

GRIDED

The Center for Grid Engineering Education

Electric Power Distribution Systems

Course Description

This course is part of an educational library of short courses developed and offered by GridEd to address several evolving forces that will alter the fundamental operating characteristics of the electric grid, transforming it from a one-way central supply structure to one that has bidirectional power flows resulting from distributed energy resources (DER). Self-generating consumers or those with electric storage devices will alter the design requirements for the electric distribution system. This course focuses on electric power distribution systems and covers background and analysis of many modern distribution problems, including:

- Integration of distributed generation
- Advanced distribution automation
- Volt-var control

This course has particular emphasis on impacts on reliability, voltage profiles, and efficiency. The course includes several problem sessions where the class will work through real-world problems. We will focus on a few cross-cutting problems. For example, as we look at volt-var control, we can cover the response of different loads to voltage changes, voltage drop fundamentals, impact of reactive power, capacitor control, and regulator control.

Who Should Attend

This course is intended for distribution engineers or engineers needing to learn about distribution systems with a background in electrical engineering. Students should have some familiarity with distribution systems and equipment.

Registration Information

PDH Available: 16 hours

Registration Fee:

- \$1,200 per person
- 20% discount for organizations with three or more attendees
- 25% discount for government employees (non-utility)
- 25% discount for university professors*
- 75% discount for graduate students*

*University IDs required to qualify for professor or graduate student discounts.

Students need to bring: laptops or tablets to access online resources and to follow class notes. Wi-Fi access is provided. Lecture slides will be provided electronically in PDF format.

For More Information

Amy Feser, afeser@epri.com, (865) 218-5909

Course Instructors

Tom Short, tshort@epri.com

Meet the Instructors



Tom Short is a Technical Executive at the Electric Power Research Institute (EPRI). His responsibilities include leading research in the areas of distribution capacitor application, distribution efficiency and volt-var control, power quality, fault location, distribution reliability, application of distributed generation, and resiliency of overhead lines during storms. Short has led instruction of utility personnel in the areas of arc flash, lightning protection, distribution system design, and application of distributed generation. Short authored the book *Electric Power Distribution Handbook*, 2nd Edition. Prior to joining EPRI, Short performed utility studies in the areas of distribution lightning protection, power quality monitoring, transient simulations of lightning and switching impacts, ferroresonance, and reliability at Power Technologies, Inc. Short taught utility courses on distribution systems, lightning protection, relay application, power quality, and application of distributed generation. Short is a fellow of IEEE based on his work in distribution engineering. Short received his Bachelor's and Master's degrees in electrical engineering from Montana State University.

Course Outline

Day 1

- **Brief introduction to distribution systems**
 - Primary distribution configurations
 - Substations
 - Loads
 - Efficiency
 - Distribution planning
- **Changes in distribution systems**
 - Integration of distributed generation and storage
 - Microgrids
 - Electric vehicles and other load changes
 - Smart grid systems and technologies
- **Basics of overhead and underground lines**
 - Impedances
 - Losses
 - Voltage drop
- **Problem session: DG impacts on voltage drop**
- **Transformer connections**
 - Grounded and ungrounded connections
 - Ferroresonance
 - Backfeeds
 - Generation issues with backfeeds
- **Problem session: DG impacts with different transformer connections**
- **Voltage regulation**
 - Voltage drop basics
 - Voltage regulator basics
 - Conservation voltage reduction
 - Regulator issues
- **Capacitors and reactive power control**
 - Line losses and vars
 - Methods of capacitor control
 - Capacitor issues
- **Problem session: Volt-var control**

Day 2

- **Faults**
 - Types of faults
 - Fault currents
 - Impacts of arcing
 - Fault location
- **Overcurrent coordination**
 - Coordinating devices
 - Fuse saving and fuse blowing
 - Locating devices
 - Arc flash
- **Problem session: DG impacts on coordination**
- **Reliability**
 - SAIFI, SAIDI
 - Worst circuits
 - Reliability programs
- **Resiliency**
 - Hardening
 - Automation
 - Undergrounding
 - Microgrids
- **Problem session: Design an automated system**
- **Power quality**
 - Voltage sags
 - Momentaries
 - Flicker
 - Harmonics
- **Problem session: Problem feeder**

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Electric Power Research Institute

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