COURSE SYLLABUS

COURSE TITLE: C - 216 Robot Systems Integration 1

INSTRUCTOR: Jacob Bradshaw

OFFICE LOCATION/HOURS: Bock, Rm 230

OFFICE PHONE: 260.665.4313

EMAIL: jbradshaw19@trine.edu

COURSE DESCRIPTION:

Students will be introduced to the basic theory, operation, and programming of industrial robots. Key skills include: interpreting robot programs, developing robot sequence operations and robot program for an application, entering robot programs and points using a teach pendant, interfacing on/off input sensors and solenoid output devices to digital I/O of robot, interfacing digital I/O of robot to PLC, and cycle time optimization. Programs commands include: 3 types of motion, speed, offset, data register, branching, digital I/O, looping, waiting, and macros. Through the use of lecture, hands-on laboratory activities, Fanuc RoboGuide software and simulation, and teach pendant programming, students will complete hands-on labs with APTMFG CSM trainer. Students will also be exposed to virtual simulations, projects, and critical thinking assignments to help prepare for the silver and gold SACA C-216 Robot Systems Integration 1 certification exam.

PREREQUISITES: None

REQUIRED TEXT: None

LEARNING OUTCOMES: Upon completion of this course, the student should be able to:

1. Identify safety hazards and apply safe working practices when working with automated equipment.
2. Demonstrate ability to set up and jog a 6-axis robot.
3. Demonstrate an ability to appropriately start, operate, and shut down an industrial robotic cell.
4. Demonstrate an ability to effectively define tool center points (TCP).
5. Develop an understanding of the various coordinate systems used in robotic programming applications.
6. Demonstrate ability to backup and restore individual files and programs.
7. Demonstrate an ability to recover robot operation from common faults and errors.
8. Demonstrate an ability to monitor, force, and simulate robot inputs and outputs.
9. Create and execute MACRO's commands within a robotic application.
10. Demonstrate an ability to create programs with a subroutine structure.
11. Demonstrate an ability to modify programmed positions.
12. Demonstrate ability to read and interpret technical documents pertaining to the robotic cell.
13. Demonstrate ability to use various types of software applicable (RoboGuide) to the course.
14. Assess readiness to take the SACA C-216 Robot Systems Integration 1 Certification exam.

COURSE REQUIREMENTS: Internet connection, min 2GB USB drive, notebook, writing device, safety glasses

ATTENDANCE/PARTICIPATION: Students are expected to attend all class and laboratory sessions. Absences may be permitted for reasonable causes, including but not limited to, illness, disabling injury, death or serious illness in the immediate family. Participation in University-sponsored activities shall also constitute a reasonable cause for absence from class. Written documentation of the reason for absence may be required and, in the case of University-sponsored events, such documentation will be provided by the University sponsor. It is the student's responsibility to discuss pending absences (field trips, athletic competitions, etc.) with his/her professor prior to the missed class period. The faculty member may require the student to complete any work due prior to the absence.

GRADING/EVALUATION:

SACA Silver Online Exam = Minimum Passing Score (80%)

SACA Gold In-Person Hands-On Practical Exam = Minimum Passing Score (100%)

OTHER POLICIES:

Trine University industrial partnerships will dictate course start and completion date. Trine University has the right to amend any current or future policies pertaining to the TCTT, Trine Center for Technical Training.

Proper clothing is required when working with a robotic application. No jewelry, no loose hair, no open toed shoes, sandals or flip flops is permitted when working within a robotic cell. This is strictly enforced.

ACADEMIC MISCONDUCT:

The University prohibits all forms of academic misconduct. Academic misconduct refers to dishonesty in examinations (cheating), presenting the ideas or the writing of someone else as one's own (plagiarism) or knowingly furnishing false information to the University by forgery, alteration, or misuse of University documents, records, or identification. Academic dishonesty includes, but is not limited to, the following examples: permitting another student to plagiarize or cheat from one's own work, submitting an academic exercise (written work, printing, design, computer program) that has been prepared totally or in part by another, acquiring improper knowledge of the contents of an exam, using unauthorized material during an exam, submitting the same paper in two different courses without knowledge and consent of professors, or submitting a forged grade change slip or computer tampering. The faculty member has the authority to grant a failing grade in cases of academic misconduct as well as referring the case to Student Life.

PLAGIARISM:

You are expected to submit your own work and to identify any portion of work that has been borrowed from others in any form. An ignorant act of plagiarism on final versions and minor projects, such as attributing or citing inadequately, will be considered a failure to master an essential course skill and will result in an F for that assignment. A deliberate act of plagiarism, such as having someone else do your work, or submitting someone else's work as your own (e.g., from the Internet, fraternity file, etc., including homework and in-class exercises), will at least result in an F for that assignment and could result in an F for the course.

ELECTRONIC DEVICES:

Use of electronic devices including smart watches and cell phones is prohibited during exams or quizzes unless directly allowed by the instructor.

ADDITIONAL INFORMATION:

Course Curriculum: "Skill" is equivalent to hands-on lab.

Week 1

1. Introduction to Robotics
    1. **Standard 216.1.1 Enter and interpret robot program with motion commands**
        - Performance Indicators:
            - Interpret a robot motion command
            - Use a teach pendant to enter a robot motion command
        - Knowledge Indicators:
        - Describe three types of robot motion commands (linear, joint, and circular)
        - Describe the parts of a robot motion command
        - Describe the position configuration settings
        - Describe operation of motion command speed settings
        - Describe types of motion command terminations
        - Describe the use of local and global points
    2. **Standard 216.1.2 Enter and interpret robot program tool and user frame offset commands**
        - Performance Indicators:
            - Interpret a robot program tool offset command
            - Interpret a robot program user frame offset command
            - Use a teach pendant to enter a robot offset command
        - Knowledge Indicators:
        - Describe the operation of the tool offset command
        - Describe the operation of the user frame offset command
    3. **Standard 216.1.3 Enter and interpret robot program data register commands**

- Performance Indicators:
  - Interpret a robot program that uses a data register command
  - Use a teach pendant to enter a robot register command
- Knowledge Indicators:
- Define a data register
- Define direct and indirect data register addressing
- Describe the operation of the arithmetic data register instruction
  - Quiz

Week 2

2. Introduction to Robotics Commands

4. **Standard 216.1.4 Enter and interpret robot program branching commands**
   - Performance Indicators:
     - Interpret a robot program that uses unconditional branching
     - Interpret a robot program that uses conditional branching
     - Use a teach pendant to enter a robot branching command
   - Knowledge Indicators:
   - Describe the function of conditional and unconditional branching commands
   - Describe the operation of the JMP and LBL commands
   - Describe the operation of the CALL command
   - Describe the operation of the Register IF command
   - Describe the operation of the Select command
5. **Standard 216.1.5 Enter and interpret robot program looping and wait commands**
   - Performance Indicators:
     - Interpret a robot program that uses looping
     - Interpret a robot program that uses a wait command
     - Use a teach pendant to enter a robot looping and wait commands
   - Knowledge Indicators:
   - Describe the function of looping commands
   - Describe the operation of the For…Do loop
   - Describe the operation of the Repeat loop
   - Describe the operation of the While loop
   - Describe the operation of the Wait command

Week 3

3. Introduction to Robotics Communications

- **TOPIC 216.2 ROBOT COMMUNICATIONS**

1. **Standard 216.2.1 Interface and test discrete robot inputs and outputs**
   - Performance Indicators:
     - Interface and test robot digital input with an input sensor
     - Interface and test robot digital output with solenoid
     - Test safety enhancing devices
   - Knowledge Indicators:
   - Describe how input/output devices are wired to a robot
   - Describe the operation of robot I/O forcing
   - Describe how safety enhancing devices are wired to a robot
   - Describe how end effector I/O are wired to a robot
2. **Standard 216.2.2 Interface and test PLC I/O to robot controller**
   - Performance Indicators:
     - Interface and test robot discrete I/O to PLC I/O
     - Interface and test robot to PLC modular I/O

- Knowledge Indicators:
- Describe the operation of modular PLC I/O
- Describe how PLC discrete I/O are wired to robot I/O

3. **Standard 216.2.3 Enter and interpret robot programs that use discrete I/O**
   - Performance Indicators:
     - Interpret robot programs that use discrete I/O
     - Interpret robot programs that use program condition monitoring
     - Use a teach pendant to enter a robot discrete I/O commands
   - Knowledge Indicators:
   - Describe two types of condition monitoring: program and system
4. **Standard 216.2.4 Connect and test robot Ethernet network communications**
   - Performance Indicators:
     - Connect and test a robot to Ethernet network connection
   - Knowledge Indicators:
   - Describe robot Ethernet communications capabilities

Week 4

4. Introduction to Robotic Applications

- **TOPIC 216.3 ROBOT APPLICATIONS**

1. **Standard 216.3.1 Enter and test a robot program Macro command**
   - Performance Indicators:
     - Enter and test a Macro command to operate an end effector
     - Enter and test a Macro command to move to a position
   - Knowledge Indicators:
   - Describe the operation of a robot macro
   - Describe the Macro table and Macros screen
   - Describe applications of macros
   - Describe manual and automatic methods of executing a macro
2. **Standard 216.3.2 Develop and test a basic pick and place robot program**
   - Performance Indicators:
     - Develop and test a basic pick and place robot program that picks up parts from a feeder and places them on a conveyor
   - Knowledge Indicators:
   - Describe the sequence of a pick and place operation
   - Describe applications of pick and place robot programs
   - Describe how to plan a motion path for pick and place with robot approach, avoidance and placement points
3. **Standard 216.3.3 Develop and test a machine load/unload robot program**
   - Performance Indicators:
     - Develop and test a machine load robot program that picks up parts from a feeder and places in a CNC machine
   - Knowledge Indicators:
   - Describe the sequence of a robot machine load operation
   - Describe applications of machine load robot programs
   - Describe how to plan a motion

Week 5

5. Introduction to Robotic Applications

4. **Standard 216.3.4 Develop and test a basic assembly robot program**
   - Performance Indicators:
     - Develop and test a basic assembly robot program that picks up parts from a feeder and assembles parts using press fit
   - Knowledge Indicators:
   - Describe the sequence of a robot mechanical assembly operation
   - Describe applications of mechanical assembly robot programs
   - Describe how to plan a motion path for assembly with robot approach, avoidance and placement points
   - Describe types of assembly feeders: gravity, vibratory, etc.

5. **Standard 216.3.5 Develop and test a basic gluing robot program**
   - Performance Indicators:
     - Develop and test a basic gluing robot program that applies a glue line on a part
   - Knowledge Indicators:
   - Describe the sequence of a robot gluing assembly operation
   - Describe applications of gluing assembly robot programs
   - Describe how to plan a motion path for gluing with robot approach and application points
   - Describe types of glue systems and end effectors

- Self-Review 1
- Quiz

Week 6

1. SACA TEST STUDY GUIDE – ROBOTIC SYSTEM INTEGRATION 1
1. SACA SILVER EXAM (Online Proctored Exam)
2. SACA GOLD EXAM (Hands-On Proctored