

€ TRAINING

AC Electrical Motors & Drives:
Troubleshooting, Maintenance & Protection



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Introduction:

AC motors represent the industry's workhorse in small, medium, and large-size applications. It is no exaggeration to suggest that more than 50% of the energy consumed worldwide is converted by AC motors into work and these motors are controlled by drives. These drives are ever-increasing more intelligent, electrical and their monitoring and operation can be integrated with the plant's SCADA system. Understanding maintenance and troubleshooting procedures of such vital industrial equipment mean that reduced downtime and increased productivity are the immediate benefits for the company and its management. Equally important, the protection requirements along with their function and integration with the overall system ensures that such expensive apparatus, requiring high capital investment, is well guarded against failures further offering safety for operations personnel as well. The seminar addresses the three topics mentioned above for both AC motors and their drives.

Course Objectives:

At the end of this course, the participants will be able to:

- Understand the operation and construction of AC electric motors and electrical drives based on modern electronics technology.
- Explain their characteristics and the need to match various load needs.
- Become more confident on how to maintain both motors and drives following well-established industrial procedures as outlined in standards.
- Become familiar with troubleshooting methods for both motors and drives the following methodologies that have been developed by manufacturers in order to reduce downtime time dramatically.
- Learn how to utilize single-line drawings, and other documentation to successfully perform commissioning, maintenance, and troubleshooting of both motors and drives.
- Become exposed to industrial standards and case studies so that to be able to apply this knowledge in the industrial plant as quickly and efficiently as possible.

Targeted Audience:

- Electricians
- Electrical supervisors
- Plant electricians
- Operations & maintenance engineers, supervisors & technicians
- Maintenance technicians

Course Outlines:

Unit 1: AC Motors:

- Introduction to magnetism, excitation, and the generation of back emf.
- Fundamentals of rotating machines theory, AC motors, and their construction, rotor slip and principles of operation, equivalent circuit, torque-speed characteristics, motoring and regenerative region of operation, efficiency, inertia, horsepower, power factor.
- Single-phase and three-phase AC motors, types of single-phase motors, split-phase, and capacitor.
- Starting with induction motors and associated techniques, accelerating.

- Speed control requirements of AC motors and load matching.

Unit 2: Drives:

- Basic principles of AC Variable-Speed Drives VSD's, constant torque region, constant power extended speed region, four-quadrant operation.
- Power semiconductors, diode, thyristor SCR, IGBT, MOSFET, GTO, and others.
- Inverters, voltage-source, and current-source, pulse width modulated PWM inverters.
- Two-level pulse width modulated inverter, DC link energy and capacitor sizing, regeneration or dynamic slowdown, dynamic braking, regeneration.
- PWM waveforms and analysis, effects of PWM on motor bearings and insulation and life expectancy, volts/Hertz control, start-up and operation, dynamics, PWM rectifier inverter systems.
- Switching transients, harmonics, and power factor.
- AC driveline power factor, the effect of AC input on drive operation, switching transients, insulation voltage stress, motor winding voltage distribution, radiated, and conducted electromagnetic interferences EMI, EMI filtering.

Unit 3: Troubleshooting and Maintenance of Motors:

- Characteristics of motors, enclosures, and cooling methods, application data, design characteristics, insulation of AC motors.
- Failures in three-phase stator windings, predictive maintenance, motor troubleshooting, diagnostic testing for motors.
- Troubleshooting and maintenance of AC motors, routine care, dirt and corrosion, lubrication, heat, noise and vibration, insulation.
- Slow acceleration or refusal to starting of an AC motor, overheating and noise making of the motor, running of bearings at high temperature, or making noise.
- Standards and testing.

Unit 4: Troubleshooting and Maintenance of Drives:

- Converter failures, common failure modes, fault current limit, device explosion rating, device application, thyristor failures, and testing, identification of failed thyristor and diode, testing of thyristor, and diode.
- Reversing circuits for single-phase and three-phase AC motors, finding open and short-circuit, detection of AC motor symptoms.
- Preventative maintenance, approaches, guidelines and scheduling, checking, dynamic and static inspections, detecting phase unbalances, loss of phases, and phase reversal.

Unit 5: Protection of Motors and Drives:

- Protection of AC motors, requirements, overload protection, currents during starting and stalled point, operation of motors under the three-phase unbalanced power supply, motor de-rating due to unbalanced currents, stator and rotor protection, single-phase over-current relays, phase unbalance relays, faults in stator and rotor windings, earth faults, phase-to-phase faults, modern relay design and applications, protection targeting AC synchronous motors, over-voltage and under-frequency protection.
- Fuses, circuit breakers, magnetic and thermal, overload, eutectic, bimetal, and solid-state, others.
- Motor protection curves, back-up protection.
- Protection of inverters and electronic converters driving motors.
- Case studies, selection, and design of systems and their protection.