Date Approved by DJUSD Board of Education:

Secondary Course Description

Course descriptions are updated and reviewed with all new text adoptions.

COVER PAGE

1. Course Title: Introduction to Robotics Engineering

2. Transcript Title / Abbreviation: Intro RobEng

3. Transcript Course Code / Number (Office Use Only):

4. School: Open to all Jr. High and High Schools in the District

5. District: Davis Joint Unified School District

6. Department: CTE, Laboratory Sciences

7. Graduation Requirement it meets: Elective, CTE

8. Length of Course: 1 year

9. Graduation Credits: Elective, CTE

10. School / District Web Site: http://www.djusd.net

11. CBEDS Course Code:

12. School Contact

Name: Steve Harvey

Title/Position: Teacher

Phone: 530-902-3180 **Ext.:**

Fax: 530-757-5423

E-mail: sharvey@djusd.net

13. Subject Area:

- ☐ History/Social Science
- ☐ English
- ☐ Mathematics
- ☐ Science
- ☐ Language other than English
- ☐ Visual & Performing Arts
- ☒ DJUSD Graduation Elective
- ☒ College Prep Elective (will seek UC/CSU approval)

14. Grade Level(s): 9, 10, 11, 12

15. UC/CSU Requirement: no

16. Seeking "Honors" Distinction? ☐ Yes ☒ No

17. GPA Types:

18. Credit Value:

- ☐ 0.5 (half year or semester equivalent)
- ☒ 1.0 (one year equivalent)
- ☐ 2.0 (two year equivalent)
- ☐ Other: _____

19. Was this course previously approved by UC? ☒ Yes ☐ No

If so, in what year? _____ **Under what course title?** _____

20. Pre-Requisites:

Co-Requisites:

21. Preliminary Approval - Secondary Site Principal Signature (Must be signed before proceeding to Step 22):

_____

22. Date Course Proposal with Preliminary Approval (Step 15) sent to Associate Superintendent, Educational Services: _____

23. Review & Approval:

Date		Signature
_____	**Site Curriculum and Instruction Leadership Team**	**Signature/Title** _____
_____	**Secondary Department Articulation/Collaboration**	**Signature/Title** _____

Secondary Principal Signatures: _____ _____

Date: _____ _____

BACKGROUND INFORMATION

Brief Course Description:

This is an introductory course designed to give students an overview of many aspects of engineering as applied to robotics applications. The emphasis of this course is to provide students with a fun, hands-on experience where they will work in small teams to design, build and program their own robot. Teams will be given several design challenges and, ultimately, participate in a competition to test the worthiness of their design. During the design and fabrication process, students will test and evaluate their robot, all the while learning important life skills and engineering concepts. Topics will include workspace safety, teamwork and organization, engineering process, mechanical design/CAD, mechanical fabrication, electronics, programming, pneumatics, media and competition strategy.

Context for Course: The course will align with California State Standards in several subject areas including:

A - Physics Standards

Motion and Forces
1. Newton's laws predict the motion of most objects.

Conservation of Energy and Momentum
2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.

Electric and Magnetic Phenomena
5. Electric and magnetic phenomena are related and have many practical applications.

B - Investigation and Experimentation Standards (Science)

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations.

C - Common Core Standards for Mathematical Practice

1) Make sense of problems and persevere in solving them.
2) Reason abstractly and quantitatively.
3) Construct viable arguments and critique the reasoning of others.
4) Model with mathematics.
5) Use appropriate tools strategically.
6) Attend to precision.

D - Career Technical Education Standards:

A variety of standards will be covered from the following pathways:

Arts, Media, and Entertainment Industry Sector
Media and Design Arts Pathway

Engineering and Design Industry Sector
Architectural and Structural Engineering Pathway
Computer Hardware, Electrical, and Networking Engineering Pathway
Engineering Design Pathway
Engineering Technology Pathway

Manufacturing and Product Development Industry Sector
Machine and Forming Technology Pathway

Marketing, Sales, and Service Industry Sector
Entrepreneurship Pathway
Professional Sales and Marketing Pathway

*This course serves as an introduction to the Engineering Design pathway.

History of Course Development:

The DJUSD School Board approved a course that is currently being taught, titled "Robotics Engineering". This course is intended to stretch, eventually, to a 3 or 4-year curriculum and would be integrated with participation in the FIRST robotics program. FIRST robotics is a highly-developed national robotics program in which the Davis team 1678 (Citrus Circuits) has risen to national recognition of the past several years.

In the first year of the program, students will be introduced to many different aspects of robotics, including design, mechanics, electronics, programming, business and media. These topics would be explored using the VEX Cortex Robotics platform. In the second year, students would specialize in a content area and work on a team to develop their skills in their chosen field. In the third year, students would continue to develop their skills in sub-teams where they would help facilitate the learning of second-year students. In the fourth (and final) year, students would take on leadership roles of sub-teams and also help facilitate community outreach programs to give back to our community. Throughout the second through fourth years of the program, students would be required to participate in the FIRST robotics competition as a Citrus Circuits team member.

The currently adopted course, "Robotics Engineering" really fits well into the second through fourth years of this program and would be best supported by an "Introduction to Robotics Engineering" course taught at the 9th grade level. This way, students would have an opportunity to enter the robotics program early and have four years to develop their skills.

COURSE GOALS AND/OR MAJOR STUDENT OUTCOMES

There are three major goals of the proposed course:

1. Prepare Students for the Robotics Engineering Course

As mentioned earlier, this course will serve as an introduction to the proposed four-year curriculum. After taking this course, students will have been exposed to a variety of skill areas from which they can choose a specialty area to continue with the course.

2. Enrichment of Current Math, Science, Art and Humanities Curricula

Students who participate in the Carnegie Mellon Vex Robotics program make strong connections between real world applications and their academic classes. The program is student-centered and requires students to collaborate in order to achieve the goals of the course. By following the Vex curriculum, students will have formal training in many disciplines including:

- Math
- Science
- Engineering
- Business
- Media
- Programming
- Technology

3. Providing Career Technical Education

One of the greatest supplemental educational benefits of The VEX Robotics program is that it provides many types of career technical education. This allows students of diverse interests and academic abilities to engage in the program. The proposed curriculum will thus provide several areas of career technical education, including:

- Industrial Safety
- CAD design
- Electronics
- Pneumatics
- Construction Technology
- Machining/Millwork
- Business Development
- Marketing
- Media (including photo and video)

COURSE OBJECTIVES

Following are the major course objectives:

1. Students will use physical science and math concepts to solve various mechanics problems regarding force, motion, rotation, energy conservation, and power transfer.

2. Students will apply the physical science and math concepts to design pneumatics systems that includes a pump, storage tanks, gauges, sensors, regulators, and linear motion cylinders.

3. Students will use physical science and math concepts to create a DC electrical system that includes a battery, wires of appropriate gauge, relays, switches, potentiometers, encoders, current regulators, fuse panels, and motors.

4. Students will write a computer program that will operate a processor to control the operation of a robotic system.

5. Students will use science and math principles to design mechanical components to work in a robotic system.

6. Students will use Computer Aided Design software to model their robotics components.

7. Students will demonstrate their ability to collaborate with others and apply their learned skills and concepts to the design, fabrication, and assembly of a competition robot. The completed robot will then be used to compete in regional and national level competitions.

8. Students will design and implement a business plan to seek and provide financial support of all activities related to the building of (and competing with) the competition robot.

9. Students will document the progress of their build and competition season through a website, social media channels, press-releases, and presentations to the community.

10. Students will develop communication and leadership skills through a system of team management and documentation.

COURSE OUTLINE

Following is the proposed course outline

1. Safety
   - Workspace organization and safety rules
   - Safe use of tools and equipment
   - Safety equipment

2 Project management
   - Master scheduling
   - Using Gantt charts and organizers
   - The engineering process

3. Mechanics Focus
   - Overview of mechanics
   - Vectors and free body diagrams
   - Force, torque, center of mass, statics, inertia, kinematics and dynamics
   - Machines and how they work

4. Pneumatics Focus
   - Pressure, force, and area
   - Ideal gas law, volume as a function of pressure
   - Introduction to common pneumatic components such as: compressor, regulator, storage tanks, gauges, sensors, solenoid controlled valves, cylinders, fittings.
   - Assembly of a complete pneumatic system to control 2 cylinders

5. Electronics Focus
   - Ohm's law
   - Series vs. parallel circuits, Kirchoff's laws
   - Introduction to common DC components such as switches, wiring and sensors.
   - Assembly of a complete electronic system to power a robot.

6. Computer Aided Design Focus
   - Solid Part Design
   - Assembly of Parts using constraints
   - Creating Annotated Drawings of Parts and Assemblies

7. Machining Focus
   - Reading part drawings
   - Using milling machine/lathe to produce parts

8. Programming Focus
   - Introduction to programming in C (syntax, variables, functions)
   - General program structure to read inputs from remote Joysticks
   - Program structure to read inputs from remote switches
   - Program structure to read other inputs from local sensors
   - Creating autonomous commands and responses.

9. Construction of an actual robot
   - Design of drive system
   - Design of manipulators and / or robotic arms
   - Design of chassis
   - Design of onboard sensors and feedback components
   - Fabrication, assembly, and testing of drive system and chassis
   - Fabrication, assembly, and testing of manipulators and / or robotic arms
   - Testing of sensors and computer program
   - Installation and testing of pneumatic components

- Installation and wiring of the electrical systems
- Testing of all systems
- Debugging and adjustments

TEXTS AND SUPPLEMENTAL INSTRUCTIONAL MATERIALS

Title, Author, Publisher, Edition: VEX Curriculum 2.0, Carnegie Mellon University

Previously Adopted? ☐ **Yes** ☒ **No (If no, provide information directly below)**

Cost per book	**Total Cost**	**Budget Source**

Other:

Carnegie Mellon provides a wealth of resources on their website at:
http://www.education.rec.ri.cmu.edu/roboticscurriculum/vex_online/main_start.htm

DIFFERENTIATED INSTRUCTIONAL METHODS AND/OR STRATEGIES

A variety of instruction methods and strategies will be used on this course. These are described in more detail below.

- Demonstration and Discussion will be used often to determine prior knowledge and identify misconceptions
- Group work will occur frequently as students will be required to experiment, assemble robotic components. Some assignments requiring research and presentation will be done in group setting with responsibilities rotated often.
- E-Mail and on-line communication tools will be used so that students may collaborate with other students, mentors, and professionals.
- Computers with CAD tutorials will be used to allow students to learn at their own pace and provide feedback and tips.
- Lecture will be used occasionally to disseminate course content.

ASSESSMENT METHODS AND/OR TOOLS

The proposed course is primarily project-based. Even though many academic principles will be taught (and are necessary to the success of the projects), the most important criteria for success in the course will be similar to those

required for success in a career. The best way to assess these criteria is to conduct periodic performance reviews of each student and provide guidance on how to improve. Performance reviews will be conducted at each grading period and the student will be assessed on their choice of an A-F or a **pass/no pass** basis.

In addition to the performance review, students will be required to keep an engineering notebook that they will continually update. The notebook will be used to record information learned during workshops and lectures and will take the form of a work portfolio.

Quizzes will be used to assess learning of key conceptual ideas.

ASSESSMENT CRITERIA

The main assessment criteria will be:

- Student attendance
- Student work-ethic (completion of tasks, level of focus, willingness to follow directions of team leaders, and taking initiative)
- Ability of student to work in a team environment
- Development of critical-thinking and problem-solving skills
- Development of written and oral communication skills

HONORS COURSES ONLY

Not Applicable