UTAH SYSTEM OF HIGHER EDUCATION

**Utah System of Higher Education**
Controls Engineering Technology
FY2025 / 14 Credits (420 Clock-Hours)

## Foundational Courses

**TECE 1000 Industrial Networking Basics** **1 Credit / 30 Clock-Hours**

This course is designed to help students understand important Ethernet and TCP/IP concepts and terminology. It will also provide essential information about the industrial protocols and topology. Students will gain a solid grasp of Ethernet basics and the concepts required for an Industrial network. The course includes switch configuration, power over Ethernet, addressing, and wireless Ethernet.

Objectives:
- Describe basic network configuration.
- Use basic networking hardware, software, and tools.
- Describe common networking communications protocols.
- Use Power over Ethernet (PoE) in a network application.
- Build and test Ethernet cables.
- Configure a wireless access point.
- Discover and assign Internet Protocol (IP) addresses for various industrial control components.
- Set up a complete Industrial Ethernet network.

**TECE 1050 Vision Systems Basic** **1 Credit / 30 Clock-Hours**

This course focuses on the Cognex Insight Easy Builder and Spreadsheet application interface with an additional emphasis on lighting, lenses, and filters. With the focus on getting the most from the In-Sight Explorer spreadsheets interface, users learn how to walk through the process of setting up a vision application using spreadsheet programming best practices. Students will learn to use advanced tools and tools recently added to the spreadsheet environment.

Objectives:
- Identify vision hardware and connections.
- Convert pixels to common measurements using calibration tools.
- Setup software interface and acquire first images.
- Identify parts using pattern matching and Logic.
- Identify presence or absence of feature using histogram tools.
- Identify part edges using edge tools.
- Identify irregular shapes using blob tools and image filters.
- Configure input and output signals then demonstrate their use.
- Send process results to external devices.
- Create custom interface for pass/fail results.
- Deploy application using simple interface and advanced interface.
- Demonstrate use of multiple lighting principles and techniques.

**TECE 1100 Programmable Logic Controllers II** **3 Credits / 90 Clock-Hours**

This course will introduce Studio 5000 Logix Designer (previously known as RSLogix 5000) and the CompactLogix PLC. Students will program using ladder logic for multiple labs based on industrial applications. Students will be required to wire, program, and troubleshoot various systems. Students will program a process on an actual machine as the final project.

Objectives:
• Connect to and configure a Programmable Logic Controller (PLC) using PLC programming software.
• Use tags, subroutines, data types, arrays, and sequencer code structure in programmable controller programming.
• Use input and output instructions, timers, counters, math instructions, and compare instructions in programmable logic controller programming.
• Connect and configure input and output (I/O) expansion cards, both local and remote.
• Demonstrate proper PLC wiring.
• Program a complete process from scratch.

**TECE 1150 Human Machine Interface (HMI) Programming** **2 Credits / 60 Clock-Hours**

Human-Machine Interface (HMI) operator stations have become commonplace in modern industry because they eliminate wiring, enable operator functions to be modified in software, and provide the ability for the operator to monitor PLC operations data. Students will learn how to convert a Programmable Logic Controller program into a graphic Human Machine Interface Panel. Training will cover major topic areas including application editing, tags and communications, creating data logs, input and output objects, local messages and alarms, diagnostics, and information messages. Prerequisite: CTRL2100 Programmable Logic Controllers 2.

Objectives:
• Describe the use and need for Human Machine Interface (HMI) in an automation environment.
• Interface an HMI with a Programmable Logic Controller (PLC) to simulate a virtualized system.
• Create graphic displays.
• Build and animate an interactive graphic display.
• Configure HMI tag-based alarms.
• Create and configure a historical trend.
• Create and view a data log model.
• Use a graphic HMI panel to control a process on an actual machine.

**TECE 1200 Industrial Networking II** **2 Credits / 60 Clock-Hours**

The Industrial Networking II course teaches students how to use industrial networks. Device communication can be one of the most challenging aspects of any automated system. In this course, students will network PLCs, remote I/O blocks, sensor systems, servo drives, and robots so they are able to consistently pass information between devices. This is done through configuring network communication between PLCs and I/O block, sensor systems, servos, and robots. Students who complete this course can setup and maintain an industrial network.

Objectives:
• Apply Industrial Networking concepts to devices used in industry.
• Set up industrial grade networking hardware.
• Configure network communication between Programmable Logic Controllers (PLCs), input and output (I/O) blocks, sensor systems, servos, and robots.
• Use standard PLC sequencer logic to control a process.
• Wire I/O and PLC network connections.
• Set up a remote connection to a PLC.

**TECE 1250 Servo Motors and Drives** **1 Credit / 30 Clock-Hours**

Introduces servomechanisms to the student. Covers the basic operation of a motion control application. Students will program a servo drive and motor to perform basic motion commands. This course will be directed to configuration and tuning of motion control applications. Students will wire and program an electric motor drive to be self-controlled within a process. Prerequisite: CTRL2150 HMI Programming.

Objectives:
• Describe the components of a servomechanism.
• Use a network to connect a PLC to motion control modules.
• Configure motion modules in a Programmable Logic Controller (PLC).
• Write a PLC program to perform motion control.
• Write a PLC program to perform motion control with multiple axes.

**TECE 1800 Integration Capstone** **4 Credits / 120 Clock-Hours**

This course will involve many aspects of an industrial control system. Students must complete a high skill level project. Students may be required to design, draw schematics, create flow charts, write progress reports, program a robot, program a Programmable Logic Controller (PLC), program servos, wire devices, or present for their capstone project. This may also include safety systems, risk assessments, and code diagrams. Students may be required to integrate the following items: PLC, HMI, servo drive, network switch, vision system, safety system, and industrial robotic arm. Instructor approval is required for the final project. Working students may propose an on-the-job project contingent on instructor and employer approval.

Objectives:
• Demonstrate advanced troubleshooting techniques.
• Build a project using advanced programming in one or more of the following: Programmable Logic Controllers (PLC), Human Machine Interface (HMI), robots, servos, safety equipment, industrial networking equipment.
• Demonstrate a structured coding method.
• Report the project while following instructor reporting requirements.

## Supplemental Courses Varies by Institution

*Bridgerland*

**TECE 1300 Programmable Logic Controllers III** **3 Credits / 90 Clock-Hours**

This course will expand on the Programmable Logic Controller II course. This course will cover operation and application of safety programmable logic controllers, safety relays, safety I/O and risk assessments. Students will program a system using PID control methods. Students will be introduced to Structured Text and Function Block programming as well as Add-On instructions. Students will learn how to program using a structured programming method.

Objectives:
• Write a Programmable Logic Controller (PLC) program that uses the PID (Proportional Integral Derivative) method to control a process.
• Program a safety PLC using regular and safety I/O.
• Use an external safety relay in a PLC application.
• Perform a risk assessment.
• Use function block and structured text in basic PLC projects.
• Use Add-On Instructions (AOI) to enhance a PLC program.
• Program a PLC using a structured method.

**TECE 1320 Vision Systems Advanced** **1 Credit / 30 Clock-Hours**

Vision systems are one of the most advanced tools in a technician's toolbox. Advances in deep learning for inspection and quality control applications, as well as character recognition, tool applications, and more advanced lighting techniques will be discussed and applied in this course. Prerequisite: CTRL2050 Vision Systems Basic.

Objectives:
• Deploy VIDI deep learning tools.
• Apply advanced find tools.
• Identify text using OCR text recognition tools.
• Identify inconsistent/flexible features using advanced edge inspection tools.
• Identify unique colors using color tools.
• Build and execute a custom script.
• Apply advanced lighting including off axis, dome, lighting controllers, strobing.

**TECE 1420 Programmable Logic Controller Platforms** **1 Credit / 30 Clock-Hours**

The Programmable Logic Controller Platforms course helps students to practice using Programmable Logic Controller (PLC) platforms. This course covers how to choose a PLC platform and how to learn the software and hardware of that system. It also goes over how to set up, configure, and program this PLC in a variety of labs simulating industrial applications to provide students with an opportunity to develop their skills. Students who complete this course demonstrate an understanding and ability to program and troubleshoot PLC platforms.

Objectives:
• Use a Programmable Logic Controller (PLC) from a selected manufacturer.
• Perform Programmable Logic Controller programming on a selected platform.
• Use Programmable Logic Controller programming software to create and edit programs on a selected platform.

**TECE 1440 Human Machine Interface (HMI) Platforms** **1 Credit / 30 Clock-Hours**

The Human Machine Interface (HMI) Platforms course covers how to choose a robot platform from a variety of available Human Machine Interface (HMI) systems. It allows students to perform fundamental HMI tasks with the selected unit. The course also introduces students to the interface, tools, and overall operation of the system from manuals and resources provided by the various vendors, with extensive instructor guidance. Students who complete this course are able to organize, operate, and troubleshoot HMI platforms.

Objectives:
• Use a Human Machine Interface (HMI) or Supervisory Control and Data Acquisition (SCADA) software from a selected manufacturer.
• Configure communication between the selected platform and a Programmable Logic Controller (PLC).
• Create graphic displays on a selected platform.
• Build an interactive graphic display on a selected platform.
• Animate an interactive graphic display on a selected platform.

**TECE 1460 Robot Platforms** **1 Credit / 30 Clock-Hours**

The Robot Platforms course covers how to choose a robot platform from a variety of available Human Machine Interface (HMI) systems and perform HMI tasks, such as creating, modifying, and executing various programs. With instructor guidance, the course introduces students to the interface, tools, and overall operation of the system from vendor provided manuals and resources. Students who complete this course demonstrate how to operate, alter, maintain, and troubleshoot robot platforms and perform HMI tasks.

Objectives:
• Power up and jog the robot.
• Recover from common program and robot faults.
• Execute production operations.
• Create, modify, and execute a material handling program.
• Monitor, force, and simulate input and output signals.
• Backup and restore individual programs and files.

**TECE 1480 Vision Platforms** **1 Credit / 30 Clock-Hours**

Students will choose a vision platform from available industrial vision systems and perform fundamental tasks using that system. With instructor guidance, students will need to be prepared to discover the interface, tools, and overall operation of the system from vendor provided manuals and resources. Prerequisite: CTRL2050 Vision Systems Basic.

Objectives:
• Identify vision hardware and connections.
• Convert pixels to common measurements using calibration tools.
• Setup software interface and acquire first images.
• Identify parts using pattern matching and Logic.
• Identify presence or absence of feature using histogram tools.
• Identify part edges using edge tools.
• Identify irregular shapes using blob tools and image filters.
• Configure input and output signals then demonstrate their use.
• Send process results to external devices.
• Create custom interface for pass/fail results.
• Deploy application using simple interface and advanced interface.

**TECE 1500 FANUC Basic Programming** **1 Credit / 30 Clock-Hours**

The course covers the tasks that an operator, technician, engineer, or programmer needs to set up and program a FANUC Robotics Handling Tool Software Package. Students will practice hands-on pendant labs with industrial grade FANUC LR Mate 200i D manipulators and FANUC System R-30i B Mate Controllers. Prerequisite: AMAR1700 Introduction to Industrial Robotics.

Objectives:
• Power up and Jog the robot using multiple coordinate systems.
• Recover from common program and robot faults.
• Execute production operations.
• Create, modify, and execute a material handling program.
• Create and execute MACROs.
• Monitor, Force, and Simulate Input and Output Signals.
• Apply positional offsets in a material handling operation.
• Backup and restore individual programs and files.

**TECE 1550 FANUC ROBOGUIDE Simulation Software** **2 Credits / 60 Clock-Hours**

This course will provide procedures for creating a HandlingPRO virtual workcell. When completed, the workcell created will contain a FANUC robot with end-of-arm tooling, one or more fixtures for holding a part, and a robot TPP Program which moves the part from one fixture to the other. Prerequisite: CTRL2500 FANUC Basic Programming.

Objectives:
• Create a new workcell.
• Edit the robot properties.
• Add a part and objects to the workcell.
• Add End-of-arm Tooling to the robot.
• Add a pick fixture to the workcell.
• Add a place fixture to the workcell.
• Create a robot program.
• Create a program using Draw Features on Part.
• Run the programs.
• Use Task Profiler to analyze program run.
• Create a program to pick and place random parts.
• Create an AVI of the workcell.
• Add a second robot to the workcell.
• Setup extended axis and add 2nd & 3rd motion group, then create machines for the 7th axis and motion groups.
• Create a program that will trace lines and move blocks.

**TECE 1620 Robot Vision and Safety** **1 Credit / 30 Clock-Hours**

This course covers the basic tasks and procedures required for an operator, technician, engineer, or programmer to set up, teach, test, and modify iRVision applications and FANUC Dual Check Safety (DCS) software. Upon successful completion of this course, students can identify the components of a vision system, install vision hardware, develop an application, program the robot, perform error recovery procedures, and follow recommended safety practices. Prerequisite: CTRL2500 FANUC Basic Programming.

Objectives:
• View and/or change robot and computer parameters to facilitate access to the robot's web page.
• Set up a camera.
• Perform an inspection vision process.
• Understand basic vision concepts and lighting.
• Master a robot using vision mastering.
• Create tool frame for the robot applicator.
• Create user frames necessary for use with the vision system.
• Calibrate a camera.
• Set up a 2D single-view vision process.
• Program the robot to respond to vision results.
• Understand the DCS menus.
• Set up and Modify DCS General parameters.
• Set up position check functions.
• Recover from DCS alarm.
• Modify DCS Zone Checks.
• Setup Stop Position Prediction.
• Create User Models and User Frames.
• Set up and modify Speed Check parameters.
• Set up and Modify DCS Safe I/O parameters.

**TECE 1700 FANUC Advanced Programming** **1 Credit / 30 Clock-Hours**

Advanced programming is the next step after a basic programming class. Topics from the previous classes will be used in this class to develop a more complex scenario. Students will be given a hypothetical example workcell. They will then be given the task of creating all the necessary programs to deal with multifaceted issues using advanced programming techniques. Prerequisite: CTRL2500 FANUC Basic Programming.

Objectives:
• Manipulate frames related to programming issues.
• Demonstrate advanced program control structures.
• Establish PLC Robot communication using User Operator Panel.
• Master the robot.
• Establish Ethernet communication.
• Set payload and payload change.
• Set tool frame offsets.
• Apply reference positions.
• Pull parts through a predefined system.
• Set up multi-tasking operations.
• Design and implement methods for Error Recovery.

**TECE 1750 Manufacturing Analytics** **2 Credits / 60 Clock-Hours**

This course will provide students with experience working with data as a control systems technician. Students will become familiar with the types of tasks which will be required of control systems technicians working with data in manufacturing. Students will learn several manufacturing data concepts while using multiple sets of data based on real-world scenarios, and apply the principles learned using real world systems.

Objectives:
• Analyze data from multiple real-world manufacturing scenarios for multiple real-world manufacturing purposes.
• Present findings using an Human Machine Interface (HMI) or a Data Visualization program.
• Setup data transfer from a Programmable Logic Controller (PLC)-driven manufacturing system to a database table or spreadsheet.

**TECE 2901 Special Applications for Controls** **6 Credits / 180 Clock-Hours**

This course provides students unique controls skill development identified as an immediate need in the current occupational industry or as needed for prerequisite training in the Controls Engineering Technology certificate. Specific course objectives will be documented and when possible, a descriptive title will be provided for the student transcript. Credit will be given in 30 hour increments up to a maximum of 180 hours.

Objectives:
• These will be determined on an individual course basis and will be made known to the student upon instructor approval of the course to be taken or the skill to be developed.

**TECE 2999 Controls Engineering Externship** **6 Credits / 270 Clock-Hours**

The Controls Engineering Externships course gives students real-world experience in a work-based environment. Students propose a high-level skill project to complete at a workplace. The project must be approved by an instructor and an employer and will be evaluated by the employer. Students may be required to design, draw schematics, create flow charts, write progress reports, program a robot, program a Programmable Logic Controller (PLC), program servos, wire devices, or present for their capstone project the following items: PLC, HMI, servo drive, network switch, vision system, safety system, and industrial robotic arm. Students who complete this course have real world experience applying what they have learned throughout their time in the program.

Objectives:
• Demonstrate advanced troubleshooting techniques.
• Build a project using advanced programming in one or more of the following: Programmable Logic Controllers (PLC), Human Machine Interface (HMI), robots, servos, safety equipment, industrial networking equipment.
• Demonstrate a structured coding method.
• Report the project while following instructor and employer reporting requirements.