Arkansas CTE

Pre-Mechatronics Intermediate: Grades 10, 11, 12

Adopted 2015

Demonstrate an understanding of Basic Electrical and Electronic Systems

1.1 Identify and demonstrate an understanding of basic electronic systems.

1. Describe the purposes and fundamental processes of electrical and electronic systems. 1.1.1
1. Identify electronic system components. 1.1.1
2. Describe the electrical characteristics of solid-state devices. 1.1.2
3. Describe the basic materials that make up solid-state devices. 1.1.3
4. Describe and identify the various types of transistors and explain how they operate. 1.1.4
5. Interpret electronic schematic diagrams. 1.1.5
6. Describe and explain the use and purpose of electronic diodes and light-emitting diodes (LEDs). 1.1.6
7. Describe how to connect silicon-controlled rectifiers (SCRs). 1.1.7
8. Identify the leads of various solid-state devices. 1.1.8

1.2 Identify and demonstrate an understanding of basic electrical charge.

1. Set up an oscilloscope to observe waveforms and determine voltage. 1.2.1
2. Explain the properties of resistance. 1.2.2
3. Identify ohmic value using an ohmmeter. 1.2.3
4. Measure voltage using a voltmeter. 1.2.4
5. Measure current using an ammeter. 1.2.5
6. Explain how a capacitor stores electrical charge. 1.2.6
7. Explain the difference between digital and analog signals. 1.2.7

1.3 Identify and demonstrate an understanding of circuit protective devices.

1. Explain the necessity of overcurrent protection devices in electrical circuits. 1.3.1
2. Demonstrate proper usage of testing devices to determine condition of a circuit breaker. 1.3.2
3. Describe the purpose and operation of a circuit breaker, fuse, resistor, and thermistor. 1.3.3
4. Apply the National Electrical Code® (NEC®) requirements for overcurrent devices. 1.3.4
5. Describe the operation of single-element and time-delay fuses. 1.3.5

Demonstrate an understanding of mechanical control systems

2.1 Analyze components of power, force, friction and acceleration in a mechanical system.

1. Describe practical application of mechanical advantage. 2.1.1
2. Explain how mechanical systems require the increase or decrease in force. 2.1.2
3. Demonstrate the use of torque in a mechanical device. 2.1.3
4. Demonstrate methods by which friction can be decreased or increased. 2.1.4
5. Demonstrate the use of bearings in mechanical systems. 2.1.5
6. Explain why processing time is critical in industrial manufacturing. 2.1.6
7. Explain how energy cannot be created, however it can be converted from one form to another. 2.1.7
8. Explain potential and kinetic energy and demonstrate its practical application. 2.1.8

2.2 Identify and demonstrate an understanding of the application of industrial motors controls.

1. Explain how RPM, torque and horsepower effect mechanical output. 2.2.1
2. Describe the various types of motor enclosures. 2.2.2
3. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor. 2.2.3
4. Define percent slip and speed regulation. 2.2.4
5. Explain how the direction of a three-phase motor is changed. 2.2.5
6. Describe the component parts and operating characteristics of a three-phase wound-rotor induction motor. 2.2.6
7. Describe the component parts and operating characteristics of a three-phase synchronous motor. 2.2.7
8. Describe the design and operating characteristics of various DC motors. 2.2.8
9. Describe the methods for determining various motor connections. 2.2.9
10. Describe general motor protection requirements as delineated in the National Electrical Code® (NEC®). 2.2.10
11. Define the braking requirements for AC and DC motors. 2.2.11

2.3 Identify and demonstrate an understanding of motor controls.

1. Identify contactors and relays both physically and schematically and describe their operating principles. 2.3.1
2. Identify pilot devices both physically and schematically and describe their operating principles. 2.3.2
3. Interpret motor control wiring, connection, and ladder diagrams. 2.3.3
4. Connect motor controllers for specific applications according to National Electrical Code (NEC®) requirements. 2.3.4

Demonstrate an understanding of the fundamental concepts of control systems

3.1 Identify and demonstrate an understanding of control systems.

1. Describe the operating principles of contactors and relays. 3.1.1
2. Explain how mechanical contactors operate. 3.1.2
3. Explain how solid-state contactors operate. 3.1.3
4. Install contactors and relays according to the NEC® requirements. 3.1.4
5. Read wiring diagrams involving contactors and relays. 3.1.5
6. Describe how overload relays operate. 3.1.6

3.2 Identify and demonstrate an understanding of programmable logic controllers.

1. Describe the function and purpose of a programmable logic controller (PLC). 3.2.1
2. Explain the purpose of binary codes. 3.2.2
3. Describe the purpose of the various power supplies used within a PLC. 3.2.3
4. Explain the general function of an input/output (I/O) module, including the following types:
Discrete
Numerical data
Special
Remote 3.2.4
5. Explain the power supply and ground connections to I/O modules. 3.2.5
6. Explain the interrelations between the various microprocessor components. 3.2.6
7. Describe the characteristics and features of a PLC processor module. 3.2.7
8. Explain the purpose of PLC software and firmware. 3.2.8
9. Describe the features and the differences between PLC programming languages. 3.2.9
10. Describe the features of relay ladder logic instruction categories. 3.2.10
11. Explain the principles used to correlate PLC hardware components to software instructions. 3.2.11

3.3 Identify and demonstrate an understanding of conductor terminations and splices.

1. Describe how to make a good conductor termination. 3.3.1
2. Explain the role of the NEC® in making cable terminations and splices. 3.3.2
3. Explain why mechanical stress should be avoided at cable termination points. 3.3.3
4. Describe the importance of using proper bolt torque when bolting lugs onto busbars. 3.3.4
5. Describe crimping and splicing techniques. 3.3.5
6. Describe the installation rules for parallel conductors. 3.3.6

Demonstrate an understanding of basic hydraulic pneumatic systems

4.1 Identify and demonstrate an understanding of basic pneumatic systems.

1. Explain compressed-air treatment. 4.1.1
2. Identify and explain pneumatic system components and symbols. 4.1.2
3. Explain the properties of pneumatic solids, liquids and gases. 4.1.3
4. Explain the differences between hydraulic and pneumatic power. 4.1.4

4.2 Identify and demonstrate an understanding of basic hydraulic systems.

1. Explain hydraulic system safety. 4.2.1
2. Explain the principles of hydraulics and power transmission. 4.2.2
3. Identify and explain hydraulic fluids and lubricants. 4.2.3
4. Explain the purpose of packing and seals. 4.2.4
5. Identify and explain system parts, pumps and motors. 4.2.5
6. Demonstrate understanding of pressure and force in a fluid power cylinder. 4.2.6