Training Program:

Power Grid Operation, Automatic Generation & Load Frequency Control

Introduction:

Power Grid Operation training course lays the basic foundations of generation plants (or generators), their control, concepts of economic dispatch, and power flow analysis. This course gives you sufficient knowledge about generator dynamics, and concept of stability in power system operation.

Power Grid Operation training course simply teaches you how the electricity is generated in power plants and what steps are taken in order to deliver the generated electricity to the customers with high reliability. Several control approaches are introduced for the generators in order to achieve stable operation of the power system. This course discusses the modern control approaches implemented for generators to maintain the voltage and frequency within the limits.

This course not only focuses on the generation side, but also covers the transmission level by introducing the concept of power flow as an advanced tool to calculate the operating points in the power system.

Also learn about

- Real-time Grid operation
- Automatic Generation Control (AGC) as a feedback control system that regulates the power output of electric generators to maintain a specified system frequency and scheduled interchange
- The area control error (ACE)
- Operational mode
- Constant Net Interchange
- Error in interchange over the tie lines
- Constant Frequency

- Frequency deviation only
- Tie Line Bias
- Tie Line Bias plus Automatic Time Error Correction
- Smart Grid operation
- Micro Grid operation

Who Should Attend?

- The power system operation training is a 5-day course designed for:
- Finally, power system operation training course will briefly introduce the economic dispatch in power system including generator cost functions considering transmission lines and generator limits.
- All individuals who need to understand how the electricity is generated in power plants and how the stable operation is achieved in power systems.
- Faculty members from academic institutes who want to teach the power system operation course.
- Investors and contractors who plan to make investments in this industry.
- Marketing people who need to know the background of the products they sell.
- Technicians, operators, and maintenance personnel who are or will be working at power plants or power system generation companies.
- Managers, accountants, and executives of power system industry.
- Scientist or non-electrical engineers involved in power system operation related projects or proposals.

Course Objectives:

This course is designed to enable participants to:

- Understand the generator models and control.
- Describe the dynamics of generators in power systems.
- Understand the concept of stability in power systems.
- Understand the operation of a generator connected to the system.
- Recognize the voltage/frequency controllers in generators.
- Discuss different types of loads connected to the power systems.
- Describe the concept of voltage stability and frequency droop.
- Model the dynamics of governor and automatic voltage regulator (AVR).
- Understand the concept of stability and operation in multi-machine power systems.
- Explain the step-by-step process of power flow analysis.
- Understand and explain different solutions for power flow equations.
- Understand the basics of economic dispatch.The power system operation training course consists of the following lessons, which can be revised and tailored to the client's need.

Course Outline

Power System Background

- History of the power generation
- Origins and evolution of the Electric Grid

- What is a generator?
- What is a transmission line?
- Distribution system
- Substations
- Definition of loads
- Improvements in modern power plants
- Legislation and governance
- DOE, FERC, NERC, ERCOT, RTO's and ISO's

Fundamentals of Electric Power

- Structure of the Electric Power System
- Operation of the Electric Power System
- Wholesale Electricity Markets
- Power System Planning
- Transmission and distribution (T&D) power grids
- Electricity-generating capacity
- Local and regional demand centers
- Electricity distribution system
- Distribution lines
- Power grid challenges and opportunities
- Today's Electric Grid
- Interconnections of the Electric Grid
- Global challenges and Opportunities

- Transmission Network and System Operations
- Blackouts
- Transmission Capacity
- System Operations
- Integration of Variable Energy Resources
- Interconnecting Variable Energy Resources
- Transmission Expansion
- Distributed Generation and Electric Vehicles
- Distributed Generation
- Micro Grid
- Electric Vehicles
- Opportunities in Distribution System Operation
- Electricity Demand
- Utility Regulation
- Regulatory objectives and processes
- Challenges for regulatory policy
- SCADA, cybersecurity, and Information Privacy
- Cybersecurity of the Electric Grid

Different Power System Levels

- Generation levels (power plants)
- Transmission levels
- Sub-transmission levels

- Stations and substations
- Distribution level

Synchronous Machines (Generators)

- Basic operation principles of synchronous machines.
    - Rotor and stator definition
    - Field and armature windings
    - Magnetic flux in the airgap
    - Voltage generation.
- Dynamic model of generators
    - Mechanical dynamics
    - Swing equation

Single Machine Infinite Bus (SMIB) Concept

- Maximum power transfer in SMIB.
- Power angle stability criterion
- Voltage stability criterion
    - Voltage collapse
    - Effect of Loads
- Real-time Operation
    - Load forecasting
    - Frequency and ACE value
- Real-time Contingency Analysis (RTCA)

- Constant loads
    - Constant admittance loads
    - Constant power loads
- Dynamic loads
    - Power electronic based loads
    - Electric vehicle charging
- Load restoration techniques
    - Tap changer transformer

Generator Control

- Voltage control
    - Definition of AVR
    - AVR model
    - AVR dynamics
- Frequency control
    - Definition of Governor
    - Governor dynamics
    - Primary frequency control
    - Secondary frequency control
    - Multi-area frequency control (ACE concept)

Power Flow Analysis

- AC power flow
- DC power flow
- Solutions for power flow
    - Gauss iterations (Gauss-Seidel)
    - Newton-Raphson
    - Fast decoupled solution

Economic Operation of Power Systems (economic dispatch)

- Formulation of economic dispatch problem
- Classical economic dispatch
- Economic dispatch considering generator and line limits
- Penalty factors

Monitoring and Control

- Supervisory Control and Data Acquisition (SCADA)
- Outage Management System (OMS)
- Energy Management Systems (EMS)
- Distribution Management Systems (DMS)
- Distribution Automation (DA)
- Demand Response (DR)
- Substation Automation (SA)

Power Grid Evolution

- Electric Power Struggles
- Smart Grid evolution
- Microgrid and Distributed Power Generation
- Renewable energy
- Sociotechnical transitions
- Climate change and mitigation
- Need for planning
- Reserves monitor
- Interchange scheduling

Hands On, Workshops and Group Activities

- Labs
- Workshops
- Group Activities

Sample Workshops and Labs for Power Grid Operation Training

- Simulating Transmission Lines with Matlab
- Simulation of Synchronous Machines
- Single Machine Infinite Bus Example in Matlab
- Demand Response Simulation and Case Study
- Lab on Generator AVR and PSS Control
- Experiment on Frequency Control for Generators

- Voltage Control by Generators Case

Accreditation:

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