Training Course on Substation Power Engineering Fundamentals

Professional Development Training Course Outline

Category	Development	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Substation Power Engineering is a critical field in the transmission and distribution of electrical energy. As renewable energy integration and smart grid technology revolutionize power systems, mastering the fundamentals of substation engineering is essential for electrical engineers, utility professionals, and energy consultants. This course provides in-depth knowledge of substation components, configurations, protection systems, and operational protocols. By the end of this course, participants will gain a practical and theoretical understanding of modern substation power systems.

Training Course on Substation Power Engineering Fundamentals is designed to be interactive, real-world oriented, and aligned with global standards such as IEEE, IEC, and NESC. It addresses the challenges of system automation, power reliability, asset management, and grid modernization. Participants will work through detailed case studies, hands-on simulations, and scenario-based assessments to build proficiency in the design, operation, and maintenance of substations.

Programme Curriculum

Training Course on Substation Power Engineering Fundamentals

Introduction

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Course Objectives

1. Understand the basic concepts of high-voltage substation engineering and grid infrastructure.
2. Analyze key substation components including transformers, circuit breakers, and busbars.
3. Apply electrical protection systems for fault detection and safety.
4. Evaluate grounding systems and their role in substation safety.
5. Design substation layouts using industry standards and digital tools.
6. Interpret single-line diagrams (SLDs) and schematic designs.
7. Integrate SCADA systems and automation in modern substations.
8. Assess the environmental and regulatory considerations for substation installation.
9. Explore renewable energy interfacing and smart grid integration.
10. Investigate power quality, load flow, and system reliability parameters.
11. Use real-world case studies to solve complex substation design challenges.
12. Optimize preventive maintenance and condition monitoring for substation equipment.
13. Prepare for certifications and competency exams in substation engineering.

Target Audience

1. Electrical Engineers
2. Power Systems Engineers
3. Utility Technicians
4. Energy Consultants
5. Maintenance Supervisors
6. Project Engineers
7. Grid Operations Managers
8. Engineering Students & Interns

Course Duration: 10 days

Course Modules

Module 1: Introduction to Substations

- Role and function of substations in power systems
- Types of substations (AIS, GIS, Hybrid)
- Voltage classifications and system hierarchy
- Overview of primary and secondary equipment
- Industry standards: IEEE, IEC
- **Case Study**: Development of a 132kV GIS substation in urban settings

Module 2: Power Transformers

- Transformer types and specifications
- Ratings, vector groups, and cooling methods
- Tap changers and voltage regulation
- Transformer protection schemes
- Testing and commissioning
- **Case Study**: Failure analysis of a 220/33kV transformer

Module 3: Circuit Breakers and Switchgear

- Types of circuit breakers (SF6, vacuum, air blast)
- Functions and operations

- Control circuits and interlocking
- Maintenance best practices
- Safety protocols for switching operations
- **Case Study**: SF6 breaker failure and root cause investigation

Module 4: Busbar Configurations and Insulation

- Single, double, ring, and mesh busbar layouts
- Selection criteria for busbar design
- Busbar insulation and fault withstand capacity
- Expansion joints and thermal management
- Load transfer schemes
- **Case Study**: Busbar fault in a 400kV system

Module 5: Protection Systems in Substations

- Overcurrent, differential, distance protection
- CTs, PTs, and relay configurations
- Protection coordination and grading
- Digital relays and IEDs
- Fault recording and analysis tools
- **Case Study**: Misoperation of distance relay in a substation fault event

Module 6: Grounding and Earthing Systems

- Importance of grounding in substations
- Design of grounding grids and rods
- Soil resistivity measurements
- Touch and step potential calculations
- Lightning protection systems
- **Case Study**: Grounding failures leading to unsafe voltage rise

Module 7: Substation Automation and SCADA

- Introduction to SCADA and RTUs
- Communication protocols (IEC 61850, Modbus, DNP3)
- Substation control hierarchy
- Data acquisition and remote monitoring
- Integration with control centers
- **Case Study**: SCADA malfunction in a 110kV substation

Module 8: Substation Design & Layout

- Physical layout and clearances
- Equipment arrangement principles
- Cable routing and trenching
- Fire safety and access paths
- Digital design tools (ETAP, AutoCAD Electrical)
- **Case Study**: Redesign of a substation to meet new grid codes

Module 9: Renewable Energy and Substation Interface

- Grid-tied renewable power stations
- Interfacing wind and solar with substations
- Challenges with variability and intermittency
- Energy storage integration

- Impact on protection and controls
- **Case Study**: Integration of 50MW solar plant with 66kV substation

Module 10: Substation Equipment Testing

- Routine and type testing of substation equipment
- Factory acceptance testing (FAT)
- Site acceptance testing (SAT)
- Diagnostic testing (IR, DGA, TTR)
- Test report interpretation
- **Case Study**: Fault isolation through transformer DGA results

Module 11: Environmental and Regulatory Compliance

- Permitting and approvals
- EMF exposure and mitigation
- Oil containment and spill response
- Noise and aesthetics management
- Fire and emergency response planning
- **Case Study**: Substation denied approval due to regulatory non-compliance

Module 12: Maintenance and Asset Management

- Condition-based vs. time-based maintenance
- Asset health index (AHI)
- Remote diagnostics and IoT
- Spare parts and inventory control
- Maintenance scheduling tools
- **Case Study**: Cost-benefit analysis of predictive maintenance in a substation

Module 13: Power Quality and System Stability

- Harmonics and transients
- Flicker and voltage sag mitigation
- Load flow analysis tools
- Real-time voltage and frequency control
- Role of capacitors/reactors
- **Case Study**: Voltage instability in a 132kV industrial substation

Module 14: Substation Safety and Risk Management

- Safety audits and compliance
- Lockout-tagout (LOTO) procedures
- Arc flash analysis and PPE
- Human error mitigation
- Emergency planning and drills
- **Case Study**: Arc flash incident investigation at a utility substation

Module 15: Project Execution and Cost Optimization

- Planning and procurement processes
- Cost estimation and budgeting
- Risk assessment and mitigation
- Stakeholder management
- Substation commissioning checklist
- **Case Study**: Cost overrun analysis of a rural substation project

Training Methodology

- Instructor-led interactive lectures and workshops
- Real-world case studies for practical insights
- Hands-on simulations and design exercises
- Group discussions and peer learning
- Post-training assessments and feedback analysis

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Ready to enroll or request a customized program? Book online or contact us:

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