



# MODERN ELECTRICAL Power Systems & Power Plants



## Course Introduction:

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Modern Electric Power System has moved away from its regulated roots and is rushing headlong toward freewheeling competition, spurring more creative uses of energy and unprecedented advancements in plant efficiencies. Environmentalism has rushed forward too, ensuring that no power-generation technology is unscathed by demands for lower emissions and ecological impacts. Also over the past decade, computer capability has skyrocketed in effectiveness and plummeted in cost, launching a mass invasion of control rooms by digital instrumentation. Changes such as these make today's power plant a more diverse and more complex mix of technologies than ever before.

This course is designed to provide a good coverage of the generation, transformation, transmission, distribution and utilization of electric power and energy as well as the modelling, analysis, planning, design, monitoring and control of modern electric power systems. It will provide a contemporary overview of this far-reaching field as well as bringing together the core of knowledge from all of the many topics encompassed by the field. The course is intended to give participants a working knowledge of the modern electric power systems operations from generation through transmission and distribution through wiring. Basic electrical terminology and concepts are discussed with regard to design, construction, operations and maintenance of power plants substations and transmission and distribution lines. The affects of the deregulation of electric power utilities are discussed with interesting examples. The basic concepts of fiber optics and other telecommunications systems used in the electric power industry are also presented.

Further, the course will introduce and explore a number of engineering and economic problems involved in planning, operating, and controlling power generation and transmission systems in electric utilities. The topics included serve as an effective means to introduce participants to advanced operations methods applied to practical electric power engineering problems. Some topics cover methods that are currently being applied in the control and operation of the modern electric power systems. However, in a 5-day course it is, of course, impossible to consider all the problems and "best practices" in this advanced field. We can only introduce the types of problems that arise, illustrate theoretical and practical approaches and point the participant the direction of seeking more information and developing advanced skills as they are required. As a matter of fact, this course covers a wide range of topics related to the design, operation and control of power systems that are usually treated separately. Various issues are treated in depth with analytical rigor and practical insight. The subject matter is presented in a very interesting and unique perspective. It combines, in a structured way, control theory, characteristics and modelling of individual elements and analysis of different aspects of modern electric power systems.

## Course Objectives:

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**Upon the successful completion of the course, participants will have the knowledge on the following topics:**

- Power System Components
- Electric Power Generation
- Transformers
- Transmission System
- Substations
- Distribution Systems
- Electric Power Utilization
- Power System analysis and Simulation
- Power System Protection
- Power System Transients
- Power System Dynamics and Stability
- Power System Operation and Control
- Power System Planning (Reliability)
- Power Electronics
- Power Quality
- Economic Dispatch of Thermal Units and Methods of Solution
- Power System Security
- Environmental Controls

## Who Should Attend?

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This course is suitable for electrical power managers, engineers, superintendents, supervisors, foremen, technicians and those who are involved in the design, engineering, operation, maintenance and control of the electric power system or anyone interested in obtaining a working knowledge of the modern electric power system.

## Course Outline:

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### Welcome & Introduction

### Overview of Modern Power System Components

- Structure of the electrical power system
- Generating units (*Synchronous generators, Exciters and automatic voltage regulators, Turbines and their governing systems*)
- Substations
- Transmission and distribution network (Overhead lines and underground cables, Transformers, Shut and series elements, Flexible AC transmission systems (FACTS))
- Protection

## **Electric Power Generation**

- Hydroelectric Power Generation
- Synchronous Machinery
- Thermal Generating Plants
- Distributed Utilities

## **Transformers**

- Theory and principles
- Power Transformers
- Distribution Transformers
- Underground Distribution Transformers
- Dry Type Transformers
- Instrument Transformers
- Transformer Connections
- Loading Power Transformers
- Transformer Testing
- Transformer Installation and Maintenance
- Problem and Failure Investigations
- On-line Monitoring of Liquid-Immersed Transformers

## **Transmission System**

- Concept of Energy Transmission and Distribution
- Transmission Line Structures
- Insulators and Accessories
- Transmission Line Construction and Maintenance
- Insulated Power Cables for High Voltage Applications
- Transmission Line Parameters
- Sag and tension of Conductor
- Corona and Noise
- Geomagnetic Disturbances and Impacts upon Power System Operation
- Lightning Protection
- Reactive Power Compensation

## **Substations**

- Gas Insulated Substations
- Air Insulated Substations
- High Voltage Switching Equipment
- High Voltage Power Electronics Substations
- Considerations in Applying Automation Systems to Electric Utility Substations
- Substation Automation

- Oil Containment
- Community Considerations
- Animal Deterrents/Security
- Substation Grounding
- Grounding and Lightning
- Seismic Considerations
- Substation Fire Protection

### **Distribution Systems**

- Power System Loads
- Distribution System Modelling and Analysis
- Power System Operation and Control

### **Electric Power Utilization**

- Metering of Electric Power and Energy
- Basic Electric Power Utilization – Loads, Load Characterization and Load Modelling
- Electric Power Utilization: Motors

### **Power System analysis and Simulation**

- The Per-Unit System
- Symmetrical Components for Power System Analysis
- Power Flow Analysis
- Fault Analysis in Power Systems

### **Power System Protection**

- Transformer Protection
- The Protection of Synchronous Generators
- Transmission Line Protection
- System Protection
- Digital Relaying
- Use of Oscillograph Records to Analyze System Performance

### **Power System Transients**

- Characteristics of Lightning Strokes
- Overvoltages Caused by Direct Lightning Strokes
- Overvoltages Caused by Indirect Lightning Strokes
- Switching Surges
- Very Fast Transients
- Transient Voltage Response of Coils and Windings

- Transmission System Transients
- Insulation Coordination

### **Power System Dynamics and Stability**

- Power System Stability
- Transient Stability
- Small Signal Stability and Power System Oscillations
- Voltage Stability
- Direct Stability Methods

### **Power System Dynamics and Stability (cont'd)**

- Power System Stability Controls
- Power System Dynamics Modeling
- Direct Analysis of Wide Area Dynamics
- Power System Dynamic Security Assessment
- Power System Dynamic Interaction with Turbine-Generators

### **Power System Operation and Control**

- Energy management
- Generation Control: Economic Dispatch and Unit Commitment
- State Estimation
- Optimal Power Flow
- Security Analysis

### **Power System Planning (Reliability)**

- Planning
- Short-Term Load and Price Forecasting with Artificial Neural Networks
- Transmission Plan Evaluation – Assessment of System Reliability
- Power System Planning
- Power System Reliability

### **Power Electronics**

- Power Semiconductors Devices
- Uncontrolled and Controlled Rectifiers
- Inverters
- Active Filters for Power Conditioning
- Fiber Optics

### **Power Quality**

- Wiring and Grounding for Power Quality
- Harmonics in Power Systems
- Voltage Sags
- Voltage Fluctuations and Lamp Flicker in Power Systems
- Power Quality Monitoring

### **Economic Dispatch of Thermal Units and Methods of Solution**

- The Economic Dispatch Problem
- Thermal System Dispatching with Network Losses considered
- The Lambda-Iteration Method
- Gradient Methods of Economic Dispatch (*Gradient Search, Economic Dispatch by Gradient Search*)
- Newton's Method
- Economic Dispatch with Piecewise Linear Cost Functions
- Economic Dispatch Using Dynamic Programming
- Base Point and Participation Factors
- Economic Dispatch Versus Unit Commitment

### **Power System Security**

- Factors Affecting Power System Security
- Contingency Analysis: Detection of Network Problems (*An Overview of Security Analysis, Linear Sensitivity Factors, AC Power Flow Methods, Contingency Selection, Concentric Relaxation, Bounding*)

### **Environmental Controls**

- Environmental Legislation and Regulation
- Air Emission Controls (Electrostatic Precipitators, Fluidized-Bed Boilers, NO<sub>x</sub> Controls, Flue-Gas Treatment)
- Water Emission Controls

### **Presentation of Certificates**

## **Course Methodology:**

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**A variety of methodologies will be used during the course that includes:**

- (30%) Based on Case Studies
- (30%) Techniques
- (30%) Role Play
- (10%) Concepts

- Pre-test and Post-test
- Variety of Learning Methods
- Lectures
- Case Studies and Self Questionnaires
- Group Work
- Discussion
- Presentation

## Course Certificate:

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**International Center for Training & Development (ICTD)** will award an internationally recognized certificate(s) for each delegate on completion of training.

## Course Fees:

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**To be advised as per course locations.** This rate includes participant's manual, Hand-Outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

## Course Timings:

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### Daily Course Timings:

08:00 - 08:20	Morning Coffee / Tea
08:20 - 10:00	First Session
10:00 - 10:20	Coffee / Tea / Snacks
10:20 - 12:20	Second Session
12:20 - 13:30	Lunch Break & Prayer Break
13:30 - 15:00	Last Session