Murrieta Valley Unified School District
High School Course Outline
May 2011

Department: Industrial Technology

Course Title: Mechatronics/ Robotics Technology II (AKA Robotics II)

Course Number: 2505

Grade Level: 11-12

Length of Course: Year

Prerequisite: Mechatronics/Robotics Technology I

UC/CSU (A-G) Requirement: NA

Brief Course Description: Robotics II will continue to explore the relations between science and technology with an emphasis on designing, building, and programming robots to compete in competitions against other high school students. Students will focus on advanced robotics concepts including becoming an advanced "C" programmer. The program is designed build upon basic concepts covered in Robotics I. A desired outcome is to design, build, and program robots for the official VEX game that is released at the beginning of each school year. In addition, involvement in the robotics program is intended to further motivate students to pursue advanced education in the engineering fields. Integrated throughout the course are career preparation standards which include basic academic skills, communicating individual and team ideas, interpersonal skills, problem solving abilities, safety, technology, and employment literacy.

I. Goals

The student will:

A. Develop and explore the relationship between science and technology

B. Solve complex problems both individually and in a cooperative group

C. Conduct research and apply technology and tools learned to solve problems

D. Be able to utilize and identify robotics concepts that can lead to solutions of specific problems

II. Outline of Content for Major Areas of Study

Semester I

A. Identification of this year's VEX Robotics game
   1. Identify game objectives
   2. Brainstorm ideas
   3. Discuss what has worked and what has not in the past
   4. Preliminary autonomous strategies
   5. Preliminary driver control strategies
   6. Robot basics

B. Safety Unit
   1. Introduce equipment and safety guidelines
   2. Emergency procedures
   3. Lab policies and procedures

C. Engineering methods
   1. The engineering notebook
      i. Identify the problem(s)
      ii. Brainstorm ideas
      iii. Research problem causes and possible solutions
      iv. Plan
      v. Design
      vi. Assemble
      vii. Test
      viii. Modify
      ix. Document
   2. Teamwork / Identifying and defining team roles
      i. Drivers
      ii. Programmers
      iii. Coaches
      iv. Public Relations
   3. Time management
   4. Accessing information
   5. Systems analysis
   6. Written reports
   7. Model building / computer simulations using Solidworks

D. The VEX robot and its components
   1. Chassis construction
      i. Stability – center of gravity
      ii. Sturdiness – bracing
      iii. Exposure and vulnerability – component/wire placement
      iv. Materials – steel vs. aluminum
   2. Drive train construction (Physics Concepts)

i. Friction
ii. Power
iii. Speed
iv. Torque

v. Pneumatics
    1. Principles of physics
        a. Force
        b. Pressure
        c. Work
        d. Power
    2. Appropriate applications
vi. Electronic Theory
    1. Voltage
    2. Watts
    3. Amps
    4. Resistance
    5. AC / DC
    6. Series and parallel circuit problems
    7. Electric motors
    8. Control systems and microprocessors
    9. Battery types/care
vii. Engineering measurement
    1. Volts, amps, watts
    2. Resistance
    3. Torque
    4. Friction
    5. Speed
    6. Measuring tools
        a. Digital Multi Meter
        b. Scales
        c. Calipers and micrometers
        d. Stopwatches

E. Engineering design
    1. Sketching
    2. Solidworks drawings of Robots
    3. Multi-view drawings using AutoCAD and Solidworks
    4. 3-dimensional drawings to check functionality of robot
    5. Computer graphics and animation

F. Advanced Robotics programming
    1. Process control
    2. Block programming
    3. Syntax

4. Motor control

G. Attend four tournaments per year, 2 per semester.
   1. Goal is to qualify for world championships by winning tournament, excellence award, or programming and/or drivers skills challenge
   2. Develop competitive tasks each team must perform.
      i. These tasks serve as stepping stones to reaching competition goals.
      ii. These will include driving tasks as well as programming tasks.

Semester II

H. Career opportunities
   1. Job search skills
      i. What is available / What is in demand
   2. Resume writing
   3. Application and follow up
   4. Interviewing skills
   5. Career outlook and post-secondary education

I. Robotics sensors
   1. Using sensors in conjunction with other sensors.
      i. Robotics I focused on using one sensor at a time. Here we will focus on using a number of different sensors simultaneously to achieve desired results.

J. Arms and end effectors
   1. Advanced robotic arms
   2. Mass, weight, center of weight, torque
   3. Relationship of torque, gear ratio and weight of payload
   4. Remote control; limit switches
   5. End effectors

K. Advanced robotics programming
   1. Variables and constraints
   2. Precedence, tests and loops
   3. Simplified symbols, logical operators, and integer math
   4. Pseudocode and turns
   5. Dead reckoning and user functions

L. Robotic design
   1. General considerations
      i. Purpose or application
      ii. Size and weight

iii. Physical limits
iv. Monetary limits
v. Time

2. Specifications
   i. Materials
   ii. Support system
   iii. Weight and balance
   iv. Wheel types
   v. Chassis design
   vi. Bracing
   vii. Detailed parts specifications
3. Implementation
   i. Following plans/design
   ii. Choosing materials
   iii. Building to specifications
   iv. Use of appropriate sensors
   v. Write working program

M. Semester projects
   1. Prepare for VEX Robotics annual challenge

N. Final Project
   1. Documentation of project and applied scientific principles involved
      i. Documentation of each step
      ii. Engineering notebook
      iii. Final report
   2. Exhibitions and competitions
      i. School / Class competitions
      ii. Local competitions w/ surrounding high schools
      iii. Demo days for registration
      iv. VEX competitions

III. Accountability Determinants

A. Key Assignments
   1. Students solve robotics problems through the engineering process of designing, building, executing, testing, and modifying robotic devices.
   2. Students lead a school team through the complete engineering process, while developing their own skills in research, problem solving, engineering, teamwork, and planning
   3. Students learn computer programming such as Visual Basic or C++ and program their robots to operate autonomously and remotely

4. Students participate in a series of class projects/competitions to demonstrate numerous physics concepts such as speed, torque, and power.
5. Students complete an individual or team-based final robotics project that incorporates all the major scientific concepts and technical skills covered during the course.
6. Students participate in a team-based comprehensive robotics competition such as VEX Robotics competitions where students can showcase their skills against other competing schools.

B. Assessment Methods

Assessment of student performance will include but not be limited to:

- Participation, effort, skill mastery and quality of work 30%
- Completion of assignments / portfolio 20%
- Individual projects/group projects/final projects 30%
- Tests and quizzes 20%

IV. Instructional Materials and Methodologies

A. Required Textbook(s)

- Robotics Demystified by Edwin Wise, McGraw-Hill Professional; 1 edition (October 20, 2004)

B. Supplementary Materials

- Materials from NASA Robotics Education Project
- Materials from the Robotics Institute at Carnegies Mellon
- Materials from VEX Robotics Design System Inventors Guide

C. Equipment

- VEX robotics kits
- VEX battery packs
- VEX programming software
- Storage for robots and parts
- Various tools required

D. Instructional Methodologies

- Project-based learning
- Student competitions and presentations
- Direct instruction
- Use of a variety of instructional materials and resources (professional journals, reference materials, electronic media, scientific literature)
- Simulations
- Real world learning opportunities
- Guest speakers

- Using technology-based resources such as computers, software design programs, the internet, scientific instrumentation
- Authentic assessment opportunities
- Investigative research to improve English language arts skills (engineering notebook, reports, analyses, journals)