Training Program:

Modern Electric Power Systems Design, Modeling, Analysis & Problem Solving

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Introduction:

Protection of low, medium and high voltage power systems requires an understanding of system faults and their detection, as well as their safe disconnection from the power system. This course presents a description of the concepts and principles of operation and application of protection schemes for various power system elements such as feeders, transformers, motors, buses, generators, etc.

The course begins with an overview of power system faults and the protection scheme requirements for the detection and coordinated clearance of these faults. Protection requirements for cogeneration, non-utility generation, and interconnection with the utility power system are covered in detail. This course deals with protection systems from a practical perspective, and includes important functional aspects such as testing and coordination of protection systems. It is specially designed for industries and utilities, which depend on proper system protection for operational efficiency and minimizing damage to equipment.

Who Should Attend?

Electrical Engineers, Electrical Technicians, Electrical Inspectors, Electrical Professionals & Supervisors, Instrumentation and Design Engineers, Maintenance Engineers, Supervisors & Technicians, Energy Management Consultants, Control Engineers & Technicians, Automation & Process Engineers, Chemical & Mechanical Engineers, Consulting Engineers, Field Technicians, Graduate Engineers, Project and Production Managers, Project Engineers, Electronic Technicians, Plant Managers, Process Control Engineers, System Engineers, System Integrators, Testing Engineers & Technicians, Power System Engineers, Power System Technicians, Utility Engineers, Managers & Team Leaders of Engineering Departments, Safety Professionals, Plant

Electricians, Facilities Engineers, Operations & Maintenance Engineers, Supervisors & Technicians, Project Engineers, Commissioning & Testing Engineers, Consulting Engineers, Electrical Technologists, Facility & Plant Managers

Course Objectives:

By the end of this course delegates will be able to:

- The operation and power flow characteristics of small and large networks and how the network can be so arranged to deliver more real power over the transmission system to load centers
- The form and use of a range of FACTS devices to improve system operation
- New CT and VT optical transducers and protection relaying system employing microprocessor configured relays
- Protection systems for thermal monitoring of cable networks
- Alternative forms of generation and embedded generation. Carbon emissions trading, etc.
- Diagnostic monitoring of plant and in particular GIS substations
- Advances in power electronics and the application to HVDC links
- High speed fault limiters and real time stability monitors
- Demand side management

Accreditation:

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

Course Outline

Power System Faults

- Different types of faults
- Incidence of faults on power system equipment
- Effects of power system faults
- Magnitude of fault current
- Detection of faults
- Clearance of faults
- Requirements of protective relaying systems

Components of Power System Protection Schemes

- Fault-detecting relays
- The transition from electro-mechanical relays to electronic and digital microprocessor-based relays
- Tripping relays and other auxiliary relays
- The application of programmable logic controllers
- Circuit breakers - bulk oil, air-blast, vacuum, SF6
- Current transformers
- Voltage transformers
- Modern microprocessor-based relays

Current Transformers (CT) and Voltage

- Various types of CTs, VTs and CVTs
- Theory and characteristics of CTs
- Application requirements of CTs for protective relaying
- Accuracy classifications
- Future trends in CT design using optics
- Testing of CTs and VTs

Feeder Overcurrent Protection

- Protective relaying requirements for radial systems
- Elements of feeder protection schemes
- High-set, low-set and inverse-timed elements
- Coordination with other devices and fuses
- Various types of overcurrent relays
- Electromechanical, electronic and digital relays
- Relay setting criteria
- Load limitations
- Testing of overcurrent protection schemes
- Microprocessor-based feeder overcurrent relays

Coordination of Electrical Protection Systems

- Fuse to fuse
- Circuit breaker to fuse

- Fuse to circuit breaker
- Computer software packages for protection coordination studies
- Auto-reclosing of circuit breakers
- Back-up protection
- Limitation of fault current
- Selective zones of protection

Switchboard and Bus Protection

- Types of bus protection schemes
- Basic concept of differential protection
- Application to various bus configurations
- Application to switchboards
- Testing of bus protection schemes

Motor Protection, Starting and Control

- Applicable motor standards
- Methods of starting
- Differential protection, phase unbalance, overcurrent
- Ground fault protection
- Canadian Electrical Code requirements
- Microprocessor-based motor control and protection devices

Transformer Protection

- Overcurrent and ground fault protection

- Application of differential protection to transformers
- Restricted ground fault protection
- Gas relays, pressure and gas accumulation
- Winding temperature and oil temperature devices
- Testing of transformer protection schemes
- Modern microprocessor-based multi-function relays

Generator Protection

- Differential protection
- Reverse power, stator ground, out-of-step, loss of field, field ground, over excitation, etc.
- Over-frequency, under frequency, overvoltage, under voltage
- Negative phase sequence or phase unbalance
- Voltage controlled and voltage restricted overcurrent protection
- Synchronizing systems, synchro-check relays
- Comparison of electro-mechanical and electronic relays
- Testing of generator protection schemes
- Microprocessor-based multi-function generator protection relays

Cogeneration and Non-Utility Generation (NUG) Protection

- Protection requirements for non-utility generating stations
- Requirements for the interconnection of NUGs to utility power systems
- Typical protection schemes for non-utility generators
- Low-cost microprocessor-based multi-function relays for small generators

- Breaker failure protection
- Testing utility tie protection schemes

Transmission Line Protection

- Interconnected systems with two-way flow of fault current
- Distance or impedance protection schemes
- Phase comparison protection schemes
- Communication channel requirements between terminals
- Coordination and transfer-tripping between terminals
- Modern microprocessor-based line protection relays

Capacitor Protection

- Application of static capacitors on power systems
- Description of protection schemes used
- Testing of capacitor protection schemes
- Microprocessor-based capacitor protection and controls relays

Recent Developments and Future Trends

- Digital relays
- Integrated microprocessor based systems for control, monitoring, and protective relaying
- Optical current transformers
- Fiber optic communications