Western Technical College

31414356 Introduction to Industrial Controls

Course Outcome Summary

Course Information

Description	This course includes fundamental wiring concepts, relay ladder logic, sensors, timers, motor fundamentals, motor starters and an introduction to Variable Frequency Drives.
Career Cluster	Manufacturing
Instructional Level	Technical Diploma Courses
Total Credits	3.00
Total Hours	108.00

Types of Instruction

Instruction Type	Credits/Hours
Lecture	1 CR / 36 HR
Lab	2 CR / 72 HR

Course History

Last Approval Date	7/7/2015

Pre/Corequisites

Pre/Corequisite	31660310 Electricity Basics

Textbooks

Electricity Basic and Intro to Industrial Controls (Custom Book). Petruzella, Frank. Publisher: McGraw-Hill Publishing Company. **ISBN-13**:978-1-3081-1020-2. Required.

Learner Supplies

Safety glasses with side eye protection that meet Z87 OSHA guidelines. **Vendor:** Campus Shop. Required.

Scientific calculator - T1-30XIIS. **Vendor:** Campus Shop. Required.

Core Abilities

1. **Apply mathematical concepts.**
   Status *Active*

2. **Demonstrate ability to think critically.**
   Status *Active*

3. **Use effective communication skills.**
   Status *Active*

4. **Use technology effectively.**
   Status *Active*

Program Outcomes

1. **Adhere to proper safety practices and procedures.**
   Type *Local* ***Code*** * * ***Status*** *Active*

2. **Exhibit professionalism.**
   Type *Local* ***Code*** * * ***Status*** *Active*

3. **Perform preventative maintenance.**
   Type *Local* ***Code*** * * ***Status*** *Active*

4. **Maintain parts and equipment inventory including service documentation.**
   Type *Local* ***Code*** * * ***Status*** *Active*

5. **Maintain electrical and electronic devices and systems.**
   Type *Local* ***Code*** * * ***Status*** *Active*

6. **Build or assemble electrical, electronic and mechanical hardware under the guidance of a journeyman electrician or electromechanical technician.**
   Type *Local* ***Code*** * * ***Status*** *Active*

Course Competencies

1. **Evaluate the electromechanical operation of pilot devices.**
   Domain *Cognitive* ***Level*** *Evaluation* ***Status*** *Active*

   Linked Core Abilities
   Use technology effectively.

   Assessment Strategies
   1.1. by demonstrating your performance in a lab exercise.
   1.2. by demonstrating your competence in a lab performance test.
   1.3. by answering questions related to the learning objectives on a unit quiz.

   Criteria

   Your performance will be successful when:
   1.1. learner categorizes pilot devices in terms of their function.
   1.2. learner correctly identifies the electrical symbol for various pilot devices.
   1.3. learner develops practical control circuits as directed using designated pilot devices.
   1.4. learner develops and verifies the operation of latching and jogging control circuits.
   1.5. learner develops and verifies the operation of non-timed sequence control circuits.
   1.6. learner employs appropriate instrumentation for pilot device testing.

Learning Objectives

1.a. Categorize pilot devices in terms of their function.
1.b. Identify the electrical symbol for various pilot devices.
1.c. Develop practical control circuits using various pilot devices.
1.d. Develop latching control circuits.
1.e. Build and verify the operation of latching control circuits.
1.f. Develop jogging control circuits.
1.g. Build and verify the operation of jogging control circuits.
1.h. Develop non-timed sequence control circuits.
1.i. Build and verify the operation of non-timed sequence control circuits.
1.j. Utilize appropriate instrumentation for pilot device testing.

2. Analyze Photoelectric and Proximity controls.

Domain *Cognitive* ***Level*** *Analysis* ***Status*** *Active*

Linked Core Abilities

Demonstrate ability to think critically.

Assessment Strategies

2.1. by demonstrating your performance in a lab exercise.
2.2. by demonstrating your competence in a lab performance test.
2.3. by answering questions related to the learning objectives on a unit quiz.

Criteria

Your performance will be successful when:

2.1. learner constructs circuits to verify the operation of through-beam photoelectric devices.
2.2. learner builds circuitry necessary to test the operation of retroreflective photoelectric devices.
2.3. learner constructs circuits to verify the operation of diffuse scan photoelectric devices.
2.4. learner explains the term "modulated light source."
2.5. learner compares "2-wire" and "3-wire" control configurations.
2.6. learner contrasts "Sinking" and "Sourcing" outputs for proximity switches.

Learning Objectives

2.a. Investigate the operation of through-beam photoelectric devices.
2.b. Investigate the operation of retroreflective photoelectric devices.
2.c. Investigate the operation of diffuse scan photoelectric devices.
2.d. Discuss the term "modulated light source."
2.e. Compare "2-wire" and "3-wire" control configurations.
2.f. Examine "Sinking" and "Sourcing" outputs for proximity switches.

3. Analyze circuit applications of control relays.

Domain *Cognitive* ***Level*** *Analysis* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Assessment Strategies

3.1. by demonstrating your performance in a lab exercise.
3.2. by demonstrating your competence in a lab performance test.
3.3. by answering questions related to the learning objectives on a unit quiz.

Criteria

Your performance will be successful when:

3.1. learner classifies control relays according to type and function..
3.2. learner describes the electrical properties of control relays.
3.3. learner develops practical control circuits using selected control relays.
3.4. learner assembles and tests control circuits using control relays.
3.5. learner develops circuits with control relays to produce sequenced control of outputs.
3.6. learner builds and tests circuits using control relays to produce sequenced control of outputs.

Learning Objectives

3.a. Classify control relays according to type and function.
3.b. Evaluate the electrical properties of control relays.
3.c. Develop practical control circuits using selected control relays.
3.d. Assemble control circuits using control relays.
3.e. Verify the operation of control circuits with control relays.
3.f. Develop control circuits to perform sequenced control of outputs.
3.g. Assemble control circuits that perform sequenced control of outputs.
3.h. Verify the operation of test control circuits that perform sequenced control of outputs.

4. Analyze control circuit applications using time delay relays and cycle timing.

Domain *Cognitive* ***Level*** *Synthesis* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Assessment Strategies

4.1. by demonstrating your performance in a lab exercise.
4.2. by demonstrating your competence in a lab performance test.
4.3. by answering questions related to the learning objectives on a unit quiz.

Criteria

Your performance will be successful when:

4.1. learner classifies time delay relays according to type and function.
4.2. learner describes the electrical properties of control time delay relays.
4.3. learner develops practical control circuits using selected time delay relays as required.
4.4. learner assembles and tests control circuits using time delay relays.
4.5. learner describes the electrical properties of cycle timers.
4.6. learner develops practical control circuits using a cycle timer.
4.7. learner assembles and tests a cycle timing circuit.

Learning Objectives

4.a. Classify time delay relays according to type and function.
4.b. Evaluate the electrical properties of control time delay relays.
4.c. Develop practical control circuits using selected time delay relays as required.
4.d. Assemble control circuits using time delay relays.
4.e. Verify the operation of control circuits using time delay relays.
4.f. Evaluate the electrical properties of cycle timers.
4.g. Develop practical control circuits using a cycle timer.
4.h. Assemble a cycle timing circuit.
4.i. Verify the operation of a cycle timing circuit.

5. Apply proper techniques to terminate conductors at wiring devices.

Domain *Cognitive* ***Level*** *Applying* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Assessment Strategies

5.1. Performance

Criteria

Your performance will be successful when:

5.1. learner can describe various types of terminal connections.
5.2. learner can identify common wiring devices.
5.3. learner can prepare conductors, cords and cables for termination.
5.4. learner can connect and terminate wires using crimp connectors.
5.5. learner can test terminated wiring for opens and shorts.

Learning Objectives

5.a. Describe various types of terminal connections.
5.b. Identify common wiring devices.

5.c. Prepare conductors, cords and cables for termination.
5.d. Connect and terminate wires using crimp connectors.
5.e. Test terminated wiring for opens and shorts.

6. Evaluate electrical conductors for applications.

Domain *Cognitive* ***Level*** *Evaluating* ***Status*** *Active*

Linked Core Abilities

Demonstrate ability to think critically.

Assessment Strategies

6.1. Written Objective Test

Criteria

Your performance will be successful when:

6.1. learner can define units of measurement related to electrical conductors.
6.2. learner can describe tools and methods to determine conductor size.
6.3. learner can determine conductor ampacity from the National Electrical Code (NEC) tables.
6.4. learner can identify types of flexible cords and cables.

Learning Objectives

6.a. Define units of measurement related to electrical conductors.
6.b. Describe tools and methods to determine conductor size.
6.c. Determine conductor ampacity from National Electrical Code (NEC) tables.
6.d. Identify types of flexible cords and cables.

7. Apply common wiring methods used in the electrical industry.

Domain *Cognitive* ***Level*** *Applying* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Assessment Strategies

7.1. Simulation

Criteria

Your performance will be successful when:

7.1. learner can identify various types of electrical boxes and fittings.
7.2. learner can install fittings into electrical boxes with and without pre-punched holes.
7.3. learner can connect cables and conduit to boxes.
7.4. learner can install various types of wiring devices.
7.5. learner can apply National Electrical Code (NEC) grounding criteria.

Learning Objectives

7.a. Identify various types of electrical boxes and fittings.
7.b. Install fittings into electrical boxes, with and without pre-punched holes.
7.c. Connect cables and conduit to boxes.
7.d. Install various types of wiring devices.
7.e. Apply National Electrical Code (NEC) grounding criteria.

8. Assess common electrical circuits.

Domain *Cognitive* ***Level*** *Evaluating* ***Status*** *Active*

Linked Core Abilities

Demonstrate ability to think critically.

Assessment Strategies

8.1. Skill Demonstration

Criteria

Your performance will be successful when:

8.1. learner can test installations for insulation integrity.
8.2. learner can test wiring for opens and shorts.
8.3. learner can test for proper circuit voltage.
8.4. learner can test for proper grounding.
8.5. learner can test for proper receptacle wiring.
8.6. learner can troubleshoot and repair defective circuits.

Learning Objectives

8.a. Test installations for insulation integrity.
8.b. Test wiring for opens and shorts.
8.c. Test for proper circuit voltage.
8.d. Test for proper grounding.
8.e. Test for proper receptacle wiring.
8.f. Troubleshoot and repair defective circuits.

9. Relate induction motor terminology, principles and theory to three-phase induction motors.

Domain *Cognitive* ***Level*** *Analysis* ***Status*** *Active*

Linked Core Abilities

Use effective communication skills.

Criteria

Your performance will be successful when:

9.1. Learner completes a written test with a passing grade.
9.2. Learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
9.3. Learner completes and submits assigned homework.

Learning Objectives

9.a. Explain the significance of nameplate data for a three-phase motor.
9.b. Describe the construction of a three-phase induction motor.
9.c. Wire a three-phase induction motor for correct operation.
9.d. Explain the rotating magnetic field of a three-phase motor.
9.e. Explain basic squirrel cage rotor principles.
9.f. Identify the terminal connections of a three-phase motor.

10. Utilize measured data to confirm the operating characteristics of induction motors.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Criteria

Your performance will be successful when:

10.1. Learner completes a written test with a passing grade.
10.2. Learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
10.3. Learner completes and submits assigned homework.

Learning Objectives

10.a. Determine voltage, current, power consumption and power factor for an induction motor by means of measurement.
10.b. Ascertain horsepower, torque, speed and efficiency characteristics of induction motors.
10.c. Explore power factor correction.
10.d. Test the insulation resistance of a motor using a megohmmeter.

11. Apply manual and magnetic motor starters to control a three-phase motor.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Criteria

Your performance will be successful when:

11.1. Learner completes a written test with a passing grade.
11.2. Learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
11.3. Learner completes and submits assigned homework.

Learning Objectives

11.a. Identify the parts and connections of a magnetic motor starter.
11.b. Apply a magnetic motor starter to control a three-phase motor.
11.c. Investigate the operation of a multi-station start/stop control.
11.d. Apply a reversing starter to control a three-phase motor in forward and reverse.
11.e. Relate the differences between NEMA and IEC starters.

12. Relate induction motor terminology, principles and theory to single-phase induction motors.

Domain *Cognitive* ***Level*** *Analysis* ***Status*** *Active*

Linked Core Abilities

Use effective communication skills.

Criteria

Your performance will be successful when:

12.1. Learner completes a written test with a passing grade.
12.2. Learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
12.3. Learner completes and submits assigned homework.

Learning Objectives

12.a. Explain the significance of nameplate data for a single-phase motor.
12.b. Describe the construction of a single-phase split phase induction motor.
12.c. Describe the construction of a single-phase capacitor start induction motor.
12.d. Connect single-phase motors for correct operation.
12.e. Explain the basic operating characteristics of a split-phase induction motor.
12.f. Explain the basic operating characteristics of capacitor start induction motors.
12.g. Identify shaded pole and universal motor applications.

13. Investigate the physical properties and construction of DC machines.

Domain *Cognitive* ***Level*** *Comprehension* ***Status*** *Active*

Linked Core Abilities

Demonstrate ability to think critically.

Criteria

Your performance will be successful when:

13.1. learner completes a written test with a passing grade.
13.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by the instructor.
13.3. learner completes and submits assigned homework problems.

Learning Objectives

13.a. Describe the construction of a DC machine.
13.b. Identify the field structure of a DC machine.
13.c. Identify the armature of a DC machine.
13.d. Identify the brushes of a DC machine.
13.e. Identify the commutator of a DC machine.
13.f. Identify the shaft and bearings of a DC machine.
13.g. Identify the end covers of a DC machine.
13.h. Identify the terminal connections of a DC machine.

14. Apply generator theory to the practical operation of DC generators.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Apply mathematical concepts.

Criteria

Your performance will be successful when:

14.1. learner completes a written test with a passing grade.
14.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
14.3. learner completes and submits assigned homework problems.

Learning Objectives

14.a. Explain the function of the generator field.
14.b. Explain the function of the generator armature.
14.c. Explain the function of the brushes and commutator.
14.d. Apply the principle of generator action to a DC generator.
14.e. Evaluate factors that affect voltage output of a DC generator.
14.f. Identify the major types of DC generators.
14.g. Test the output voltage characteristics of a DC generator.
14.h. Evaluate the effect of load changes on a DC generator.
14.i. Discuss generator efficiency.

15. Evaluate the physical and electrical properties of DC motors.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Apply mathematical concepts.

Criteria

Your performance will be successful when:

15.1. learner completes a written test with a passing grade.
15.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
15.3. learner completes and submits assigned homework problems.

Learning Objectives

15.a. Identify similarities and differences between the DC generator and motor.
15.b. Explain the significance of DC motor nameplate specifications.
15.c. Classify DC motors according to mounting types.
15.d. Apply motor wiring diagrams.
15.e. Test the insulation resistance and windings of a DC motor.
15.f. Identify different types of DC motors.
15.g. Discuss DC motor problems and maintenance.

16. Apply motor theory to the practical operation of DC motors.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Apply mathematical concepts.

Criteria

Your performance will be successful when:

16.1. learner completes a written test with a passing grade.
16.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
16.3. learner completes and submits assigned homework problems.

Learning Objectives

16.a. Explain the function of the motor field.
16.b. Explain the function of the motor armature.
16.c. Explain the function of the brushes and commutator.
16.d. Apply the principle of motor action to a DC motor.
16.e. Describe the effect of counter-electromotive force on motor operation.
16.f. Evaluate the effect of voltage polarity and magnitude on the operation of DC motors.
16.g. Evaluate DC shunt motor operation under load.
16.h. Describe methods for controlling the speed of DC motors.
16.i. Evaluate motor operation in terms of horsepower, torque, speed and efficiency.

17. Apply solid state overload protection to an AC motor.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Criteria

Your performance will be successful when:

17.1. learner completes a written test with a passing grade.
17.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
17.3. learner completes and submits assigned homework problems.

Learning Objectives

17.a. Interpret equipment installation and operation manuals.
17.b. Identify the functional characteristics of a solid state overload relay.
17.c. Connect and test a solid state overload relay to protect a motor.
17.d. Ascertain the rance of capabilities of a solid state overload relay.

18. Apply resistance reduced voltage starting to an AC motor.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Criteria

Your performance will be successful when:

18.1. learner completes a written test with a passing grade.
18.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
18.3. learner completes and submits assigned homework problems.

Learning Objectives

18.a. consult equipment manuals as needed.
18.b. Identify relay based methods of reduced voltage starting.
18.c. Discuss the need for reduced voltage starting.
18.d. Construct and test a reduced voltage starting system.

19. Apply solid state soft starting to an AC motor.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Criteria

Your performance will be successful when:

19.1. learner completes a written test with a passing grade.
19.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
19.3. learner completes and submits assigned homework problems.

Learning Objectives

19.a. Interpret equipment installation and operation manuals.
19.b. Identify the functional characteristics of a solid state soft starter.
19.c. Connect and test a solid state soft starter controlling a motor.
19.d. Ascertain the range of capabilities of a solid state soft starter.

20. Apply solid state methods of speed control to AC and DC motors.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Use technology effectively.

Criteria

Your performance will be successful when:

20.1. learner completes a written test with a passing grade.
20.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by the instructor.
20.3. learner completes and submits assigned homework problems.

Learning Objectives

20.a. Utilize equipment manuals to connect and test DC and AC motor speed controllers.
20.b. Connect and test a solid state DC motor speed controller.
20.c. Determine the capabilities of a solid state DC motor speed controller.
20.d. Connect and test an Adjustable Frequency Drive (AFD) for an AC motor.
20.e. Program an AFD for a variety of operating parameters.
20.f. Identify the functional characteristic of AFDs.

21. Apply fuse and circuit breaker fundamentals.

Domain *Cognitive* ***Level*** *Application* ***Status*** *Active*

Linked Core Abilities

Demonstrate ability to think critically.

Criteria

Your performance will be successful when:

21.1. learner completes a written test with a passing grade.
21.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
21.3. learner completes and submits assigned homework problems.

Learning Objectives

21.a. Apply proper terminology relative to fuses and circuit breakers.
21.b. Explain fuse operation.
21.c. Explain circuit breaker operation.
21.d. Identify different types of fuses and circuit breakers for application.
21.e. Explain the difference between current rating and interrupting rating.
21.f. Explain the significance of voltage rating for fuses and circuit breakers.
21.g. Determine if a fuse is blown or a breaker is tripped.

22. Evaluate the operation of common single and three-phase electrical systems.

Domain *Cognitive* ***Level*** *Analysis* ***Status*** *Active*

Linked Core Abilities

Apply mathematical concepts.
Demonstrate ability to think critically.

Criteria

Your performance will be successful when:

22.1. learner completes a written test with a passing grade.
22.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity

signed off by an instructor.

22.3. learner completes and submits assigned homework problems.

Learning Objectives

22.a. Outline the method of transmitting power over long distances.
22.b. Describe the layout of a typical 120/240 V single-phase power distribution system.
22.c. Perform tests to determine proper operation of a 120/240 V single-phase power distribution system.
22.d. Measure voltage, current and power in a single-phase 120/240 V system.
22.e. Calculate voltage current and power relations in a single-phase system.
22.f. Describe the layout of typical Wye and Delta three-phase power distribution systems.
22.g. Measure voltage, current and power in a three-phase system.
22.h. Construct single and three phase load circuitry.
22.i. Discuss the significance of the neutral wire in systems which require one.

23. Evaluate the operation of power transformers.

Domain *Cognitive* ***Level*** *Analysis* ***Status*** *Active*

Linked Core Abilities

Apply mathematical concepts.
Demonstrate ability to think critically.

Criteria

Your performance will be successful when:

23.1. learner completes a written test with a passing grade.
23.2. learner completes the supporting lab activities, makes corrections as necessary and has the activity signed off by an instructor.
23.3. learner completes and submits assigned homework problems.

Learning Objectives

23.a. Apply proper terminology relative to power transformers.
23.b. Explain the significance of transformer nameplate specifications.
23.c. Determine transformer current ratings.
23.d. Connect power transformers per their wiring diagrams.
23.e. Test the insulation resistance of a power transformer.
23.f. Calculate and measure voltage current and power relative to a power transformer.
23.g. Connect transformers in Wye and Delta configurations.