2011
Advanced School in Power Engineering

August 23 to December 8

A Power Engineering Program conducted annually by The Pennsylvania State University, Department of Electrical Engineering, Monroeville, Pennsylvania USA
http://www.engr.psu.edu/powerengineering
The Tradition
The annual Advanced School in Power Engineering was launched in 1971 by the partnership of The Pennsylvania State University and the Westinghouse Electric Corporation. Since 1992 it has been solely sponsored by The Pennsylvania State University. More than 1,300 engineers from sixty countries have attended this program.

The mission of the Advanced School has always been to provide electric utility engineers with a comprehensive education in power systems engineering, with emphasis on practical applications. Advanced School instructors are practicing expert engineers, offering their students an education that can be immediately applied to the workplace and will ultimately provide a positive payback to their corporate sponsors. We are committed to providing education on current and emerging technologies essential to the future of electric power systems.

The Program
The curriculum covers all aspects of modern electric utility and industrial power systems and consists of courses, workshops, special lectures, and visits to electric utility facilities. The courses are taught at an academic level, with extensive practical application.

Weekday mornings are generally devoted to lectures and class recitations with case studies and homework assignments in the afternoons. Some courses require evening study. The afternoon and evening studies offer an opportunity to reinforce the lecture concepts through individual and group assignments. Extensive interaction and idea exchanges with engineers from other companies have proven to be very beneficial. Examinations are given to provide both the students and the faculty with measures of the proficiency and comprehension acquired through the program.

The program is four months in duration and organized into four independent and successive sessions. The courses will be delivered serially in order to offer opportunities for students to attend the entire program or to attend selected sessions or individual courses. Hot topics such as deregulation, asset management, energy theft, renewable energy, electricity pricing, power quality and smart grid have been enhanced to match their importance.

Faculty
The faculty are highly qualified engineers from electric utilities, consultants, academia, and manufacturers, with many years of teaching experience. The instructors' emphasis is always on applying theory into practice.

Attendees
The school is designed for engineering graduates with at least two years of work experience. The scope of the school is sufficiently broad to benefit those working in all areas of utility engineering. Students are encouraged to take advantage of the learning opportunity inherent in group interaction activities. All students should, if possible, bring laptop computers.

Enrollment and Fees
The 2011 Advanced School has been structured so that students can enroll for the entire School or for selected sessions or courses. Fees and payment options are listed on the registration form. Fees do not include housing.

Other Expenses
Each student will pay his/her individual expenses, including housing, salary, travel, telephone, internet service and food. It is highly recommended that all students and their accompanying spouses and/or children, have health insurance coverage.

Accommodations
The program is conducted in Monroeville, a suburb of Pittsburgh, Pennsylvania. The fee for the program does not include living accommodations. Apartment housing is available in the Monroeville area and we will assist students, and their families, in finding suitable accommodations. If requested, the University will furnish housing and add that cost to the Advanced School fee. Minimal local public transportation is available. The decision to bring or rent an automobile is left to the student. International students should bring an international driver’s license. The University will provide no-cost assistance in registration of students’ children in Monroeville schools, finding rental cars, banking and other ancillary needs.

Language
All courses are conducted in the English language.
SCHOOL SESSIONS & SCHEDULE

First Session – Energy/Economics
Aug 23 to Sep 16, 2011
Aug 23-26  Engineering Economics
Aug 29-Sep 1  Electricity Pricing
Sep 6-9  Distributed Generation
Sep 12-15  Generation Planning
Sep 16  Renewable Energy Technology

Second Session - Systems Analysis
Sep 19 to Oct 14, 2011
Sep 19-22  Power Systems Analysis
Sep 26-29  Transients
Oct 3-6  Reliability
Oct 10-13  Surge Protection
Oct 13-14  Fault Arc Flash Calculations

Third Session - Systems Integrity/Design
Oct 17 to Nov 11, 2011
Oct 17-20  Testing & Maintenance
Oct 24-27  Substation Design
Oct 28  Transmission Line Design & Constr
Oct 31-Nov 3  Protection
Nov 4  Smart Grid
Nov 7-10  Harmonics
Nov 11  HVDC

Fourth Session – Distribution/Multidiscipline
Nov 14 to Dec 8, 2011
Nov 14-17  Distribution Planning
Nov 18  Energy Theft/Revenue Protection
Nov 21-23  Distribution Automation
Nov 29  Deregulation
Nov 30-Dec 1  Electric & Magnetic Field Effects
Nov 30  Secondary Networks
Dec 2  Asset Management
Dec 5-8  Power Quality
Dec 6  Automated Meter Reading

First Session – Energy/Economics

Engineering Economics
The course is directed to engineering economics as it relates to electric utilities. Engineers working in a deregulated utility environment must understand the financial implications of investment opportunities in:
- traditional generation, transmission & distribution
- application of new technologies
- renewable energy
- cogeneration
- load management
- distributed generation
- automated meter reading
- distribution automation
- flexible AC thyristor-controlled devices

Distributed Generation
The course provides an in-depth coverage of the technical and financial effects Independent Power Producers (IPP’s) injected directly into transmission and/or distribution lines. Both nonrenewable and renewable forms of generation are addressed for the full range of size(s) commercially available from industrial size cogeneration projects to the new wave of small scale distributed generation. This includes:
- various types of independent power producers
- methods of application
- technical analysis
- methods of operation
- economics
- operation
- planning
- protection
- reliability
- interface requirements
- determination of potential threshold limitations
Economic feasibility evaluation is presented, given real world technical constraints, including impacts on existing operations.

Electricity Pricing
The course focuses on the technical business concepts and applications utilized to establish sound prices for electric service. Key topics include:
- cost-of-service elements for differentiating electric service by customer classes and costing components
- alternative rate structure designs and their inherent risk characteristics
- practical analysis techniques used in rate development and administration
- regulated and competitive electric services
- bundled and unbundled pricing methods
- pricing strategies that promote customer value and service provider profitability

The information requirements and resources necessary for electricity pricing are discussed. Problem solving sessions provide for a “hands-on” approach to learning.
Generation Planning
The course covers the major topics related to generation planning in both regulated and deregulated environments. It describes modeling techniques and modern tools available to generation planners such as:
• load modeling & forecasting techniques
• methods for simulation & optimization
• approaches to production costing
• reliability criteria & indices
• economic calculations
• forecast uncertainty
• environmental & financial restrictions
• capital costing
• RTO/ISO market reforms
The students will have an opportunity to utilize software models to practice generation planning techniques throughout the course of study.

Renewable Energy Technology
Renewable energy resources are available in the United States and throughout the world. Some are universally available while others are limited to particular areas. For a variety of regulatory, social, economic, and environmental reasons and in particular, the concern about (1) dependence on oil, (2) long-term impacts of atmospheric greenhouse gases, and (3) energy security, there is an increased interest in renewable energy technology. The workshop will cover:
• wind
• biomass
• solar photovoltaics
• geothermal
• solar thermal
• wave-tidal energy hydro
• energy storage technologies
• utility standards for interconnections
The workshop will provide a basic reference on technical and economics assessment of renewable energy generation technologies. Design, cost, and performance information provide the basics to perform preliminary generation technology evaluations and application.

Second Session – Analysis

Power Systems Analysis
This course covers a review of the electric power system basics including:
• phasors & three phase power
• transmission line parameters
• transmission line modeling
• transformer, generator & load modeling
• power flow analysis
• batteries & chargers
• symmetrical components
• short circuit analysis

Transients
The course covers lumped and distributed parameter analysis of electrical transients in power systems. The objectives for this course are:
• to develop an understanding of how surges and electrical transients originate and propagate throughout a power system.
• to develop the capability to understand the nature and calculation of such surges and transients.
• to be able to understand transients issues related to power system apparatus and overvoltage protection schemes for acceptable system operation with regard to insulation performance.
The course will cover:
• fundamental Notions about Electrical Transients
• transient Solutions by Laplace Transform and by deduction
• simple Switching Transients and Damping
• transmission Line Equations and Traveling Waves
• behavior of Traveling Waves at Junctions - Surge impedance Terminations
• behavior of Traveling Waves at Junctions - Complex terminations and Bifurcation
• lattic (Bewley) Diagrams
• attenuation and Distortion of Traveling Waves
The workshop includes two terminal and multi-terminal systems and presents the techniques for studying HVDC power systems and planning considerations.

Reliability
The course covers the complete realm of power system reliability computation, evaluation, and improvement. Extensive case studies are utilized
• prediction methods
• indices
• measurement
• probability theory
• probability models
• stochastic processes
• applications
• data collection
• study results

Surge Protection
The course presents the theory and methods for the specification of surge protection. It includes:
• review of probability calculations
• overview of insulation coordination
• classification of switching surges
• engineering parameters of the lightning stroke
• impulse wave shapes, test methods and corrections
• models for shielding transmission lines and stations
• transmission line shielding failure flashovers
• traveling waves and impulse voltages on the tower
• backflash and lightning flashover rate
• lightning impulse surges into the substation
• neutral grounding of power systems
• selection and application of surge arrestors
• comparison of IEEE & IEC standard
Fault Arc Flash Calculations
This workshop is directed to graduate electrical engineers who are interested in a better understanding of electrical power systems. It covers short circuit calculations using the point-to-point method, the per unit method and the ohmic method; conversion of time varying periodic waveforms to phasor form; phasor algebra; per unit; symmetrical components; grounding methods; ground fault equations; methods of calculating ground fault using sequence network diagrams; ground fault detection methods for power systems; arc fault and arc flash calculations. It will also benefit anyone who is preparing to take the Professional Engineering Exam for electrical engineers.

Third Session – Systems Integrity/Design

Testing & Maintenance
This course covers electrical equipment acceptance and maintenance test methods and procedures and overall power system equipment selection and application. Numerous test techniques are discussed, and the importance and benefit of sound electrical power system maintenance and testing practices are emphasized. Applicable test equipment will be demonstrated. Topics include:
• Power Transformers
• Circuit Breakers
• Voltage Regulation
• Capacitors
• Arresters
• Batteries & Chargers
• Power Switches & Motor Mechanisms
• Demonstrations

Substation Design
The course presents the essential elements that must be completed in designing a modern distribution or transmission substation. Considerations include:
• siting
• voltage requirements
• transformers
• grounding
• insulation coordination
• breakers
• capacitors
• phasing
• arrangement
• standards

Transmission Line Design & Construction
The workshop presents an overview of the civil, environmental, and structural engineering tasks required for the siting, design, and construction of high voltage transmission lines. Emphasis is given to the practical aspects of the design process, but draws on the necessary theoretical concepts, where required, for a complete understanding of the various siting, design, and construction activities.

Protection
The course provides instruction in:
• power system protection concepts and philosophy
• protective device coordination
• application and setting of protective relays including microprocessor-based systems
Students will participate in the design and setting of protection schemes for common power system elements.

Smart Grid
Advanced Metering Infrastructures (AMI) allow utilities to obtain consumption reads, energized state, and perhaps voltages and power qualities of meters much more frequently than the monthly billing cycle and on demand. These capabilities allow the utility to greatly enhance their customer services, revenue management, distribution operations and outage management. AMI further enables customer choices in energy usage in response to actual energy prices at the time. Demand Response (DR) technologies, such as smart thermostats, smart A/C cycling controls, in-home displays, etc., allow customers to execute their choices conveniently. AMI and DR together offer alternatives in addition to renewable energy to help solve the global energy supply and transmission capacity constraint problems. Smart Grid technologies combine broadband communications (e.g. Broadband on Power Line) and intelligent electronic devices (smart relays and distribution automation devices). Coupled with much timelier data on customer loads and voltages through AMI and potential load reductions through DR, It provides unparallel capabilities in monitoring, controlling, optimizing the efficiencies, and automating the restoration of the energy delivery grid.

Harmonics
The course covers the spectrum of harmonics in electric power systems. This includes:
• how harmonics are generated
• system response to the harmonics
• the effects of the harmonics
• harmonic control
• analysis methods
• measurements
• harmonic mitigation

HVDC
The workshop provides a basic understanding of how HVDC systems operate and interact with AC systems. It covers:
• AC to DC conversion
• harmonics and filtering
• control
• station design
• insulation coordination
• reliability
The workshop includes two terminal and multi-terminal systems and presents the techniques for studying HVDC power systems and planning considerations.
Fourth Session – Distribution/Multidiscipline

Distribution Planning
The course provides an in-depth look at the issues, challenges and engineering methods involved in planning modern, low-cost power distribution systems, including operation, performance, reliability, service quality and economics. The full spectrum of modern planning methods is presented from simple rules to complex computerized techniques for optimization and risk minimization. Particular attention is paid to meeting regulatory requirements for examination of alternatives, cost and site justification, and demonstration of due diligence. Techniques for meeting mandated budget limits and optimizing existing system capacity by minimizing capital and deferring additions are the focus of this course. Emphasis is placed on methods to identify opportunities for cost savings and ways to exploit them for maximum gain. The topics covered help participants develop an understanding of distribution system design and promote an intuitive feel for capital and operating costs and ways to reduce them. Participants will be challenged to reexamine their company’s planning methods with an eye toward improving bottom-line costs.

Energy Theft/Revenue Protection Workshop
The workshop focuses on how a utility can reduce losses. The technical losses in a utility are typically between 3 and 6 percent and non technical losses can vary from 2 to 40 percent. These losses result in energy shortages, degraded apparatus life, poor service voltages and loss of revenue. One of the most significant non technical losses is energy theft. Discussions will cover:
- identification of non technical losses
- common methods used to steal energy
- investigative procedures/methods of detecting theft
- correcting/mitigating and prosecuting energy thieves
- incorrect meter installations
- erroneous billing
- inaccuracy of meters
- justifying revenue protection programs
- implementing a revenue protection program

Distribution Automation
Automated power distribution systems offer significant improvements in T&D capacity utilization, voltage quality, and reliability of service. Through the course, the participants will get a thorough understanding of the steps required to justify and set up a distribution automation (DA) program. The course explores various DA functions, describes the equipment and software used to implement these functions, their capabilities, costs, and performance. Included are:
- alternatives for system architecture
- interaction between DA and SCADA and DSM
- radial load flow and network reconfiguration
- intelligent switching systems
- adaptive protection and harmonic penetration
- issues with the communication system needs
- cost-benefit studies
- defining measurements for verifying the expected system improvements

Deregulation
This workshop presents an overview of deregulation, its facets and how they interrelate, including, but not limited to:
- types of deregulated industry structures
- new entities
- competition/marketplace
- holding companies
- legislation
- FERC
- standardized market design
- the California experiment
- supply and demand
- national energy policy
- energy supplies
- environment
- risk management
- the Enron effect

Electric & Magnetic Field Effects
The workshop provides an overview of electric and magnetic field concepts specific to electric power systems, moving from basic field concepts to measurement techniques and discussions of relevant issues such as health effects and electromagnetic interference. The main topics are:
- physics of electric and magnetic fields
- DC fields (static)
- AC fields (alternating)
- measurement techniques
- power line field health effects and exposure guidelines
- interference from power systems (EMI)
- modeling electric and magnetic fields
- field management (mitigation)

Both simple and highly sophisticated magnetic field instrument packages will be used to demonstrate both the simplicity and subleties of magnetic field measurements.
Asset Management
The workshop presents the functions and value of a utility asset management operation along with the cultural changes and the organizational steps required to develop it. Included are:
- scope
- importance
- characteristics of an asset management driven company
- role of the asset manager
- real life examples and applications
- asset strategies
- risk management investment planning performance management opportunity development
- decision making tools and models
- technology integration plan

Power Quality
The course approaches power quality from the standpoint of customer value maximizing power quality and price from the customer’s perspective: high reliability and quality are always possible if cost is no object, but cost is a concern. Therefore, whether a regulated franchise or a competitive retailer, an electric utility has an incentive to provide the best combination of power quality and price to match its customers’ needs. The course explores the various aspects of:
- power quality
- interruption of service
- voltage flicker and control
- voltage swells and sags
- surges
- harmonics
For each, its causes and effects, and ways to record, measure, evaluate, and “curve” the problems are discussed, both with theory and engineering methods and case studies.

Automated Meter Reading
This workshop presents the scope of an extensive AMR system. This includes background, fixed network, business benefits, outage management, revenue protection, asset management, new opportunities, meter analysis and smart meters.

Secondary Networks
This workshop presents an overview of the design, operation, and protection of low-voltage secondary network systems. These systems supply major metropolitan areas in the USA and elsewhere with the highest level of reliability and service possible with conventional power distribution systems. Topics included are:
- fundamental design considerations
- operation for faults in different zones
- supply substation configurations
- grounding methods for primary feeders
- overcurrent protection of primary system
- equipment overview and characteristics
- network protector types and functions
- network protector relay trip and close settings and characteristics
- network protector fuses and cable limiters
- spot networks layout

Alumni Countries
Abu Dhabi  Honduras  Pakistan
Argentina  India  Panama
Bangladesh  Indonesia  Philippines
Belize  Iran  Puerto Rico
Bermuda  Israel  St. Kitts
Bolivia  Italy  St. Vincent
Botswana  Ivory Coast  Saudi Arabia
Brazil  Jamaica  Singapore
Burma  Japan  South Africa
Cambodia  Jordan  Spain
Canada  Kenya  Sudan
China  Khmer Republic  Syria
Colombia  Korea  Taiwan
Costa Rica  Kuwait  Tanzania
Cyprus  Libya  Thailand
Ecuador  Malaysia  Trinidad
Egypt  Mexico  USA
England  Nepal  Venezuela
Finland  New Zealand  Vietnam
Ghana  Nigeria  Zimbabwe
Advanced School Fees

Advanced School - All Four Sessions - $22,250

Individual Sessions - $7,200 each

First Session - Energy & Economics
Second Session - Systems Analysis
Third Session - Systems Integrity & Design
Fourth Session - Distribution & Multidiscipline

Course Fee - $1,700 each

- Engineering Economics
- Distributed Generation
- Electricity Pricing
- Generation Planning
- Power Systems Analysis
- Transients
- Reliability
- Surge Protection
- Testing & Maintenance
- Substation Design
- Protection
- Harmonics
- Distribution Planning
- Distribution Automation
- Power Quality

Course Fee - $1,300 each

- Fault Arc Flash Calculations
- Electric & Magnetic Field Effects

Course Fee - $750 each

- Renewable Energy Technology
- Transmission Line Design & Construction
- Smart Grid
- Energy Theft/Revenue Protection
- Deregulation
- Asset Management
- Secondary Networks
- Automated Meter Reading

Registration Form:
This form is for registration for the Advanced School, individual sessions, or individual courses. Email registration form and your selection to NLL2@psu.edu

<table>
<thead>
<tr>
<th>First Name</th>
<th>Middle Name</th>
<th>Family Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
<th>Street</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>Country</th>
<th>Zip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Telephone No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fax No.</th>
<th>E-mail Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Signature Date

Payment Methods:

Send Bank Draft or Money Order to:

The Pennsylvania State University
One Monroeville Center
3824 Northern Pike, Suite 375
Monroeville, PA 15146

Wire Transfer Directions:

Wire Transfer To:
Citizens Bank
Philadelphia, PA USA
ABA #036076150
SWIFT: CTZIUS33

For Credit To:
The Pennsylvania State University
Account #6100011682
Reference: Monroeville

Please direct your inquiries to:

The Pennsylvania State University
One Monroeville Center
3824 Northern Pike, Suite 375
Monroeville, Pennsylvania 15146

Phone: 412-372-8063
Fax: 412-372-0753

E-Mail contacts:
Nancy Lucas NLL2@psu.edu
or
Ralph Powell RWP5@psu.edu

http://www.engr.psu.edu/powerengineering

Visa
International candidates may apply for a student or business visa through their local consular office. Applicants for a student visa will need immigration form DS2019, which we will supply, after receipt of the paid registration form.

The Pennsylvania State University reserves the right to modify the School content or to cancel or discontinue the program or individual courses. In the event of cancellation or discontinuance, a prorated refund will be made. On student withdrawals, no refunds will be made after the first week.

“The Pennsylvania State University is committed to affirmative action, equal opportunity, and the diversity of its workforce”