STRANDS AND STANDARDS
ROBOTICS 2

Course Description

The second in a sequence of courses that prepares individuals with a lab-based, hands-on curriculum combining electrical, mechanical and engineering principles. Students will learn to design, build, program, and control robotic devices. A rigorous study and application of electrical concepts will include: sources of energy, electrical safety, use and identification of basic electronic components, sensors and actuators. Engineering concepts will include: mechanical design, prototype development, design testing, programming, and proper engineering documentation.

Core Code	38.01.00.00.032
Concurrent Enrollment Core Code	None
Units of Credit	0.5
Intended Grade Level	10-12
Prerequisite	Robotics 1
Skill Certification Test Number	612
Test Weight	0.5
License Type	Secondary Education 6-12
Required Endorsement(s)	Technology & Engineering, or
	T&E Electronics

STRAND 1

Students will follow safety practices.

Standard 1

Identify potential safety hazards and follow general laboratory safety practices.

- Assess workplace conditions regarding safety and health.
- Identify potential safety issues and align with relevant safety standards to ensure a safe workplace/jobsite.
- Locate and understand the use of shop safety equipment.
- Select appropriate personal protective equipment.

Standard 2

Use safe work practices.

- Use personal protective equipment according to manufacturer rules and regulations.
- Follow correct procedures when using any hand or power tools.
- Ref: https://schools.utah.gov/cte/engineering/resources

Standard 3

Complete a basic safety test without errors (100%) before using any tools or shop equipment.

STRAND 2

Students will identify the ethical and social impacts of robotics and automation.

Standard 1

Evaluate the social benefits and the negative consequences of robotics and automation.

Standard 2

Describe the ethical impact of robotics and automation.
Example discussion points:

- Discuss military and political use of robots; e.g. Unmanned Aerial Vehicles (UAVs) or drones.
- Discuss who is responsible for a robot's intended use; e.g. a robot made to search a mine v/s the same technology used to invade someone's privacy.
- Discuss ethical and professional behavior in the development and use of technology.

Standard 3

Identify local companies where industrial robots are used on a daily basis.

Standard 4

Identify the uses of robotics in industry and how it impacts manufacturing and production.

- Describe how robotics can improve manufacturing safety.
- Identify five or more industries that utilize robotic applications.
- Identify the advantages and disadvantages of automated assembly lines.

STRAND 3

Students will report on educational pathways and career opportunities in robotics and automation.

Standard 1

Identify at least four engineering fields that impact the robotic and automation industry.

- Mechanical Engineering
- Electrical Engineering
- Manufacturing Engineering
- Computer Science

Standard 2

Explain the difference between Operators, Maintenance Technicians, Controls Technicians, and Controls Engineers. What are the pay scales, employment outlook, local job opportunities, etc.

Standard 3

Identify different types of occupational training that would prepare them for a career in robotics.

Standard 4

Respond to the question "Will robots take our jobs?" by researching what has happened to jobs in the past, and what the outlook for employment will be in the future.

STRAND 4

Students will identify, understand, and utilize mechanical advantage and efficiency to perform robotic tasks.

Standard 1

Identify the six simple machines and apply their use to a structural design.
The six simple machines defined by Renaissance scientists are:

- Levers
- Wheel and axle
- Pulley
- Inclined plane
- Wedge
- Screw

Standard 2

Calculate the mechanical advantage of gears, pulleys, and levers.

Standard 3

Discuss and calculate mechanical rates.

- Discuss the difference between distance, displacement, speed, velocity and acceleration.
- Calculate both linear and angular velocity.

STRAND 5

Students will create program code for robots and automated systems.

Standard 1

Use flow charting to design useable code.

- Identify standard programming flow chart symbols.
- Demonstrate an understanding of robot programming principles by planning programs which start by flow charting the process.
- Create various robot programs incorporating robot motion, I/O, decision making, delays, comments, and the use of subroutines.
- Plan a motion path including safe positions, approach and exit points using instructor provided flow charts.

Standard 2

Demonstrate an ability to control a robot by writing code for specific motions.

- Define Joint, Linear, Circular, and Spline motion types.
- Create and verify the path of a job for robot motion using Joint, Linear, and Circular motion types.
- Perform position/path confirmation by executing the code one line at a time.
- Run a job automatically or autonomously by running through a job at slower speeds before running at full speed.
- Modify position, motion type, speed, and information for an existing job.

Standard 3

Demonstrate an understanding of programming logic and number systems.

- Define Inputs and Outputs and how they relate to external devices and sensors.
- Monitor input and output signals.
- Define Base numbering systems like $Base_{10}$, $Base_{2}$, and $Base_{16}$.
- Demonstrate understanding of Binary by turning outputs on and off.
- Demonstrate understanding of Binary Decimal values by turning multiple inputs and outputs on and off at the same time using one line of code.
- Program I/O Instructions into a job using binary and binary decimal values.
- Demonstrate understanding of Octal and Hexadecimal value calculation, their application, and their relationship to binary and binary decimal values by calculating the same values in decimal, octal, and hexadecimal.

Standard 4

Create useable code that meets industry standards.

- Define when and how variables are used in programming languages.
- Define different types and examples of variables, e.g. integer, float, string, and boolean.
- Identify variables to include in motion program.
- Access/Edit Arithmetic Variables
- Change Variables

- Demonstrate understanding and importance of code comments by entering job descriptions at the top, and single line and multi-line comments throughout.
- Demonstrate understanding of subroutines by using them in a program to execute a common section of code over and over again without having to write the same lines of code over and over again.
- Demonstrate understanding of delay or pause commands by using them in a program to halt program execution.
- Demonstrate knowledge of jump statements, using them in a program to create loops and skip code.
- Demonstrate understanding of conditional statements by using them in code to make decisions.
- Demonstrate geometric translation by mathematically shifting or offsetting a set of Cartesian points by adding or subtracting one set of X, Y, Z points to another.

STRAND 6

Students will practice basic robot operations using a teach pendant.

Standard 1

Define Cartesian coordinate systems.

- 2-dimensional (2D)
- 3-dimensional (3D).

Standard 2

Demonstrate ability to identify points in 2-dimensional space and plot a path between multiple points using X and Y coordinates.

Standard 3

Demonstrate ability to identify points in 3-dimensional space and plot a path between multiple points using X, Y, and Z coordinates.

Standard 4

Define Yaw, Pitch, and Roll.

Standard 5

Demonstrate knowledge of the industrial robotics right hand rule by showing how a 6-axis robot moves in an X, Y, and Z directions, and Yaw (rotate around X axis RX), Pitch (rotate around Y axis RY), and Roll (rotate around the Z axis RZ).

Standard 6

Jog the robot manually (One motor at a time) through each axis of the Cartesian coordinate system (X, Y, Z, RX, RY, and RZ).

Standard 7

Define the home position of an industrial robot and explain what it means to master and re-master robot.

Standard 8

Identify basic error and fault recovery.

STRAND 7

Students will be familiar with and use preventive maintenance procedures.

Standard 1

Define preventative maintenance (PMs).

Standard 2

Demonstrate understanding of preventative maintenance by developing a maintenance schedule and/or plan for a robot system, and executing the PMs listed on the schedule.

NOTE:

If VEX *or* First Robotics *are used as the primary method of instruction in this course, then this standard could be applied by creating a pre-match checklist where things like rubber bands, battery connections, visual inspections, etc could be listed. Preventative maintenance is probably the first thing a student will do when entering the workforce. It is important for them to see and understand real world PM sheets.*

Skill Certificate Test Points by Strand

Test Name	Test #	Number of Test Points by Strand							Total Points	Total Questions
		1	2	3	4	5	6	7		
Robotics 2	612	4	3	3	6	14	6	2	38	32

Performance Skills

1. Create and utilize an engineering notebook per established conventions. https://schools.utah.gov/cte/engineering/resources
2. Demonstrate practice of the *Technology & Engineering Professional Workplace Skills*. https://schools.utah.gov/cte/engineering/resources
3. Participate in a significant activity that provides each student with an opportunity to render service to others, employ leadership skills, or demonstrate skills they have learned through this course, preferably through participation in a Career & Technical Student Organization (CTSO) such as the Technology Student Association (TSA).
4. Working in teams, design, build, and formally present a properly functioning robot that addresses a task(s) assigned by the instructor.