Master Course Syllabus

IMM 1015 – Electrical Systems

Purpose of Document

This document contains important information about this course's objectives. It may be helpful for you to retain a copy for your records, along with the class specific syllabus. This document will be especially helpful if you decide to later change your course of study.

Pikes Peak State College and the Colorado Department of Higher Education have determined that graduates should have a broad range of learning skills as well as discipline related skills. Both types of skills are detailed below.

Course Description

Introduces industrial maintenance technology used in electrical systems. Focuses on how electrical power is converted into energy. Explains electrical applications and the theory on which they operate. The content in this section will help prepare student to earn the NIMS Industrial Technology Maintenance Level 1 Electrical Systems credential.

Credit Hours: 3
Contact Hours: 67.5 (Lecture/Lab Combination)

Course Learning Outcomes

1. Explain the difference of series and parallel circuits.
2. Describe the basics of magnetism and how electricity and magnetism are related.
3. Apply Ohm's law to calculate voltage, current, and resistance.
4. Describe the relationships between voltage, current, resistance, and power.
5. Explain the use of test lights, continuity testers, and receptacle testers.
6. Discuss the use of a phase sequence tester.
7. Define basic principles of alternating current, including phase, cycle, and sine wave.
8. Calculate the phase and line voltage and current for delta and wye connections.
9. Describe the resistor as a physical device and understand how it is rated.
10. Explain the operation and use of circuit breakers.
11. List common methods of termination and describe how to apply and test them.
12. Identify three-phase transformer applications and connection methods.
13. Explain the operation and connection methods of a three-phase induction motor.
14. Identify the principles of general maintenance for AC and DC motors.
15. Describe the basic functions of motor control circuits.
16. Recognize the features of ladder diagrams and understand how to read them.

17. Discuss National Electrical Codes grounding specifications and why grounding is necessary in a system.
18. Discuss various sources of energy for industrial systems and their related sensors.

Topical Outline

I. Fundamentals of electricity

A. Atoms and subatomic particles

B. Static electricity

C. Coulomb's law of charges

D. Conductors and insulators

E. Basic electrical circuits

1. Electrical source
2. Current
3. Circuit loads
4. Switches
5. Short circuits and open circuits

F. Types of circuits

1. Series circuits
2. Parallel circuits
3. Complex circuits

G. Magnetism

1. Magnetic fields
2. Polarity
3. Electromagnetic induction
4. Magnetic fields produced by current flow

II. Ohm's law, Kirchhoff's laws, and the power equation

A. Ohm's law

1. Finding voltage with ohm's law
2. Finding current with ohm's law
3. Finding resistance with ohm's law
4. Example calculations with ohm's law

B. Total resistance of multiple resistor networks

1. Resistors in series

2. Resistors in parallel
3. Example calculations of total resistance in parallel

C. Kirchhoff's laws

1. Rule #1 series circuit current
2. Rule #1 series circuit current
3. Rule #3 parallel circuit current
4. Rule #4 parallel circuit voltage

D. Complex circuits

1. Series circuit with parallel components
2. Parallel circuit with series components

E. The power equation

1. Combining the power equation and ohm's law
2. The ohm's law wheel

III. Electrical test and measurement equipment

A. Field testing and bench testing

B. Field testing and bench testing

C. Electrical measurement tools

1. Test lights
2. Continuity tester
3. Receptacle testers
4. Digital multimeter (DMM)
5. Clamp-on ammeter
6. Megohmmeter
7. LCR meter
8. Oscilloscopes
9. Power supplies
10. Arbitrary function generators
11. Phase sequence tester
12. Infrared thermometer

D. Calibration

IV. Alternating current

A. Principles of alternating current

1. Period of a cycle
2. Phase
3. Instantaneous voltage
4. Root-mean-square (RMS)

B. Reactance

1. Inductive reactance
2. Capacitive reactance

C. Resistor-inductor (RL)circuits

1. Impedance in RL circuits
2. Ohm's law for alternating current (AC) circuits
3. Series RL circuits
4. Parallel RL circuits
5. Power in AC circuits
6. Power factor and phase angle

D. Resistance and capacitance (RC) circuits

1. Impedance in RC circuits
2. Resonance
3. Bandwidth
4. Filters

E. Three-phase alternating current

1. Phasing
2. Generating three-phase alternating current
3. Three-phase connections
4. Power calculations in three-phase circuits

V. Electrical components and circuit materials

A. Resistors

1. Tolerance
2. Power rating
3. Variable resistors
4. Tapped resistors

B. Capacitors

1. Dielectric constant
2. Capacitance
3. Working voltage
4. Capacitors in parallel
5. Capacitors in series
6. Capacitor classifications

C.Circuit boards

D. Fuses and circuit breakers

1. Fuses
2. Circuit breakers

E. Relays

1. Relay contacts
2. Relay coils
3. Dual relays

F. Wire

G. Cable

H. Methods of termination

1. Crimping
2. Wire connectors
3. Soldering

VI. Transformers

A. Transformer theory

B. Transformer ratios

1. Turns ratio
2. Voltage ratio
3. Current ratio

C. Transformer power

D. Transformer losses

E. Transformer efficiency

F. Transformer ratings

G. Multiple windings and transformer taps

H. Transformer polarity and phasing

I. Specialized transformers

1. Autotransformers
2. Variable voltage transformers
3. Ferroresonant transformers
4. Current transformers

J. Three-phase transformers

1. Delta and wye combinations
2. Three-phase transformer connections and phasing
3. Connecting the windings

K. Troubleshooting

VII. Motors, generators, and alternators

A. Motor specifications

B. Alternating current motors

1. Induction motors
2. Rotating field
3. Three-phase stator
4. Motor speed
5. Slip
6. Torque
7. Dual-voltage motor
8. Shaft currents
9. Single-phase induction motor
10. Single-phase capacitor-start motor
11. Single-phase capacitor-start, capacitor-run motor

C. Direct current motors

1. Permanent-magnet motor
2. Series and shunt DC motors
3. Universal motors
4. Servo motors

5. Stepper motors

D. Generators and alternators

1. Generators
2. Self-excited generator
3. Alternators

E. Motor maintenance

VIII. Motor controls

A. Basic motor controls

B. Fuses in control circuits

C. Selecting circuit breakers and fuses

D. Input devices and symbols

1. Pushbuttons and indicators
2. Switches

E. Motor starters and contactors

1. Construction
2. Overloads and sizing
3. Reversing starters
4. Reversing drum switches
5. Troubleshooting

F. Output devices and symbols

1. Relays
2. Timers
3. Solenoids

IX. Industrial wiring diagrams and practices

A. Electrical diagrams

1. Ladder diagrams
2. Wiring diagrams
3. Panel layout diagrams
4. Three-line and single-line diagrams
5. Highway diagrams

B. National Electrical Code (NEC)

C. Wiring standards

1. Wire sizing
2. Branch circuit, feeder, and service calculations
3. Overcurrent protection
4. Color coding
5. Grounding

D. Switchboards and panelboards

E. Disconnecting means

F. Busways

G. Raceways

H. Industrial wiring practices

X. Electrical troubleshooting

A. Controls, settings, and adjustments

1. Adjustable components
2. Human-machine interface (HMI)
3. Programmable logic controllers (PLCs)

B. Sources of energy

C. Documentation

1. User's manual
2. Diagrams
3. Data sheets
4. Troubleshooting flowchart

D. Calling technical support

E. Digital multimeter (DMM)

1. Voltmeter testing
2. Ohmmeter testing
3. Capacitor testing
4. Diode measurements
5. Current measurements

F. Troubleshooting methodologies

1. Measurement by comparison (MBC)

2. Step-by-step
3. Binary search
4. Root cause analysis (RCA)