Three-Phase Systems

Course 208: Three-Phase Systems

Covers three-phase motor principles for induction, synchronous, and multi-speed dual-voltage motors. Gives recommended maintenance practices for large AC motors. Covers principles of three-phase motor starters, part winding, reversing, jogging, alternator principles and operation. Describes three-phase power distribution.

TPC Training is accredited by IACET to offer **1.0 CEU** for this program.

Lesson 1: Principles of Three-Phase Motors

Topics

Induction Motors; Squirrel-Cage Rotors; Rotating Field; Pole-Phase Relationships; Development of Torque; Rotor Speed and Slip; Rotor Frequency; Rotor Resistance and Reactance; Rotor Current and Potential Difference; Power Factor of Induction Motors; Induction-Motor Torque; Variations in Torque

Objectives

- Describe a squirrel-cage rotor.
- List the factors that determine the strength of the magnetic field in an induction motor.
- Discuss pole-phase relationships.
- Demonstrate how to reverse the rotation direction of the magnetic field.
- Discuss the relationship between rotor speed and frequency.

Lesson 2: Induction Motors

Topics

Characteristics of Squirrel-Cage Motors; Stator Construction; Rotor Construction; Air Gap; Operating Features; Torque; Care of Stator Windings; Wound-Rotor Induction Motors; Brushes and Slip Rings; Wound-Rotor Characteristics; Wound-Rotor Maintenance; Applications of Wound-Rotor Motors; Maintaining Induction Motors

Objectives

- List the main parts of the stator.
- List operating characteristics of a wound-rotor motor.
- Demonstrate how to check rotor windings for short circuits.
- State the definition of a standard motor.

Lesson 3: Synchronous Motors

Topics

Characteristics of Synchronous Motors; Operating Principles; Synchronous Motor Fields; Starting Characteristics; Pull-In Torque; Effects of Slipping a Pole; Synchronous-Motor Applications; Power Factor of a Synchronous Motor; Improving the Power Factor; Brushless Synchronous Motors; Motor Efficiency and Care

Objectives

- List factors that contribute to the torque of an industrial synchronous motor during starting.
- Explain the effects of an amortisseur winding in a synchronous motor.
- State the definition of pull-in torque.
- State the reason why using synchronous motors can increase a low power factor in a plant.
- List the characteristics of brushless synchronous motors.

Lesson 4: Multispeed Motors

Topics

Multispeed Induction Motors; Consequent-Pole Motors; Consequent-Pole Motor Connections; Constant-Horsepower Motor Connections; Constant-Torque Motor Connections; Variable-Torque Motor Connections; Dual-Voltage Motor Connections; Y-Connected Dual-Voltage Motors; Delta-Connected Dual-Voltage Motors

Objectives

- Discuss the operating characteristics of multispeed induction motors.
- Select the best motor for driving equipment that requires the same torque at both high and low speeds.
- State the definition of a variable-torque motor.
- Explain the difference between a constant-horsepower motor and a constant-torque motor.

Lesson 5: Maintaining Three-Phase Motors

Topics

Maintenance Requirements; Cleaning Motors; Care of Stator Windings; Rotor Winding Care; Air Gap; Overload and Single-Phase Operation Problems; Motor Shaft Currents; Induction-Motor Bearings; Bearing Temperatures; Lubricating Motor Bearings; Maintenance Schedule

Objectives

- List the steps in measuring the resistance of the insulation on motor windings.
- Explain how to raise the temperature of a motor winding.
- List the steps in lubricating motor bearings.
- List the conditions that must exist before you can lubricate bearings.

Lesson 6: Motor Starters

Topics

The Need for Motor Starters; Electrical Limitations; Mechanical Limitations; Full-Voltage Starting; Typical Across-the-Line Starting; Methods of Reducing Starting Currents; Primary-Resistance Starter; Secondary-Resistance Starter; Reactor Starter; Part-Winding Starter; Y-Delta Starter; Synchronous-Motor Starters; Maintaining Motor Starters

Objectives

- Explain how a motor starter works.
- Explain the difference between open transition and closed transition.
- Name the common kinds of reduced-voltage starters.
- List the steps in inspecting motor starters.

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Lesson 7: Three-Phase Motor Controllers

Topics

Motor Starters; Circuit Protection; Multiple Start-Stop Control; Across-the-Line Reversing Starters; Plugging Control; Jogging; Controlling Surge and Backspin; Manual Compensator Starter; Magnetic Compensator Starters; Primary-Resistance Starters; Reactor Starters; Wound-Rotor Motor Starters

Objectives

- Explain how to select the best motor starter for a particular application.
- Explain the difference between low-voltage release and low-voltage protection.
- Describe the plugging process.
- Explain how to prevent backspin.

Lesson 8: Alternators

Topics

Alternator Characteristics; Three-Phase Alternators; Air Gap; Slip Rings; Exciters; Rating of Alternators; Alternator Windings; Effect of Current in the Armature; Voltage Regulation; Load Characteristics and Effects

Objectives

- Describe a three-phase alternator.
- Discuss the operating characteristics of alternators.
- List the characteristics that must be considered when you work on alternator windings.
- Name the causes of change in potential difference between terminals as the load changes.
- Demonstrate how to calculate three-phase power in an alternator.

Lesson 9: Auxiliary Generator Systems

Topics

Emergency Generator Requirements; Voltage-Control Equipment; Control Equipment; Manual Transfer Systems; Automatic Transfer Systems; Time-Delay Transfer; Safety Switches; Engine Protection; 400 Hz Generating Systems; General Characteristics; Controlling Potential Difference; Prime Movers and Output Control; 400 Hz Distribution; Maintenance Procedures

Objectives

- Explain how an automatic auxiliary generator works.
- List the methods of overcoming voltage-drop problems when starting loads.
- List the parts of a hydraulic starting system.
- State the definition of a prime mover.
- List the four guidelines to follow when troubleshooting or performing routine maintenance on generators.

Lesson 10: Power Distribution Systems

Topics

Distribution Voltages; Systems of 600 V or Less; Heat Losses; System Grounding; Benefits of System Grounding; Overcurrent Relay Protection; Overcurrent Relays with Voltage Control; Ground Relays; Phase-Sequence or Reverse-Phase Relays; Circuit-Opening Devices; Kinds of Protection; Selective Tripping; Cascade Tripping; Network Protection; Typical Small-Plant System; Distribution-System Testing

Objectives

- State the reasons why 240-volt systems are not as widely used as are 480-volt systems.
- Explain the difference between system grounding and equipment grounding.
- List the benefits of system grounding.
- Explain how an overcurrent relay works.
- Name common circuit-opening devices.