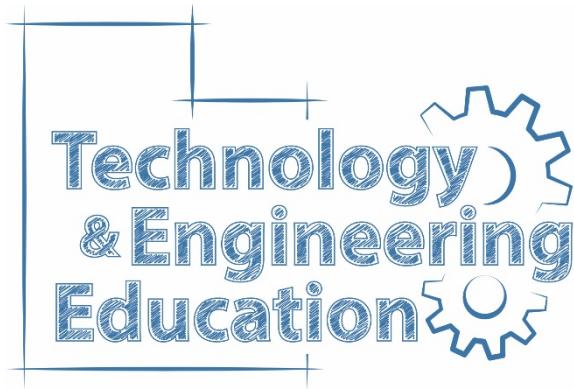# STRANDS AND STANDARDS
## ROBOTICS 2



## 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 | None |
| Skill Certification Test Number | 612 |
| Test Weight | 0.5 |
| **License Type** | Secondary Education 6-12 |
| **Required Endorsement(s)** | Technology & Engineering, or |
| | T&E Electronics |



CTE® Learning that works for Utah

# 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/tech/publicationsresources

## 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/tech/publicationsresources

2. Demonstrate practice of the *Technology & Engineering Professional Workplace Skills*.
   https://schools.utah.gov/cte/tech/publicationsresources

3. Participate in a Career & Technical Student Organization (CTSO), preferably 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.