GridEd
The Center for Grid Engineering Education

ELECTRIC POWER RESEARCH INSTITUTE

Addressing the Educational Needs for Engineers for Planning, Designing and Operating Present and Future Electric Grids

2018 GridEd Short Course Offerings

http://grided.epri.com/courses.html

The following courses are part of a growing library of courses offered under the GridEd family of educational training activities. These courses are compact to provide state-of-the-art understanding in key areas of a rapidly changing electric system environment. Courses can be taken independently or can be grouped to meet objectives of a particular training need. Some of the listed courses are under development.

Application of Smart Inverters Technology – Greater adoption of distributed energy resources (DER), especially solar photovoltaic (PV) systems, interconnected on distribution feeders can create grid management challenges. However, PV and energy storage inverters are also capable of being "smart," delivering timely support for grid voltage and frequency, limiting active power generation when necessary, and maintaining operation during transient events. This course focuses on these smart inverter functionalities, from their fundamentals through applications to the growing number of distributed resources being integrated into the power system.

Big Data Analytics for Electric Power Distribution Systems – This course is one in a series of several courses developed and offered by GridEd to address the 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 will alter the design requirements for the electric distribution system.

This course focuses on applications of predictive analytics on smart electric power distribution systems and the use of Large Scale (Big) Data Analytical methods and their application to electric distribution system analysis and design. The basics of big data analytics and the electric power distribution system will be introduced. Four data-driven applications in electric power distribution systems will be studied closely. These include 1) Distribution system topology identification using smart meters data; 2) Distribution system power flow and state estimation; 3) Distributed energy resources adoption forecasting; and 4) Load and demand response forecasting. This is a first course in developing techniques to analyze the distribution system in a Big Data format. These techniques will be applied in subsequent courses to analyze such industry challenges as electricity markets and including design approaches to distribution system operator (DSO) managed electricity market. Six problem sessions and case studies are included in this interactive short-course.

Bulk System Integration of Variable Generation – This course will review topics related to variable generation (VG) integration into the bulk electric system. Increasing penetration of wind and solar (collectively, VG) can have significant impacts on bulk power system planning and operations. This includes the impact of transmission connected resources, but also the impact of the aggregate of large penetrations of Distributed Energy Resources on the bulk system.

Business Case Analysis in the Electric Utility Industry – This course introduces participants to financial and economic principles and practices electric utilities employ to plan and operate power systems. Utilities are a business, but they operate under financial, commercial and regulatory conditions that in many respects differ from those of competitive firms. Principal among them is their charter to provide universally least cost, reliable service, and operating under a regulated rate of return. Moreover, those circumstances differ among utilities depending on the market structure they operate in.

Data Communication Technologies and Analytics – Today, the digital revolution is touching all facets of the production, delivery, and use of electricity. The core of the digital revolution for the electric industry is the use of communication systems along with data capture, transport, & archive practices. This course will focus first on the fundamental communication technology options such as Wi-Fi, powerline carrier, radio, among other technology choices. System interface designs based on platform approaches will also be explored. The fundamentals of modern metering methods and products will be examined as the needs for electronic and digital metering, end-use metering, and other practices are evolving. Other advanced automation practices such as including distributed energy resources (DER), advanced metering Interface (AMI), the OpenADR protocol and other demand response (DR) protocols will be considered. Data formats and structures will be evaluated to determine suitability and best practices. Size and frequency of information packets will also be considered.

Distributed Generation Interconnection on Radial Distributions Systems – This course addresses 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.

Distributed Generation Technologies – A range of distributed generating technologies are explored including photovoltaics -- characterizing the solar resource, materials & electric characteristics, and systems; CSP solar; wind power systems; fuel cells; and distributed fossil generation systems. The economics of all these systems will be evaluated. Some additional details will be provided for solar PV including autonomous and grid-connected systems, utility scale, inverter topologies, technology performance differences, instrumentation & monitoring considerations, as well as operation & maintenance needs.

Power Distribution Reliability – (Under Development) The course will focus on distribution reliability. Typical reliability indices are considered useful for distribution capacity planning, such as SAIFI, loss of load expectation, expected energy not supplied, and others. Computational methods of reliability indices are presented and introduction to commercial reliability software. In addition, causes of interruptions will be considered. Reliability modeling and reliability analysis methods are explored. The course closes out by examining several case studies.

Electric Power Distribution Systems – This course addresses 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.

Electric Power Quality – This short course relates to electric power quality, the characteristics of maintaining rated electrical parameters in a power system. The topics discussed are the main points that encompass this field in the world today including voltage sags, harmonics, momentary events, interference, and waveform distortion. These topics are studied in terms of definitions and theoretical bases; measurement and instrumentation; circuit analysis methods; standards; sources of problems; and alternative solutions. An important objective of the short course is to acquaint the attendee with the most recent developments, issues and solutions in electric power quality engineering.

Electric Transportation – Electric fuel for transportation systems is rapidly moving into the marketplace. In this course, the fundamentals of various electric transportation products and systems for moving people and materials are presented. The properties of electric transport vehicles as in passenger cars, trucks, lift trucks, utility vehicles, vans, and commercial and industrial vehicles will be characterized. The basics of the battery systems, electric drive train, and onboard diagnostics and displays are reviewed. A crucial part of establishing electric transportation as viable is an effective refueling infrastructure. The evolution of infrastructure requirements for charging vehicles with both conventional and fast charge options are developed. This includes both AC and DC systems as well as novel charging apparatus. All forms of charging including public, at work, at home, fleet, and other configurations are described. Various types of electricity rates and recharging pricing programs are considered. Finally, utility impacts of all types of electric vehicles are evaluated for their consequences.

Electricity Markets – The course, developed by Case Western Reserve University (CWRU) and the Electric Power Research Institute (EPRI), teaches the fundamental principles which govern electricity market operation and pricing dynamics. Course participants will learn about the electrical power system infrastructure and reliability operation, and the locational marginal cost based pricing mechanism underlying the wholesale electricity market design. Additional topics include market settlement, the capacity and Financial Transmission Right (FTR) markets, and management of generation portfolios by the load serving entities. Impacts from integrating intermittent renewable generation, energy storage and demand-side resources will also be discussed. Further, the CWRU has developed an online electricity market simulator that allows course participants to play realistic market clearing scenarios while acting as market participants. As a key component of the course, the interactive market simulation exercises supplement the course lectures with hands-on learning experience. Course participants will retain online access to the market simulator tool for six months after the course.

Energy Storage Technologies, Applications and Integration – This course addresses 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, flexible power flows resulting from the integration of energy storage systems. This course focuses on energy storage technologies and applications for transmission and distribution connected systems. Students will learn about the policy, cost, and technical challenges facing the wider use of energy storage and what can be done to address those challenges. Additionally, considerations for energy storage project development and deployment will be discussed.

IEEE 762 – This course covers the principles of IEEE Standard 762, "IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability and Productivity" (2006 version, reaffirmed 2011). It also explores how plant performance standards need to be adopted for variable wind and solar. The standard provides a methodology for the interpretation of electric generating unit performance data from various systems and it facilitates comparisons among different systems. It also standardizes terminology and indexes for reporting electric generating unit reliability, availability, and productivity performance measures. This standard is intended to aid the electric power industry in reporting and evaluating electric generating unit reliability, availability, and productivity while recognizing the power industry's needs, including marketplace competition. The course includes unit states, time destinations, energy states, performance indices, calculations of indices, and how the standard can be extended from conventional power plants to non-dispatchable solar and wind powered generation.

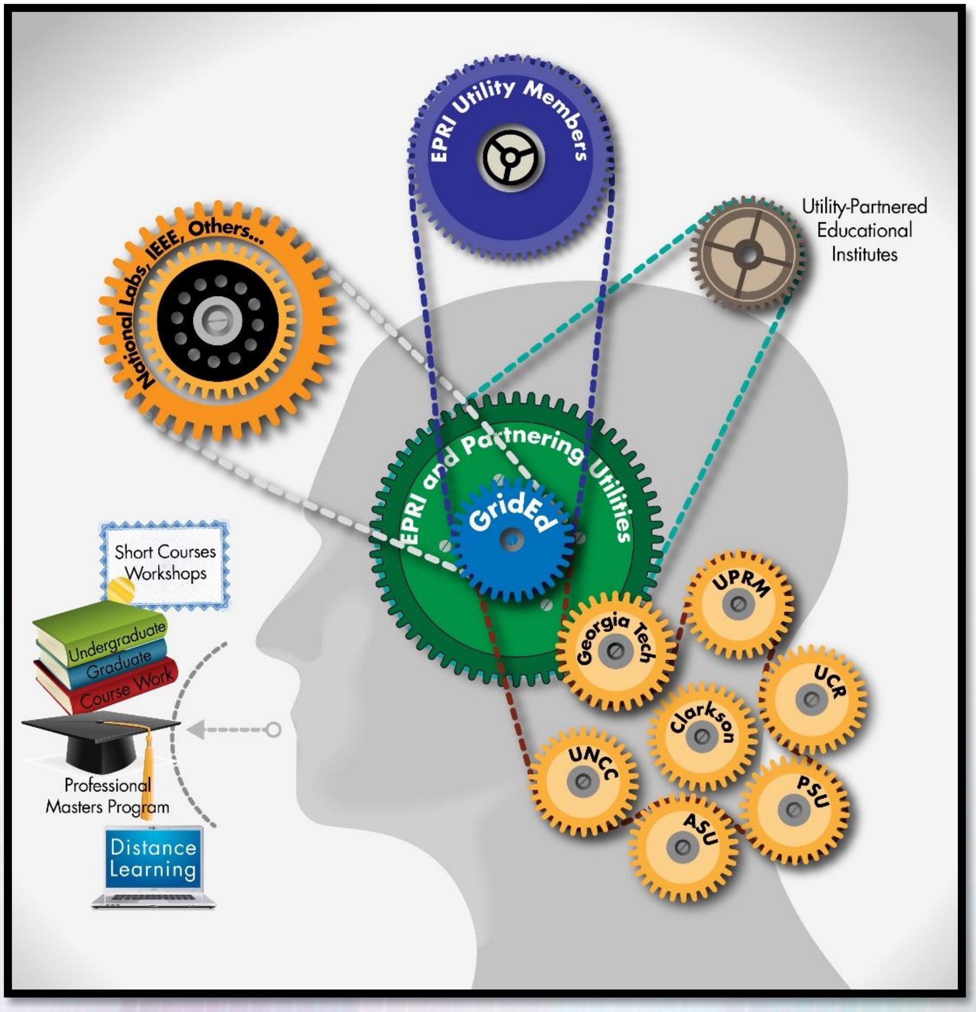
Micro-Grid Concepts and Designs – The principles and practices of microgrids are presented and evaluated. Microgrids are used in a variety use cases such as improving end-use reliability, increasing energy efficiency, using photovoltaics more effectively, providing resiliency in the event of grid outages. The popularity of microgrids is on the rise resulting in a rapid growth of system deployment. In particular, consideration will be given to renewable energy generation and energy storage and their roles in the microgrid implementation. The principles of load/generation balance will be examined and how to best go about achieving it. The value proposition for applications to military bases, eager to increase local reliability and decrease reliance on local grids especially with an emphasis on the use of renewable energy sources such as photovoltaic (PV) panels and small wind turbines, moderated by energy storage and fossil distributed generation devices such as microturbines and fuel cells. Agent-based modeling methods will be considered for evaluating performance. Various microgrid control strategies will be designed and evaluated. Also, the role of microgrids supporting system resiliency efforts will be analyzed.

Unbalanced Distribution System Analysis – This course focuses on analysis tools for unbalanced power systems. The physical and mathematical concept of a three phase balanced electric power system will be reviewed. Discussion will involve, how and when a balanced electric power system becomes unbalanced, why a distribution system could normally be unbalanced, and the importance of developing and using alternate mathematical models and methods of analysis to study unbalanced power systems. Examples will be used to compare the behavior of unbalanced distribution systems with balanced systems.

Utility Applications of Power Electronics – This course is one in a series of several courses developed and offered by GridEd to address the 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). This course addresses aspects of interfacing various generation technologies with the utility grid through power electronics. This class identifies and serves to fill the gaps between common course offerings such as Power Electronics and Power Systems. The class covers steady state and dynamic aspects of grid interface, along with teaching about various industry standards that require compliance prior to interconnection with the power grid. Students will also learn about modeling grid tied inverters which is a common building block to interface modern generation technologies with the utility grid.

Semester Courses

Fundamentals of Electric Power Systems – The purpose of this course is to provide engineers and analysts an introduction to electric power systems analysis. It is offered in two parts: 1) fundamental components and 2) analysis methods.



To be added to the GridEd short course invitation list, please request by emailing: afeser@epri.com