Western Technical College

# 10620103 Industrial Electricity

## Course Outcome Summary

### Course Information

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| **Description** | This course covers fundamental DC and AC electricity concepts as applied to industrial control systems. Electrical quantities, measurements and circuit characteristics/configurations will be introduced. DC, Single Phase and 3 Phase AC will be addressed along with transformers and inductance as related to motor control applications. |
| **Career Cluster** | Manufacturing |
| **Instructional Level** | Associate Degree Courses |
| **Total Credits** | 2 |
| **Total Hours** | 54 |

### Textbooks

*Delmar's Standard Textbook of Electricity*. 7th Edition. Copyright 2020. Herman, Stephan L. Publisher: Cengage Learning. **ISBN-13:** 978-1-337-90034-8. Required.

### Success Abilities

1. Cultivate Passion: Enhance Personal Connections
2. Cultivate Passion: Increase Self-Awareness
3. Live Responsibly: Develop Resilience
4. Refine Professionalism: Act Ethically
5. Refine Professionalism: Improve Critical Thinking

### Program Outcomes

1. Perform work safely.
2. Troubleshoot electrical and mechanical systems and devices.
3. Repair electrical and mechanical systems.

4. Communicate technical information.

## Course Competencies

### 1. Explore the properties of electrical circuits.

**Assessment Strategies**

1.1. Demonstration
1.2. Written Product

**Criteria**

*You will know you are successful when*

1.1. you explain the requirements of a complete electrical circuit.
1.2. you differentiate between an open circuit condition and a closed circuit condition.
1.3. you follow safety guidelines when circuit is attached to a source.
1.4. you define the terms "pole" and "throw" as they relate to mechanical switches.
1.5. you apply simple switching devices to open and close electrical circuits.
1.6. you construct electrical circuits.

**Learning Objectives**

1.a. Understand the requirements of a basic electrical circuit.
1.b. Identify the schematic symbols of the components of a basic electrical circuit.
1.c. Apply switching devices to open and close electrical circuits.
1.d. Differentiate between an open circuit condition and a closed circuit condition.
1.e. Become familiar with a variety of switch types.

### 2. Investigate electrical quantities and their characteristics.

**Assessment Strategies**

2.1. Written Objective Test

**Criteria**

*You will know you are successful when*

2.1. you explain the differences between conductors, insulators, and semiconductors as they apply to the atomic model.
2.2. you list the most common materials used as insulators and conductors.
2.3. you explain the theory of electrical charges.
2.4. you describe voltage, current, resistance, and power as they apply to an electrical circuit.
2.5. you calculate values of voltage, current, resistance, and power in a single resistor circuit utilizing Ohm's and Watt's Laws.
2.6. you explain the difference between "electron flow" and "conventional" current flow.

**Learning Objectives**

2.a. Describe the model of an atom, naming the characteristics of its structure and associative connection to electronics.
2.b. Discuss the theory of electrical charges.
2.c. Explain the differences between conductors, insulators, and semiconductors as they apply to the atomic model.
2.d. Describe voltage, current, resistance, and power as they apply to an electrical circuit.
2.e. Calculate values of voltage, current, resistance, and power in a single component circuit using Ohm's and Watt's Laws.
2.f. Discuss the conceptual differences between electron flow and conventional current
2.g. Identify fixed resistor component values and tolerances using the EIA color code.
2.h. Use Ohm's Law and Watt's Law to determine the resistance and wattage ratings for resistors used in electronic circuits.
2.i. Calculate energy consumption and apply cost factors.

### 3. Explore electrical circuit configurations.

**Assessment Strategies**

3.1. Skill Demonstration

3.2. Written Product

**Criteria**

*You will know you are successful when*

3.1. you reduce a series resistive circuit to an equivalent resistance.
3.2. you calculate, using Ohm's Law and Watt's Law, all electrical quantities for series resistive circuits.
3.3. you identify a series electrical path.
3.4. you calculate voltage drops, using Kirchoff's Voltage Law and the voltage divider rule, for all resistive values in open and closed series resistive circuits.
3.5. you build lab circuits to operate to specified tolerances.
3.6. learner identifies a parallel resistive circuit containing a multiple number of resistors.
3.7. learner applies Ohm's Law and Watt's Law to obtain all values of parallel circuit models.
3.8. learner calculates total circuit resistive values in parallel circuits.
3.9. learner verifies calculated values with working models for parallel circuits.
3.10. learner reduces a combinatorial series - parallel resistive circuit to an equivalent resistance.
3.11. learner calculates, using Ohm's, Watt's, and Kirchoff's Laws, all electrical quantities throughout a three-resistor combination series - parallel resistive circuit.
3.12. learner measures values in combinatorial series - parallel circuits to verify theoretical values.

**Learning Objectives**

3.a. Build three configurations of electrical circuits.
3.b. Apply Ohm's Law and Watt's Law to obtain unknown values in different circuit configurations.
3.c. Discuss the characteristics of various circuit configurations.
3.d. Identify three types of electrical circuit configurations.

## 4. Investigate sources of DC and AC electrical power

**Assessment Strategies**

4.1. Skill Demonstration
4.2. Written Product

**Criteria**

*You will know you are successful when*

4.1. learner explains various types of battery technology.
4.2. learner analyzes the results of series and parallel battery connections.
4.3. learner describes the process of AC generation.
4.4. learner explains the difference between an AC sinusoid and an equivalent steady state DC source for a period of time.
4.5. learner converts a sinusoid period to its equivalent frequency.
4.6. learner labels a sine wave at its peak amplitude and zero crossings for one cycle with the related degree representations.
4.7. learner calculates peak and RMS values from sine wave peak-to-peak values.
4.8. learner calculates peak-to-peak values from peak and RMS values for sine waves.
4.9. learner identifies the hot, neutral, and ground connections on the front face of the AC outlet.
4.10. learner lists the terminal screw colors for the hot, neutral, and ground connections of an AC outlet.
4.11. learner lists the expected voltage readings between connections of a standard 120VAC outlet.
4.12. learner verifies predicted AC values with a digital multimeter.

**Learning Objectives**

4.a. Investigate the generation of AC power.
4.b. Calculate the relationship between frequency and period for a complete AC cycle.
4.c. Compare a sinusoidal waveform to a circle in degrees.
4.d. Convert values between peak, peak to peak, and RMS for sine wave voltages.
4.e. Relate the effective value of an AC voltage source to an equivalent DC voltage source.
4.f. List the names of the three connections of a single phase AC outlet.
4.g. Identify the hot, neutral, and ground connections on the front face of the AC outlet.
4.h. Verify predicted AC values with a digital multimeter and an ocscilloscope or scopemeter.

## 5. Investigate the operation of inductors and capacitors in DC and AC circuits.

**Assessment Strategies**

5.1. Demonstration

5.2. Written Product

**Criteria**

*You will know you are successful when*

5.1. learner explains inductance.
5.2. learner relates the principles for electromagnetism to inductors.
5.3. learner calculates total inductive values in series and parallel inductors circuits.
5.4. learner describes the initial instantaneous condition for the application of DC to a resistor - inductor circuit model, then compares this condition to the circuit after five time constants.
5.5. learner describes plate area and separation as they relate to capacitance.
5.6. capacitors are measured for comparison to their tolerance standards.
5.7. capacitors are arranged in series and parallel configurations to measure total capacitance and compare with calculated values.
5.8. learner describes the initial instantaneous condition for the application of DC to a discharged capacitor, correlating the condition to a fully charged capacitor.
5.9. Investigate the principles of magnetism and electromagnetism.
5.10. learner demonstrates the operation of a relay and solenoid.

**Learning Objectives**

5.a. Describe the electromagnetic field storage ability of an inductor.
5.b. Use measuring instruments to compare nominal with actual inductance values.
5.c. Describe several inductor applications.
5.d. Investigate the L/R Time constant characteristics for a series RL circuit.
5.e. Describe the electrostatic field storage ability of a capacitor.
5.f. Discuss capacitors in terms of type, tolerance, polarities and labeling methods.
5.g. Measure capacitance values using proper test equipment.
5.h. Calculate and measure total capacitive values of combination series and parallel capacitors.
5.i. Describe several capacitor applications.
5.j. Investigate the RC Time constant characteristics for a series RC circuit.

## 6. Explore the characteristics of a single phase transformer

**Assessment Strategies**

6.1. Demonstration
6.2. Written Product

**Criteria**

*You will know you are successful when*

6.1. learner explains transformer characteristics including isolation and phase relationships.
6.2. learner calculates the turns ratios of both step-up and step-down transformers.
6.3. learner describes basic transformer action from the primary to secondary windings.
6.4. learner defines losses that affect efficiency of transformers.
6.5. learner utilizes appropriate instrumentation for transformer circuit measurement to verify predicted values.

**Learning Objectives**

6.a. Describe basic transformer action from the primary to secondary windings.
6.b. Discuss transformer characteristics including isolation and phase relationships.
6.c. Define losses that affect efficiency of transformers.
6.d. Calculate the turns ratios of both step-up and step-down transformers.
6.e. Utilize appropriate instrumentation for transformer circuit measurement.

## 7. Compare single phase and three phase power systems.

**Assessment Strategies**

7.1. Demonstration
7.2. Written Product

**Criteria**

*You will know you are successful when*

7.1. learner determines the angular relationship between the three phases of a three phase power system.

7.2. learner explains the basic Wye and Delta configurations of three phase circuits.
7.3. learner lists three reasons why three phase power is superior to single phase.
7.4. learner calculates the phase voltage in balanced three phase wye and delta circuits based on a given line voltage.
7.5. learner calculates the line voltage in balanced three phase wye and delta circuits base on a given phase voltage.
7.6. learner calculates the phase current in balanced three phase wye and delta circuits based on a given line current.
7.7. learner calculates the line current in balanced three phase wye and delta circuits based on a given phase current.
7.8. learner calculates individual voltage, current, and power values for resistive loads in balanced three phase wye and delta circuits base on given parameters.
7.9. learner calculates the total three phase power for resistive loads in balanced three phase wye and delta circuits base on given parameters.

**Learning Objectives**

7.a. Examine the benefits of three phase power over single phase.
7.b. Discuss the basic principles of three phase power generation.
7.c. Investigate the basic Wye and Delta configurations of three phase circuits.
7.d. Discuss the terms "phase" and "line" as related to three phase power systems.
7.e. Explore the mathematical relationships between phase voltage and line voltage in Wye and Delta configurations.
7.f. Explore the mathematical relationships between phase current and line current in Wye and Delta configurations.
7.g. Calculate electrical quantity values for resistive loads in balanced three phase wye and delta circuits.
7.h. Measure voltage and current values in Wye and Delta three phase circuits to verify predicted values.

## 8. Examine AC circuits containing resistance, inductance, and capacitance.

**Assessment Strategies**

8.1. Demonstration
8.2. Written Product

**Criteria**

*You will know you are successful when*

8.1. learner defines inductive reactance, states its units and indicates its symbol in electrical equations.
8.2. learner calculates inductive reactance of an inductor based on given values of inductance and source frequency.
8.3. learner describes the phase shift between voltage and current in an inductive circuit.
8.4. learner calculates impedance for AC combination series and parallel RL circuits.
8.5. learner defines capacitive reactance, states its units, and indicates its symbol in electrical equations.
8.6. learner calculates capacitive reactance of a capacitor based on given values of capacitance and source frequency.
8.7. learner describes the phase shift between voltage and current caused by a capacitor in an AC circuit.

**Learning Objectives**

8.a. Explore the operating characteristics of inductors and capacitors in an AC circuit.
8.b. Discuss why inductors and capacitors cause a phase shift between voltage and current in AC circuits.
8.c. Define inductive reactance and capacitive reactance and indicate the symbols in electrical equations.
8.d. Calculate inductive reactance and capacitive reactance.
8.e. Investigate the effect of changing the source frequency on values of inductive and capacitive reactance.
8.f. Define and calculate impedance in an AC inductive or capacitive circuit.
8.g. Apply Ohm's Law to capacitive and inductive AC circuits.
8.h. Utilize appropriate instrumentation for RC and RL circuit measurement to verify predicted values.