Murrieta Valley Unified School District
High School Course Outline
April 2011

Department: Industrial Technology

Course Title: Robotics Technology I

Course Number: 2500

Grade Level: Murrieta Mesa 11-12
Murrieta Valley 10-12

Length of Course: Year

Prerequisite: Murrieta Mesa - Engineering I, Algebra, Geometry.
Murrieta Valley – Drafting I

UC/CSU (A-G) Requirement: G College Prep Elective

Brief Course Description: Robotics Technology will explore the relations between science and technology. The program is designed to introduce students to basic and advanced concepts in robotics. Course information will be tied to lab experiments where students will work in teams to build and test complex VEX-based mobile robots. Included in this instruction will be the historical development of robotics as a field, the importance of integrating sensors, effectors and control, basic control, the key approaches to mobile robot control (reactive, behavior-based, and hybrid), and discussion of robot learning and multi-robot systems history.

Students will work in small teams to research, design, program, and construct robotic devices in competitions amongst each other and other schools in the area. 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. Introduction to robotics technology
    1. History of robotics
    2. Identifying various technologies used in robotics
    3. Robotics theory
    4. The importance of robotics and technology in society
    5. Robotics in the media (I.E. Books, TV, Movies, News, etc.)
    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 / working in groups
    3. Time management
    4. Accessing information
    5. Systems analysis
    6. Written reports
    7. Model building / computer simulations

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
    2. Drive train construction (Physics Concepts)
        i. Friction

ii. Power
iii. Speed
iv. Torque
v. Simple Machines
    1. Gears – Speed and Strength / Ratios
    2. Pulleys
    3. Levers
vi. Hydraulics and pneumatics
    1. Principles of physics
        a. Force
        b. Pressure
        c. Work
        d. Power
    2. Appropriate applications
vii. 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
viii. 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. Multi-view drawings using AutoCAD and Solidworks/Inventor
    3. Design unique electrical and mechanical configurations/components
    4. 3-dimensional drawings to check functionality of robot
    5. Computer graphics and animation to meet FIRST requirements

F. Beginning Robotics programming
    1. Process control
    2. Block programming

3. Syntax
4. Motor control

G. Semester projects
    1. Squarebot
    2. Motion path challenge
    3. Hill climb
    4. Tractor pull
    5. Prepare for FIRST VEX challenge

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. Introduction to sensors
    2. Open-loop vs. closed loop systems
    3. Ultrasonic sensors
    4. Light sensors
    5. Pressure sensors
    6. Rotational sensors
    7. Infrared sensors
    8. Temperature sensors
    9. Cameras

J. Arms and end effectors
    1. Introduction to robotic arms, degrees of freedom
    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. Bumper car/ Bumper books
2. Line following robot
3. Pick up / Drop off (Arm project)
4. Windshield wiper
5. Prepare for FIRST VEX 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. FIRST 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 the NASA sponsored VEX league 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)