Digital Substation Technologies Training Course

Professional Development Training Course Outline

Category	Renewable Energy	**Duration**	5 Days
Base Fee	$1,500 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Digital Substation Technologies Training Course provides a comprehensive, industry-focused understanding of how modern electrical substations are being transformed through digitalization, smart grid technologies, IEC 61850, substation automation, intelligent electronic devices (IEDs), process bus, station bus, digital protection, SCADA, cybersecurity, and real-time monitoring. The course explores the architecture, engineering, commissioning, operation, maintenance, and troubleshooting of next-generation digital substations, enabling participants to understand the transition from conventional hardwired substations to highly integrated, data-driven power systems. Particular emphasis is placed on IEC 61850 communication networks, GOOSE messaging, Sampled Values (SV), MMS, merging units, digital relays, time synchronization, Ethernet-based architectures, condition monitoring, asset performance management, and smart grid integration. Participants will gain practical knowledge of how digital technologies improve power system reliability, operational efficiency, protection performance, interoperability, predictive maintenance, and grid resilience.

Designed for today's rapidly evolving energy sector, the program combines technical theory with practical engineering scenarios, industry case studies, fault-analysis exercises, and real-world digital-substation applications. Participants will examine how utilities and industrial power systems implement AI-enabled monitoring, edge computing, Industrial IoT (IIoT), cloud-connected analytics, digital twins, advanced cybersecurity, automation, remote asset management, and data-driven predictive maintenance. Through structured learning and application-based exercises, delegates will develop the skills required to evaluate digital-substation architectures, configure and analyze communication systems, understand protection and control schemes, diagnose network and IED issues, and support digital transformation projects. The course is particularly valuable for professionals seeking to strengthen their capabilities in smart grids, energy transition, substation automation, critical infrastructure protection, and future-ready power-system operations.

Programme Curriculum

Digital Substation Technologies Training Course

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Course Duration

5 days

Course Objectives

By the end of this training course, participants will be able to:

1. Understand the architecture, components, and operating principles of digital substations and smart grid systems.
2. Explain the role of IEC 61850 in modern substation automation and interoperability.
3. Analyze Station Bus, Process Bus, Ethernet, GOOSE, MMS, and Sampled Values communication technologies.
4. Understand the functions and integration of IEDs, merging units, intelligent sensors, and digital protection relays.
5. Evaluate digital protection and control architectures for high-speed, reliable, and resilient power-system protection.
6. Develop an understanding of IEC 61850 engineering, SCL files, logical nodes, datasets, and communication services.
7. Identify best practices for time synchronization, including GPS, PTP/IEEE 1588, IRIG-B, and network-based synchronization.
8. Apply techniques for SCADA, HMI, remote monitoring, and substation automation in digitally connected environments.

9. Diagnose common communication, protection, control, and networking problems using digital troubleshooting and fault analysis.
10. Understand OT cybersecurity, zero-trust principles, network segmentation, access control, and critical infrastructure protection.
11. Explore AI, Industrial IoT, edge computing, digital twins, and predictive analytics for smart-substation applications.
12. Apply digital technologies to improve asset performance, predictive maintenance, reliability, and operational efficiency.
13. Develop practical strategies for implementing future-ready digital substation transformation and smart-grid modernization projects.

Target Audience

1. Electrical and Power Systems Engineers
2. Substation Design and Protection Engineers
3. Power System Automation and Control Engineers
4. SCADA, Telecom, and Industrial Networking Professionals
5. Utility and Transmission/Distribution Company Personnel
6. Operations, Maintenance, Testing, and Commissioning Engineers
7. Electrical Project Managers and Asset Management Professionals
8. Energy, Smart Grid, Digital Transformation, and OT Cybersecurity Specialists

Course Modules

Module 1: Digital Substation Fundamentals and Smart Grid Transformation

- Evolution from conventional substations to **digital and intelligent substations**.
- Digital substation architecture, functional levels, and key technologies.
- Role of **smart grids, automation, IIoT, edge computing, and real-time analytics**.
- Digitalization benefits for reliability, efficiency, safety, and asset management.
- **Case Study:** Transformation of a conventional transmission substation into a digitally integrated smart substation.

Module 2: IEC 61850 Architecture and Communication Technologies

- Fundamentals of **IEC 61850**, logical nodes, objects, datasets, and services.
- Understanding **MMS, GOOSE, and Sampled Values** communications.
- Station Bus versus Process Bus architectures.
- Ethernet networking, VLANs, QoS, redundancy, and high-availability concepts.
- **Case Study:** IEC 61850-based protection and control communication architecture for a high-voltage substation.

Module 3: Intelligent Electronic Devices, Merging Units and Digital Protection

- Functions and applications of **IEDs, digital relays, merging units, and intelligent sensors**.
- Digital protection schemes for transmission and distribution networks.
- Integration of current transformers, voltage transformers, and **non-conventional instrument transformers**.
- High-speed protection using GOOSE and Sampled Values.
- **Case Study:** Digital distance protection scheme using IEDs, merging units, GOOSE, and Process Bus technology.

Module 4: Process Bus, Station Bus and Substation Networking

- Design principles of **Process Bus and Station Bus** networks.
- Network switches, VLAN configuration, redundancy, and traffic management.
- PRP, HSR, and other **high-availability Ethernet technologies**.
- Network performance monitoring, packet analysis, and troubleshooting.
- **Case Study:** Troubleshooting intermittent GOOSE communication failures in an IEC 61850 substation network.

Module 5: Digital Substation Engineering, Automation and SCADA

- Digital substation engineering workflow and **IEC 61850 System Configuration Language (SCL)**.
- Integration of IEDs, gateways, SCADA, HMI, and control-center systems.
- Automated control, interlocking, alarm management, and event recording.
- Remote operation, condition monitoring, and centralized asset visibility.
- **Case Study:** Engineering and commissioning workflow for an automated substation integrated with a utility SCADA system.

Module 6: Time Synchronization, Testing and Commissioning

- Importance of accurate time synchronization in **digital protection and event analysis**.
- GPS, PTP/IEEE 1588, IRIG-B, NTP, and redundant timing architectures.
- Testing GOOSE, Sampled Values, IED configurations, and communication performance.
- Commissioning, validation, documentation, and troubleshooting methodologies.
- **Case Study:** Root-cause analysis of protection-event timestamp errors caused by a failed synchronization architecture.

Module 7: Digital Substation Cybersecurity and Advanced Technologies

- **OT cybersecurity**, threat identification, risk assessment, and critical infrastructure protection.
- Network segmentation, firewalls, secure remote access, authentication, and access management.
- Zero-trust concepts, security monitoring, incident response, and cyber resilience.
- Applications of **AI, machine learning, digital twins, edge computing, cloud analytics, and Industrial IoT**.
- **Case Study:** Cybersecurity assessment and modernization of a digitally connected utility substation.

Module 8: Predictive Maintenance, Asset Management and Future Digital Substations

- **Condition-based monitoring, predictive maintenance, and asset performance management**
- Digital monitoring of transformers, circuit breakers, switchgear, batteries, and auxiliary systems.
- Use of AI and analytics for **early fault detection and predictive asset health assessment**
- Digital twins, advanced analytics, remote operations, and future smart-grid integration.
- **Case Study:** AI-enabled predictive maintenance strategy for transformer and switchgear assets in a digitally monitored substation.

Training Methodology

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.

- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

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	27 Nov 2026	Online	$1,000
23 Nov 2026	27 Nov 2026	Physical	$1,500
23 Nov 2026	27 Nov 2026	Physical	$3,000
23 Nov 2026	27 Nov 2026	Physical	$3,000
23 Nov 2026	27 Nov 2026	Physical	$6,000
23 Nov 2026	27 Nov 2026	Physical	$4,500

Start Date	End Date	Location	Price
23 Nov 2026	27 Nov 2026	Physical	$6,000
23 Nov 2026	27 Nov 2026	Physical	$6,000

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