



Training Program:

**New Monitoring, Protection And Control In Electric
Power Systems**

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Introduction:

New solutions to the protection, control, and monitoring of power systems are being put to work all the time, by scientists, engineers, and technicians in utilities and industry around the world.

The expansion of the existing interconnected electric power transmission systems offers significant advantages with respect to operational security, integration of renewable energy, as well as energy trading. On the other hand, the complexity of operational problems significantly increases and hence large R&D efforts are urgently required in order to make full use of recent technological innovations with respect to new power system components like wide area monitoring, control, and protection equipment.

The effective operation of power systems in the present and the future depends to a large extent on how well the emerging challenges are met today. Power systems continue to be stressed as they are operated in many instances at or near their full capacities. In order to keep power systems operating securely and economically, it is necessary to further improve power and control system protection. Synchronized phasor measurements-time synchronization allows synchronized real-time measurements of multiple remote measurement points on the grid. The advantage of referring phase angle to a global reference time is helpful in capturing the wide area snap shot of the power system. Effective utilization of this technology is very useful in getting the real time behavior of the power system. This course provides the challenges and opportunities the utilities and power industry face in new protection and control schemes and also applying PMUs in improving the protection schemes.

This course will be of interest and use to people working in protection, control, communications, planning, operations, maintenance, regulation, and design.

Who Should Attend?

Personnel working in all areas of electricity section who wish to understand the various aspects of smart metering and smart grid, Managers, network and distribution engineers, Instrumentation engineers, senior technical staff, plant designers, plant managers, Energy Management System, etc.

Course Outline

MODULE-01: FUTURE IN POWER SYSTEM

- Introduction
- Time-synchronized measurements
- Distribution systems
- Transmission systems
- Transformers
- Buses
- Generators
- Wide-area systems

- Communications
- Integrated systems
- Cybersecurity
- Reliability and testing
- Providing complete solutions
- Asset management
- Call to action

MODULE-02: PROTECTIVE RELAYING REVIEW

- Introduction to Power System Relaying
- Purpose and Function of Protective Relays
- Power System Faults
- Instrument Transformers
- Relay Construction & Operation
- Types of Relays
- Synchronizing and Synchronizing Equipment
- Power System Equipment Review
- Introduction to Equipment Review
- Generators
- Power Transformers

- Transmission Lines
- AC Circuit Breakers & Switches
- Thyristor Systems

MODULE-03: TRANSMISSION LINE PROTECTION

- Transmission systems of today and tomorrow
- Line protection principles
- Directional overcurrent protection
- Distance protection
- Sources of distance element errors
- Directional comparison protection
- Differential protection
- Phase comparison protection
- Line protection sensitivity
- Instrument transformer accuracy
- Series-compensated line protection
- Single-pole tripping
- Power swing blocking and out-of-step tripping
- Thermal protection
- Fault locating

- Single-ended methods
- Multiended method

MODULE-04: TRANSFORMER PROTECTION AND MONITORING PROTECTION AND CONTROL

- Variable dual-slope percent differential protection
- Magnetizing inrush and overexcitation blocking
- Phase & ground overcurrent elements
- Adaptive time overcurrent using FlexCurves elements
- Underfrequency/Overfrequency Protection
- Frequency rate-of-change Detection
- Overexcitation (V/Hz) Protection
- Restricted Ground Fault Protection
- Transformer overload protection
- Communications
- Networking interfaces - 10Mbps Ethernet, RS232, RS485 and RS422 ports
- Ethernet port, 10Mbps
- Multiple protocols - ModBus™ RTU, ModBus™ RTU TCP/IP, DNP 3.0 Level 2

MODULE-05: BUS AND BREAKER-FAILURE PROTECTION

- Modern solutions for bus protection

- Introduction Breaker Failure Protection (BFP) Fundamentals
- BFP Practices in Three Utilities
- BFP Mis-operations
- Methods to Improve the Security and Dependability of BFP

MODULE-06: GENERATOR PROTECTION AND MONITORING

- Modern multifunction generator relays
- Protection and Control
- Generator stator differential
- 100% stator ground
- Loss of excitation
- Distance backup
- Reverse power (anti-motoring)
- Overexcitation
- Ground directional overcurrent
- Inadvertent energization
- Breaker failure
- Stator and bearing thermal monitoring
- Stator and bearing vibration monitoring
- Negative sequence overcurrent

- Communications
- Networking interfaces - RS232, RS485, 10Mbps copper Ethernet
- Multiple protocols - ModBus™ RTU, ModBus™ TCP/IP, DNP 3.0 Level 2

MODULE-07: MODERN SOLUTIONS FOR DISTRIBUTION SYSTEM PROTECTION, AUTOMATION, AND MONITORING

- New abilities
- More sensitive fault detection
- Faster fault clearing
- Faster service restoration
- Higher reliability and lower cost

MODULE-08: SUBSTATION PROTECTION, CONTROL, AND MONITORING SYSTEM DESIGN

- Introduction
- Design objectives of substation protection, control, and monitoring systems
- DC control power system requirements for substations
- Protection system redundancy
- DC logic circuit design
- AC sensing circuit design
- Application of test switches
- DC elementary (schematic) diagrams

- Logic diagrams
- Standards
- Purpose of a substation control enclosure
- Protection, control, and monitoring panel design
- Effects of integrated protection, control, and monitoring systems on enclosure design
- Substation control enclosure environmental system
- Eliminating the centralized control enclosure
- Relay testing and commissioning
- Selecting reliable protective relays
- Fault-tree analysis method
- Integrated IEDs networks
- Communication makes IEDs informed and organized
- Hierarchical levels of integrated IED networks
- Serial networks and Ethernet local-area networks
- Star, multidrop, and ring LAN configurations
- Best Practice Methods support serial and Ethernet LANs

MODULE-09: PMU APPLICATIONS FOR SYSTEM MONITORING AND PROTECTION

- Introduction to Synchrophasors

- Measuring Synchrophasors using PMU
- Early PMU applications
- PMU in power system protection
- WLS method of State Estimation (SE)
- SE with PMU and SCADA data
- Effect of PMU integration
- Remedial Action Schemes
- Adaptive relaying
- PMU-Based Adaptive Relaying
- New PMU Applications in Oscillation Detection and Control
- PMU-Based Out-of-Step Protection Scheme
- Pinpointing the Initiating Location of a Disturbance
- Adaptive Out-of-Step Relaying
- Overview of Wide Area Voltage Stability Problem
- Opportunities for PMU Application in Fault Location

Accreditation:

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