its robot and not the final outcome of the competition.

The winning team will receive a trophy for their teamwork and the performance of the working robot. The details about the anticipation and competition tasks will be announced during class. Students are advised to work enthusiastically on their robots during the entire course to avoid last minute complications.

Class and Laboratory Rules

The following rules must be observed by students at all times:

a) Attend classes daily and on time.

b) Participate and contribute to group assignments and projects.

c) Exercise safety and common sense at all times.

d) All other laboratory rules apple. (No food or drinks, no texting, etc.)

Course Topics

Section 1: Introduction to Robotics

This section introduces students to the basic principles of robotics, engineering design and computer science. The topics will cover fundamental topics related to engineering processes, design, computer science and robotics.

List of topics

1.1 – Introduction to Robotics.

1.2 – The Engineering Design Process.

1.3 – Best practices in engineering design.

Section 2: Introduction to Computer Programming

This section introduces students to computer programming. The topic covered in this section will help students understand how to computers are programmed to execute tasks and how to approach problems analytically, implementing solutions for those problems in computer programs.

List of topics

2.1 – Fundamentals of computer languages and and machine logic.

2.2 – The "Hello World!" program.

2.3 – Variables, arithmetic operations and logical operations.

2.4 – Conditional statements.

2.5 – Loops and Iterations.

2.6 – Functions and calls.

2.7 – Libraries.

Section 3: Introduction to Electric Circuits

This section introduces students to fundamental concepts of electricity, electric circuits and electronics. The topics covered in this section will prepare students to understand how the majority of the components on the VEX kit function and how they can be used to design circuits and robots.

List of topics

3.1 – Electricity, voltage and current.

3.2 – Fundamentals of electric circuits.

3.3 – Ideal sources and resistors.

3.4 – Ohm's law and Kirchhoff's law,

3.5 – Capacitors and RC circuits.

Section 4: Early Robotic Topics, Sensors, Actuators and Manipulators

This section introduces students to some of the basic components used to design robots. The topics covered in this section will prepare students to understand the challenges of robotic design. After completing this section students will be prepared to experiment with basic components of the robotic kit.

List of topics

4.1 – Micro controllers

4.2 – Sensors and actuators

4.3 – Manipulators

4.4 – Gears and other mechanical systems.

Section 5: Introduction to Robot Mechanics

This section introduces students to some of the fundamental models of robotic design. The topics covered in this section will help students understand the techniques used to design robots that perform different tasks, their limitations and advantages. After completing this section, students will be prepared to start designing their robots for the final project.

List of topics

5.1 – Power and torque

5.2 – Acceleration and velocity.

5.2 – Design models for ground mobile robots.

5.3 – Design models for mechanic arms and lifting systems.

5.4 – Fundamentals of kinematics.

Section 6: Advanced Topics on Robotics

This section introduces students to some advanced topics on Robotics. The topics covered in this section will give students a better perspective on some of the more advanced techniques of engineering, mathematics and science currently used in robotics. After completing this section, students should be able to reevaluate their

robotic designs using the new concepts studied. Students are encouraged to apply new ideas and challenging strategies.

List of topics

6.1 – Sensing distance and direction.

6.2 – Line Following Algorithms.

6.3 – Feedback Systems.

6.4 – Other topics on advance robotic techniques.

Compliance with Curriculum Standards

This program aligns with the contents suggested by the National Science, Mathematics and Technology standards in the following areas:

1) From the Science Standards, the following are some examples of the topics addressed:

   a) Systems, orders and organization: robots are excellent examples of systems, with many heterogeneous components interacting in organized, methodical ways to achieve results as a whole that they could not have achieved separately.

   b) Evidence, models and explanation: robots present students with various forms of evidence that allows them to scientific principles in electricity, chemistry and physics. (sections 2 and 3)

   c) Constancy, change and measurement: This topic is specially addressed during the study of sensors, actuators and manipulators and their use in the subsequent laboratories. (section 4 and 6)

   d) Physical Science: robots are able to demonstrate and apply many physical concepts. (Sections 2, 3 and 4)

2) From the Mathematics Standards, the following are some examples of the topics addressed:

   a) Numbers and operations: numbers and operations are used in every aspect of robotics, especially in mechanic calculations and programming.

   b) Geometry: robotics relies on geometry to calculate wheel rotations, positions and movement. (Sections 3 and 4)

   c) Problem solving: robots require the implementation of many computers functions to complete tasks or solve obstacles. (Sections 5, 6 and 7).

   d) Connections: one of the most important aspects of robotics is its constant combination between sciences, mathematics and engineering.

3) From the Technology Standards, the following are some examples of the topics addressed:

   a) The nature of technology: all robotics activities provide direct exposure to advanced technology and helps students discover its possibilities and applications.

   b) Technology and society: robots are designed to interact with the real world, generally to complete tasks that fulfill a social need. The final project of this program brings students into such scenario.

   c) Design: students will design their own robot using the knowledge acquired in this course.