EPRI | ELECTRIC POWER RESEARCH INSTITUTE

GEARED

GridEd

The Center for Grid Engineering Education

Distributed Generation Interconnectionon Radial Distribution Systems

Live Online

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 includes discussion of key issues that arise when distributed generation is added to radial distribution systems and followed by computational exercises on specific issues. Key topics include:

- Voltage rise/drop
- Voltage regulation
- Grounding and Temporary Overvoltage
- Fault performance and protection

This course includes three design case studies based on the open source software Open DSS. An OpenDSS tutorial will be provided as part of this course and no previous experience with this software is needed. The case studies include material on Smart Inverter capability and the traditional methods for identifying DG penetration level limitations. This course is being offered in a web-based format with 8 sessions (90-minutes each) scheduled over a 4-week period.

Who Should Attend

This course is intended for distribution engineers and distributed generation design engineers with a background in electrical engineering. Students should have some familiarity with distribution systems and equipment.

Registration Information

PDH Available: 16

Registration Fee:

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

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

Particpants will need: *access to an Ethernet broadband internet connection (wireless not recommended) from a standard desktop/laptop computer equipped with speakers, microphone and common web browser, i.e. Internet Explorer, FireFox, Google Chrome, etc. Students will join live, synchronous web conference sessions via Adobe Connect, with two-way voice capability through a telephone bridge. Students will need to install OpenDSS software prior to the start of the course. OpenDSS is unbalanced load flow software that is open source and downloadable free of charge. Sessions will be recorded and posted for later viewing.*

Course Instructor: Tom Ortmeyer, Clarkson University
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EPRI Contact:, Amy Feser, (865) 218-5909, afeser@epri.com

*Professional Development Hours

Course Outline

Session 1
- Characteristics of Traditional Primary Radial Distribution Systems
- Voltage Regulation with Capacitors and Voltage Regulators
- Smart Distribution
- Group Discussion of Current Practices and Experiences with DG

Session 2
- OpenDSS Tutorial
- Distributed Generator Characteristics: Synchronous Machines and Inverters
- Voltage Regulation with Inverters
- Modeling Synchronous Generations in OpenDSS
- Modeling Switching Capacitors in OpenDSS
    - Case Study 1: (Assigned in Session 2, due in Session 3): Large Synchronous DG Impact on a Radial Line with Switched Capacitors

Session 3
- Characterizations of Wind and Photovoltaic Generation
- IEEE 1547 Interconnection Standard
- Group Discussion of Experience with IEEE 1547

Session 4
- Discussion of Case Study 1
- Modeling PV Sources in OpenDSS
- Modeling Voltage Regulators in OpenDSS
- System Unbalance
- Case Study 2: (Assigned in Session 4, due in Session 5):
    - Large PV DG Impact on Distribution System Small Single Phase PV Impacts on Distribution System

Session 5
- Review of Symmetrical Components and Fault Current Calculations
- Fault Performance of Modern Inverters
- Effective Grounding and Temporary Overvoltage
- Fault Clearing with Circuit Breakers, Reclosers and Fuses

Session 6
- Discussion of Case Study 2
- Running Fault Studies with OpenDSS
- Transformer Connection Options for Large DG Installations
- Impact of DG on Circuit Breaker, Fuse Interrupting Requirements
- Impact of DG on Temporary Overvoltages
    - Case Study 3: (Assigned in Session 6, due in Session 7): Fault Impacts of Synchronous Generator and Inverter Connected DG

Session 7
- Group Discussion of Large DG Impacts on Fault Performance
- Discussion of Transformer Connection Practices with Large DG
- PV Ride Through and Anti-Islanding Controls

Session 8
- Discussion of Case 3
- Overview and Discussion: Protection Issues with Large DG

Meet the Instructors

Tom Ortmeyer is Professor of Electrical and Computer Engineering at Clarkson University. At Clarkson, he teaches courses in the areas of electric machinery, power systems, protection, and power quality. Ortmeyer began his career at Commonwealth Edison Company, where he was a member of the Operations Analysis Department. While on the Clarkson faculty, he has held short term appointments or fellowships at NASA, US Air Force, Kumamoto University, University of Canterbury, and EPRI. At Clarkson, he was the founding director of the Alcoa Experiential Learning Program, and is currently involved in collaborative research projects with New York State Energy Research and Development Authority, Department of Energy, National Grid and others. Ortmeyer is a fellow of IEEE based on his work on the modeling and analysis of power system harmonics. He received his Bachelor's, Master's and Ph.D. degrees in electrical engineering from Iowa State University.

Tom Key is a Senior Technical Executive at EPRI. He has over 30 years' experience in technical direction, planning and management of energy related R&D in the US Navy, at Sandia National Laboratory in Albuquerque, and at EPRI. He has specific expertise in electric power systems, energy storage, renewable technologies, power quality, and related power electronics and system integration. He is a Fellow of the IEEE and a nationally recognized leader in power system compatibility research, integration of distributed and renewable energy resources, application energy storage and power electronic technologies. He is currently leading EPRI activities in the area of integration of renewable energy into the electric grid.

Brian Deaver is a Senior Technical Executive at EPRI. He has worked in the electric distribution industry for over 30 years, and is a Senior Member of IEEE. Brian leads EPRI's research portfolio regarding Distribution Operations. This research covers a wide range of applications including Distribution Automation, Automated Service Restoration, Volt/VAR Control, Distribution Management Systems, Fault Location and Switching. Additionally, Brian is moderator of EPRI's Distribution Operations Interest Group which provides control center managers and staff the opportunity to discuss and share experiences related to the critical issues surrounding deployment, operation, maintenance and training on key control center technologies and processes.

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