Course Outline - Electrical DC / AC

Course Topic: Electrical DC/AC
Contact Hours: 120 hours

Course Description:

This course introduces the basic theories of electricity as they relate to Direct Current such as: the electron theory, Ohm's Law, conductors and insulators, series circuits, parallel circuits, series/parallel circuits, magnetism, electromagnetic devices, electrical nomenclature, units of measurement, resistors, graphic and electrical symbols. Practical laboratory exercises are integrated with the theory to acquaint the student with the basic processes of constructing functional circuits and the correct use of basic measuring instruments, such as analog and digital multimeters. Refer to current Schedule of Classes for software version(s). Course/lab fees

Outcomes and Objectives

BEE-1 Safely work with electrical components

1. Describe the importance of observing electrical safety
2. Describe the various practices that should be followed to prevent electrical hazards
3. Describe how various types of electrical devices are engineered to prevent electrical hazardous conditions from occurring
4. Match a list of the kinds of personal protection equipment to their proper description
5. Identify the level of current that poses a serious life-threatening condition to the human body

BEE-2 Explain the basic concepts of electricity

1. Use scientific notation to represent quantities
2. Work with electrical units and metric prefixes
3. Convert from one unit with a metric prefix to another
4. Describe the basic structure of the atom
5. Explain the concept of electrical charge
6. Define voltage and explain its characteristics
7. Define current and explain its characteristics
8. Define resistor and explain its characteristics
9. Describe the basic electrical circuit
10. Make basic circuit measurements
11. Explain Ohm’s law
12. Use Ohm’s law to determine voltage, current ,or resistance
13. Define energy and power
14. Calculate power in a circuit

Course Outline - Electrical DC / AC

15. Properly select resistors based on power considerations
16. Explain voltage drop
17. Match a list of the fundamental ways of generating electricity with examples of each
18. Use scientific notation to represent mathematical quantities.
19. Demonstrate the ability to represent a given quantity using the following prefixes: milli, micro, nano, pico, kilo, meg, giga, and tera.
20. Match the following list of electrical terms to their proper definition:
    - Volt
    - Ampere
    - Ohm
    - Conductance
    - Resistance
    - Insulator
    - Resistor
    - Open
    - Short
    - Coulomb
21. Given a 10VDC supply and a 10K ohm resistor, calculate the current flow in the circuit, construct, and verify with the use of an ammeter
22. Construct, and debug a series circuit containing 3 resistors and a 10VDC supply. Using Ohm's Law and Kirchhoff's Law, calculate the total current flowing in the circuit, the total resistance of the circuit, the voltage drop across each resistor, and the power requirement for each resistor. Then verify all calculations with the use of a multi-meter
23. Construct, and debug a parallel circuit containing 3 resistors and a 10VDC supply. Using Ohm's Law, Kirchhoff's Law, and the Parallel Resistance formula, calculate the total current flowing in the circuit, the total resistance of the circuit, the current flow through each resistor, and the power requirement for each resistor. Then verify all calculations with the use of a multi-meter
24. Given a circuit containing (3) series resistors and a 20VDC supply, determine what will happen to all voltages and currents and the total resistance if any one of the resistors is shorted or opened. Design, construct, and debug the circuit, and verify all calculations with a multi-meter
25. Match standardized symbols used in schematic diagrams to their proper electronic components
26. Using schematic diagrams construct and debug various electrical resistive circuits
27. Construct, and debug series and parallel Inductive AC circuits. Use an oscilloscope to measure and analyze the waveforms. Calculate all voltages, currents, powers, and phase angles for the circuit. Verify all voltage, current and phase angle calculations through the proper use of meters and scopes
28. Construct, and debug series and parallel Capacitive AC circuits. Use an oscilloscope to measure and analyze the waveforms. Calculate all voltages, currents, powers and phase angles for the circuit.

Course Outline - Electrical DC / AC

Verify all voltage, current and phase angle calculations through the proper use of meters and scopes.

29. Given values of inductors and resistors, calculate the LR time constant. Construct an inductive/resistive electrical circuit and verify results
30. Given values of capacitors and resistors, calculate the RC time constant Construct a capacitive/resistive electrical circuit and verify results
31. Match a list of terms for transformers to their proper description
32. Given primary voltage and current, use the known turns ratio to calculate the transformer's secondary terminal voltage and current
33. Match a list of markings, single phase, and three phase wiring schemes (Wye, Delta) to their proper description
34. Match a list of the following tests performed on transformers to their proper description:
    - Polarity test
    - Insulation resistance test
    - Excitation and Power factor test
    - Impedance measurement
    - Winding resistance and short circuit test
    - Thermal test
    - Frequency response
    - Loading, off loading

BEE-3 Interpret schematics, cross reference prints, trace circuits, interpret sequential function charts, line drawings, and timing charts

1. Identify standardized symbols used in schematic diagrams that represent various electronic components
2. Follow schematic diagrams, assemble electronic circuits

BEE-4 Demonstrate electrical measurement instruments, including digital and analog multimeters, clamp-on ammeters, meg-ohmmeters, and the oscilloscope

1. Describe how to setup, connect and operate a multi-meter to measure voltages in a circuit
2. Describe how to setup, connect and operate a multi-meter to measure current in a circuit
3. Describe how to setup, connect and operate a multi-meter to measure resistance
4. Describe how to setup, connect and operate an oscilloscope
5. Demonstrate proficiency in the use of the following test equipment:
    - Digital multi-meter
    - Analog multi-meter
    - Clamp-on meter

Course Outline - Electrical DC / AC

- Meg-ohmmeter
- Oscilloscope

BEE-5 Demonstrate how to fabricate and verify DC/AC series/parallel circuits

1. Identify a series resistor
2. Determine total resistance
3. Determine the current throughout a series circuit
4. Apply Ohm's Law in series circuits
5. Determine the total effect of voltage sources connected in series
6. Apply Kirchhoff's voltage law
7. Use a series circuit voltage divider
8. Determine power in a series circuit
9. State how to measure voltage with respect to ground
10. Troubleshoot series circuits
11. Identify a parallel resistive circuit
12. Determine total parallel resistance
13. Apply Ohm's law in a parallel circuit
14. Apply Kirchhoff's current law
15. Use a parallel circuit as a current divider
16. Determine power in a parallel circuit
17. Determine power in a parallel circuit
18. Troubleshoot parallel circuits
19. Identify sinusoidal waveform and measure its characteristics
20. Determine the voltage and current values of sine waves
21. Apply the basic circuit laws to resistive AC circuits
22. Use the oscilloscope to measure waveforms
23. Describe the basic structure and characteristics of an inductor
24. Analyze series and parallel inductors
25. Analyze inductive AC circuits
26. Describe the basic structure and characteristics of a capacitor
27. Analyze series and parallel capacitors
28. Analyze capacitive AC circuits
29. Determine the resistance values of color banded Carbon resistors through the interpretation of the bands and verify their results through the use of a digital or an analog ohmmeter
30. Construct an electromagnet using a battery, a coil of wire, and a ferromagnetic core. Estimate and verify what will happen to the strength of magnetic field when the number of turns is increased

Course Outline - Electrical DC / AC

31. Given a graphical representation of an AC sine wave, calculate the Peak to Peak voltage, Peak voltage, RMS voltage, Average voltage, Period, and the Frequency, when some of the values are given
32. Setup the scope to take measurements from a starting condition of all adjustments fully counterclockwise, all switch positions in the center, left position if only a 2-position switch, and all push buttons out
33. Construct, and debug a circuit with 2 resistors in series and an AC source of 10 to 20VAC. Calculate the voltage drop across each resistor and verify with a multi-meter. Also, verify with an oscilloscope and compare the two measurements
34. Using the Reactance Formula, determine the Inductive Reactance of an Inductor in an electrical AC circuit
35. Using the Reactance Formula, determine the Capacitive Reactance of a Capacitor in an electrical AC circuit
36. Construct and debug a series/parallel electrical circuit. Apply Thevenin's theorem to simplify the circuit for analysis. Verify the results through practical substitution and measurement
37. Construct and debug series/parallel Inductive/Capacitive/Resistive AC circuits. Use an oscilloscope to measure and analyze the sinusoidal waveforms, calculate and then measure the voltage and current values of the sine waves. Measure the phase angle between the applied voltage and the total current
38. Use a continuity checker and an ohmmeter to verify the normally open and normally closed set of contacts on a switch
39. Using live electrical circuits, make voltage measurements with respect to ground
40. Use a voltmeter to determine the state of a switch (open or closed) in a circuit under power. Additionally, predict and verify with an ammeter whether current is flowing.
41. Given a switch, a DC relay, DC power source, light bulb, and AC power source, determine the N/O contacts of the relay and construct a circuit where the DC switching circuit controls the AC power to the light bulb.
42. Given a schematic, construct and debug an electrical circuit used for the purpose of troubleshooting. Demonstrate fault finding skills with the use of multi-meters to locate shorted and open circuits, induced by the Instructor
43. Demonstrate the induction method of generating a voltage using a coil of wire and a permanent magnet, then estimate and verify using a multi-meter or oscilloscope. What will happen if:
    - The number of turns is increased
    - The strength of the magnet is increased

BEE-6 Demonstrate how to fabricate and verify DC series-parallel circuits

1. Identify series-parallel relationships
2. Analyze series-parallel circuits

Course Outline - Electrical DC / AC

3. Describe the loading effect of voltmeter on a circuit
4. Apply Thevenin's theorem to simplify a circuit for analysis
5. Troubleshoot series-parallel circuits

BEE-7 Identify and explain Conductors, Insulators, and Protection Devices

1. Explain the differences between conductors and insulators
2. Explain the purpose of fuses and circuit breakers
3. Describe wire size
4. List the factors that determine the current capacity of a wire conductor
5. Match a list of fuses and circuit breakers to their proper descriptions.
6. Match wire samples to a list of their proper size and description
7. List the factors that determine the current capacity of a wire conductor

Course Outline - Electrical DC / AC

SAFETY DISCLAIMER:

M-SAMC educational resources are in no way meant to be a substitute for occupational safety and health standards. No guarantee is made to resource thoroughness, statutory or regulatory compliance, and related media may depict situations that are not in compliance with OSHA and other safety requirements. It is the responsibility of educators/employers and their students/employees, or anybody using our resources, to comply fully with all pertinent OSHA, and any other, rules and regulations in any jurisdiction in which they learn/work. M-SAMC will not be liable for any damages or other claims and demands arising out of the use of these educational resources. By using these resources, the user releases the Multi-State Advanced Manufacturing Consortium and participating educational institutions and their respective Boards, individual trustees, employees, contractors, and sub-contractors from any liability for injuries resulting from the use of the educational resources.

DOL DISCLAIMER:

This product was funded by a grant awarded by the U.S. Department of Labor's Employment and Training Administration. The product was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.

RELEVANCY REMINDER:

M-SAMC resources reflect a shared understanding of grant partners at the time of development. In keeping with our industry and college partner requirements, our products are continuously improved. Updated versions of our work can be found here: http://www.msamc.org/resources.html.