

## Substation Design & Operation

### **DAY 1**

#### Role of Substations in Power Networks

- Power System Principles & Circuit Analysis
- Complex Numbers and Engineering Math
- Substation Types
- Substation Drawings and Diagrams (*SLD, Layout, Schematics, Auxiliary AC & DC*)
- Substation Main Components
- Substation Location
- Soil Parameters and Calculations
- Substation Busbar Configuration
- Substation Voltage Selection
- Environmental issues in the location of a switchyard and mitigation techniques

### **DAY 2**

#### Substation Major Equipment

- Circuit Breaker Types & Applications
- Switchgear Types, Components, and Applications
- Auto-reclosers
- Sectionalizers
- Disconnect Switches
- RMU's
- Earthing Switches
- SF6 Properties
- GIS Substations
- HV Cables Types & Calculations
- Power & Distribution Transformers
- Batteries & Battery Chargers
- Power Conditioner

### **DAY 3**

#### Substation Studies & Calculations

- Power System Studies
- Power System Planning
- Substation Load Studies
- Per Unit System
- Fault Calculations
- Switchyard Lightning Protection
- Instrument Transformers (CT's & VT's)
- Earthing Systems

## **DAY 4**

### **Substation Protection & Control**

- Power System Studies
- Power System Planning
- Protection Zones, Local & Backup Protection
- Sequence Networks
- Fuse Types, Applications, Selection, and Coordination
- Protection Relay Types and Functions
- Protection Relaying Technology
- Overcurrent Protection
- Earth Fault Protection
- IDMT O/C & E/F Protection
- Definite Time (DT) Protection
- High-set Instantaneous Protection
- Transient Overreach
- Transformer O/C and E/F Protection
- Transformer Unit Protection (*REF and Diff*)
- Buchholz & Pressure Relief
- Transformer Differential Protection Complexities & Solutions
- Interposing CT's
- Transformer-feeder Protection Schemes

## **DAY 5**

### **Substation Safety Issues**

- Ungrounded vs. Grounded Systems

- Touch & Step Voltages, Mesh Voltage
- Earth Potential Rise (EPR), Transferred Voltages
- Soil Resistivity
- Verification of Adequacy
- Lightning Protection Techniques (*rolling spheres, cone of protection*)
- Embedded Generation
- Power Factor Compensation (PFC)
- Power Quality (*harmonics, voltage flicker*)
- Clearance Distances