

Mechatronics – Electrical Troubleshooting (Level 1)

Domains and Competencies

Electricity and Electrical Circuits

Describe the two types of electrical current and give an application of each
Describe the function of the four basic components of an electric circuit
Describe the operation of two types of power supplies and give their schematic symbols
Describe the function of an electrical schematic
Describe the operation of a manual switch that controls NO and NC contacts and give the symbol that represents the component.
Describe the function of a switch that controls an output device and draw a circuit that represents it and contains the correct symbols.
Describe the operation of five types of electric output devices and give their schematic symbols

Measuring Voltage, Current & Resistance

Define voltage and give its units of measurement
Describe how to connect a voltmeter in a circuit to correctly measure voltage.
Describe how voltage works in series and parallel circuits.
Define current and give its units of measurement
Describe how to use an ammeter to measure current
Describe the current characteristics in series and parallel circuits
Define resistance and give its units of measurement
Describe how resistance and continuity is measured in series and parallel circuits.
Describe how a voltage drop is measured in a series and parallel circuit.
Describe how to measure amperage in a series and parallel circuit.
Describe how to measure resistance of a single component.
Measure the resistance in series and parallel circuits

Power and Circuit Protection in Series and Parallel Circuits

Describe how Ohms law is used to calculate values of an electrical circuit.
Describe how Krichhoffs is used for the calculation of values in an electrical circuit.
Define power and give its units of measurement
State a formula for calculating the total power used in an electrical circuit
State Kirchhoff's Current Law and give an application
State a formula for calculating total parallel resistance
Describe the function of two types of circuit protection and give an application of each
Describe the operation of a fuse and give its schematic symbol
Describe the operation of two types of circuit breakers and give their schematic symbols
Calculate series resistance given each load's resistance
Use Ohm's Law to calculate voltage, current, and resistance in a series circuit
Calculate the total power used by a series circuit
Calculate the main line current in a parallel circuit
Calculate the total parallel resistance
Calculate the total power used in a parallel circuit

Electromagnetism, Inductance & Capacitance and their Application

Define inductance and give its units of measurement
Describe the effect of an inductor in a DC circuit and give an application
Describe the effect of an inductor in an AC circuit and give an application
Define capacitance and give its units of measurement
Describe the operation of a capacitor and give its schematic symbol
Describe the effect of the three types of capacitive circuits.
Describe the effect of a capacitor in an AC circuit and give an application
Describe the function of capacitors and inductors in electric power supplies

Combination Circuits

Describe how to identify a series and parallel circuit.
Describe the function of a variable resistor and give an application.

Basic Circuits and Troubleshooting

Describe how to find a short in an electrical circuit.
Describe the three basic steps for troubleshooting an open circuit
Locate a short circuit
Locate an open circuit

Transformers

Describe how control transformers are applied in industrial circuits
Describe the relationship between input and output current, voltage, power, and turns ratio for a control transformer.
Describe how to troubleshoot a transformer
Describe how to connect and operate control transformers with multi-voltage taps

Introduction to 3–phase motors

Describe the operating data on motor and transformer nameplates and the identification, marking and connection of their leads.
Describe the basic characteristics of 3–phase AC electricity including grounded and ungrounded conductors, neutral, ground and wye and delta systems.
Describe the use of overcurrent protection and disconnect devices in 3–phase circuits.
Describe why power transformers are used in industrial and commercial systems.
Describe the safety procedures for working with 3–phase systems.

Manual Motor Control and Protection

Describe the purpose and function of manual, 2 wire, and 3 wire motor control.
Describe the protective functions of a motor starter and the sizing of fuses and overloads.

Electrical Control Ladder Logic

Describe the structure and organization of a basic control system.
Describe JIC and IEC symbols & standards for industrial electrical documentation.
Describe the logical operations of AND, OR, NOR, NAND, NOT, and MEMORY in hard-wired systems.
Apply inputs, outputs and logic to perform control functions.

Describe control relay components, function and operation.
Describe operation and function of various control circuits including 2 wire and 3 wire control.
Describe methods of testing various industrial electrical control component including pilot devices, relays, transformers and motors.
Describe methods of analyzing symptoms and troubleshooting systems of industrial electrical components.

Basic Electrical Wiring and Construction

Describe how wire is sized for an application.
Describe the function of the National Electrical Code
Describe two factors to consider when sizing wire for an application
Describe how a three wire AC power cord works.
Calculate line drop
Size wire for an application
Describe the three factors that determine the number of wires that can be installed in conduit
Describe the function and operation of a 3-way switch
Describe the function of an electrical outlet
Describe two common methods for splicing wires when it is permissible
Determine the number of wires that can be installed in one conduit
Connect the wiring system to the service

Control Relays and Pilot Devices

Describe the function of a control relay and give an application.
Describe the operation of a control relay and give its schematic symbol.
Describe the operation of two types of control relays and give an application of each.
Describe how detached symbology is used to show a control relay on a ladder diagram.
Describe the operation of memory logic and give an application.
Describe the operation of a magnetic motor starter.
Describe the operation of a two-wire motor control circuit and give an application.
Describe the operation of a three-wire motor control circuit and give an application.
Describe the function of a push-to-test pilot light and give an application.
Describe the operation of a push-to-test pilot light and give its schematic symbol.

Introduction to Control Component Troubleshooting

Describe two levels of troubleshooting and give an application of each
Describe three methods of testing components and give an application of each
Describe how to test an indicator lamp
Describe how to test a manual switch
Describe how to test a control relay
Describe how to test a motor contactor
Describe how to test an overload relay
Describe how to test a 3-phase motor.

Safety

Describe the process of Lockout/Tagout as a safe work practice
Understand the general requirements of the NFPA 70E standard as it relates to industrial electrical hazards in the workplace.
Understand the necessary equipment and safety considerations to prevent Electrical Shock in the workplace.