Training Program:

Introduction to Electrical Engineering

Introduction:

Reliable service is dependent upon properly designed and periodically tested protective relay systems. These systems, and their protective relays, are explained for transmission lines, substations, and distribution lines. The reader learns how the entire electric power system is designed to protect itself.

This course is intended to give nonelectrical professionals a fundamental understanding of large, interconnected electrical power systems with regard to terminology, electrical concepts, design considerations, construction practices, and industry standards, control room operations for both normal and emergency conditions, maintenance, consumption, telecommunications, and safety. Several practical examples, photographs, drawings, and illustrations are provided to help the reader gain a fundamental understanding of electric power systems. The goal of this book is to have the nonelectrical professional come away with an in-depth understanding of how power systems work, from electrical generation to household wiring and consumption by connected appliances. Starting with terminology and basic electrical concepts used in the industry are also covered. Then, progress through generation, transmission, and distribution of electrical power. The reader is exposed to all the important aspects of an interconnected power system. Other topics discussed include energy management, conservation of electrical energy, consumption characteristics, and regulatory aspects to help readers understand modern electric power systems in order to effectively communicate with seasoned engineers, equipment manufacturers, field personnel, regulatory officials, lobbyists, politicians, lawyers, and others working in the electrical industry.

Objective:

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

- Discuss the history of electricity
- Present a basic overview of today's electric power system
- Discuss general terminology and basic concepts used in the power industry
- Explain the key terms voltage, current, power, and energy
- Discuss the nature of electricity and terminology relationships
- Describe the three types of consumption loads and their characteristics
- Describe how voltage is produced in a conductor when in the presence of a changing magnetic field
- Explain how three coils of wire in the presence of a changing magnetic field produce three-phase voltage
- Describe how current flowing through a wire produces a magnetic field
- Discuss how generator rotors provide the magnetic field for the generation of electricity
- Describe the three main components of a generator
- Explain what is meant by real-time generation
- Discuss the two different ways to connect three generator windings symmetrically
- Discuss the different types of generation plants (i.e., steam, nuclear, wind, etc.)
- Describe the different power plant prime-mover types

- Explain why high-voltage transmission lines are used
- Explain the different conductor types, sizes, materials, and configurations
- Discuss the different types of insulation used for overhead and underground conductors
- Identify the common electric power system transmission voltage classes
- Discuss the different transmission line electrical design characteristics (insulation, air gaps, lightning performance, etc.)
- Explain the differences between ac and dc transmission line design, reliability, applications, and benefits
- Discuss overhead and underground transmission systems
- Identify all major equipment used in substations
- Describe the purpose and operation of each major equipment type
- Discuss the different types of transformers
- Explain the operation of voltage regulators and tap changers
- Understand the advantages and disadvantages of oil and gas equipment
- Discuss the different types of circuit breakers and how they are used
- Explain the purpose of capacitors, reactors, and static VAR compensators used in electric power systems
- Discuss the effective preventative maintenance programs used for substation equipment
- Explain the basic concepts of overhead and underground distribution systems
- Discuss how distribution feeders are operated radially

- Discuss grounded wye and delta distribution feeders and laterals
- Discuss the advantages and disadvantages of wye versus delta
- Explain how three-phase transformer banks are connected
- Explain how distribution transformers produce 120/240 Vac
- Describe the different underground system components
- Explain secondary service wire connections
- Explain the difference between “system protection” and “personal protection”
- Explain the difference between “electromechanical” and “solid state” protective relaying
- Explain the concept of inverse current and time
- Describe one-line diagrams and how they are used
- Explain the function and application of the various types of relays
- Discuss what is meant by zones of protection
- Explain the difference between transmission, substation, distribution, and generation protection requirements
- Describe the steps needed to synchronize a generator onto the power grid
- Explain the importance of electric system control centers
- Discuss the equipment used in system control centers
- Discuss SCADA (Supervisory Control and Data Acquisition)
- Explain what the system operators monitor and control
- Explain how substation equipment is controlled remotely

- Explain what the Energy Management System does
- Describe the software tools used by system operators
- Describe the types of telecommunications systems used with SCADA
- Explain why electric power companies are using more and more fiber optics
- Discuss “personal protection” in the context of electric power systems safety
- Explain human vulnerability to electricity
- Explain how one can be made safe by “isolation”
- Explain how one can be safe in a “zone of equipotential”
- Discuss “ground potential rise”
- Explain why it is so important to know about “touch” and “step” potentials
- Discuss how line maintenance is performed safely when lines are “energized” or “deenergized and grounded”
- Explain what is meant by “switching”
- Discuss the “safety hazards” around the home

Course Outline

System Overview, Terminology, and Basic Concepts

- Objectives
- History of Electric Power System

- Overview Terminology and Basic Concepts

Generation of AC Voltage

- Objectives
- AC Voltage Generation
- The Three-Phase ac Generator
- Real-Time Generation
- Generator Connections
- Wye and Delta Stator Connections Power Plants and Prime Movers

Transmission Lines

- Objectives
- Transmission Lines
- Conductors
- Transmission Line Design Parameters (Optional Supplementary Reading)
- Underground Transmission
- dc Transmission Systems

Substations

- Objectives
- Substation Equipment
- Transformers
- Regulators Circuit Breakers
- Reclosers
- Disconnect Switches
- Lightning Arresters Electrical Bus
- Capacitor Banks Reactors
- Static VAR Compensators Control Buildings Preventative Maintenance

Distribution

- Objectives
- Distribution Systems
- Transformer Connections (Optional Supplementary Reading)
- Fuses and Cutouts
- Riser or Dip Pole Underground Service

Consumption

- Objectives
- Electrical Energy Consumption
- Power System Efficiency
- Power Factor
- Supply and Demand Demand-Side Management
- Metering Performance-Based Rates
- Service-Entrance Equipment

System Protection

- Objectives
- Two Types of Protection
- System-Protection Equipment and Concepts
- Distribution Protection
- Transmission Protection
- Substation Protection
- Generator Protection

- Generator Synchronization
- Overall Transmission Protection
- Interconnected Power Systems
- Objectives

Interconnected Power Systems

- Regulatory Environment
- Interchange Scheduling
- Interconnected System Operations
- System Demand and Generator Loading
- Reliable Grid Operations

System Control Centers and Telecommunications

- Objectives
- Electric System Control Centers
- Supervisory Control and Data Acquisition (SCADA)
- Energy Management Systems
- Telecommunications

Personal Protection (Safety)

- Objectives
- Electrical Safety
- Personal Protection

DAY 5

- Comprehensive Approach to Power System Security
- Requirements
- Application of power system controls
- Defense plans against extreme contingencies
- On-line security assessment
- Reliability management system
- Real-time monitoring and control
- Risk-based Dynamic security Assessment

Accreditation:

BTS attendance certificate will be issued to all attendees completing a minimum of 80% of the total course duration.