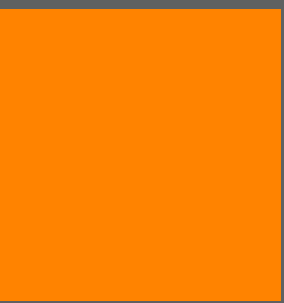
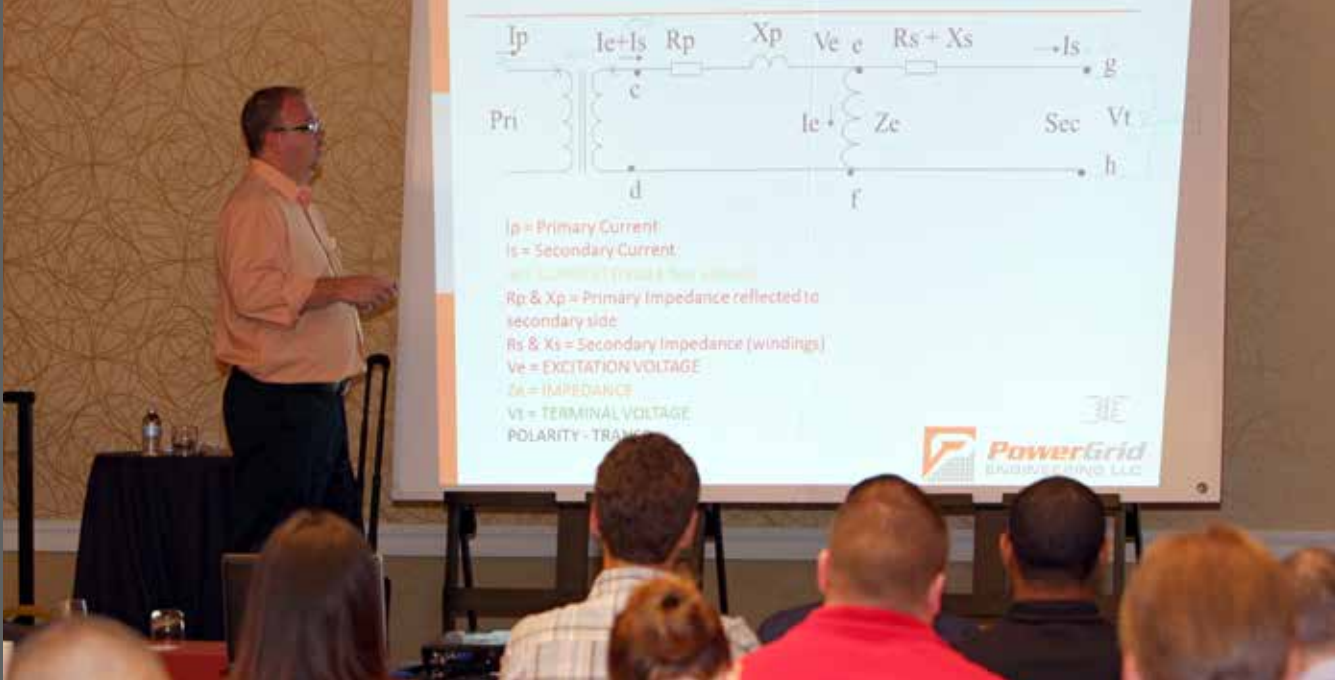




PGE POWER SYSTEMS SEMINAR SERIES



PowerGrid[®]
ENGINEERING LLC
A Qualus Power Services Company



POWER SYSTEMS TRAINING

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POWER SYSTEMS LETTER FROM **Michael J. Wright**

Welcome to PGE Power Systems

Power Grid Engineering, LLC (PGE) is happy to welcome you to our series of training seminars as we share our experience, knowledge and excitement about power systems to industry professionals. When I began teaching the Relay Philosophies course in 2001, I did so by trying to answer all the “big picture” questions that I had when I was new to the industry; I could have titled the class, “Everything I Wish Someone Had Taught Me My First Year on the Job.” Since, then, hundreds of utility company professionals have completed Power Systems 101: Relay Philosophies I. Attendees have stated that the class helped them understand Protection & Control better than other classes they have previously taken.

In 2012, responding to feedback from the Power Systems 101 class, we created PGE Power Systems 102: Relay Philosophies II which covers a new set of topics including generator theory and protection and SCADA systems (just to name a few), but with the same “big picture” approach. Several team members helped me create this second class and each bringing their own set of stories, experiences and industry expertise to the sessions.

From there, we began Power Systems 103: Relay Commissioning I in 2016 and now our brand new course, Power Systems 104: Relay Commissioning II to expand on topics such as protective relaying and commissioning.

Our course curriculum continues to evolve based on our attendees’ needs and requests. Among four seminars offered, we cover a variety of complex topics, but in an easy and interactive way, so that even non-Protection & Control professionals can understand.

PGE also provides you with the opportunity to earn credits and maintain your credentials such as Professional Engineering Licenses or NETA certifications.

To learn more about Power Grid Engineering and our Power Systems seminars, visit us at powergridengineering.com/seminars or email me at mwright@powergridmail.com. We hope you’ll join us for one of our unique seminars.

Sincerely,

MICHAEL J. WRIGHT, PE

President, Power Grid Engineering

Program Director, PGE Power Systems Seminar Series





POWER SYSTEMS 101

Relay Philosophies I Seminar

PGE's Power Systems 101 Seminar is a stand-alone class that has been specifically developed for engineers, engineering technicians, and field relay technicians. It aims to provide attendees with a strong basis of knowledge in relay protection philosophy and design theory.



"This course really helped with understanding how relays work and how to read plans."

"Instructed in a way that all levels of experience could follow."

Training Curriculum:

Power Systems 101 is an intense four (4) day course, eight (8) hours per day, which covers the following curriculum:

Substation Layouts & Protection Zone Diagrams / 4 PDH / 4 CTD

- Transmission system overview • Types of generation • What is a fault? • Substation layouts
- Protection zone diagrams

Functional Diagram Exercise / 4 PDH / 4 CTD

- Hands-on functional diagram • Line protection • Bus protection • Transformer protection
- Breaker failure • Lockouts

Current Transformers / 4 PDH / 4 CTD

- CT basics • Ratios • CT classes T&C • CT ratings • Saturation current and curves
- Equivalent circuits • CT Testing • IEEE standards

Breaker Control / 4 PDH / 4 CTD

- Mechanical operation • Trip circuits • Close circuits • Anti-pump circuits • Reclosing
- Specifications and ratings • Alarms • IEEE standards

Differential / 4 PDH / 4 CTD

- Types of bus differentials • KCL theory • Differential CT circuits
- Calculating current in differential circuits • Mismatched CTs • Rolled CTs • CT polarity
- High impedance differential application • IEEE Standards

Transformer Protection / 4 PDH / 4 CTD

- Transformer theory • Equivalent circuit • Types of transformers • Transformer losses
- Transformer ratings • Tap changes • IEEE Standards

Line Protection / 4 PDH / 4 CTD

- Physical characteristics of transmission lines • MHO circle
- Theory of impedance protection • Zones of protection
- POTT, PUTT, DCB, & DCUB end-to-end schemes • Reliability and security • IEEE standards

Breaker Failure / 4 PDH / 4 CTD

- Breaker failure initiates • Current requirements • Breaker position
- Critical clearing time • System stability • Various breaker failure logic schemes
- Trip and lockout theory • IEEE standards

NETA/PE Credits

Earn PDH credits to maintain your PE license or earn CTDs for NETA Certification. Visit page 10 for full details.



“Mr. Zvarych is a wealth of knowledge and information.”

“I enjoyed the real world examples – I am fairly new and the personal stories put things into perspective.”

NETA/ PE Credits

Earn PDH credits to maintain your PE license or earn CTDs for NETA Certification. Visit page 10 for full details.

POWER SYSTEMS 102

Relay Philosophies II Seminar

PGE's Power Systems 102 Seminar is a stand-alone class that has been specifically developed for engineers, engineering technicians, and field relay technicians. It aims to provide attendees with a strong basis of knowledge in relay protection philosophy and design theory.

Training Curriculum:

Power Systems 102 is an intense four (4) day course, eight (8) hours per day, which covers the following curriculum:

Power Systems Overview / 1.5 PDH / 1.5 CTD

- What Is A Power System • Grid Component Relationships • System Stability Considerations

Generator Theory / 2 PDH / 2 CTD

- Generator Types • AC & DC Current • Right Hand Rule & Establishing a Field
- Establishing Voltage, Current & Frequency • Stator, Rotor & Synchronous Machines

Generator Protection / 2 PDH / 2 CTD

- Unit One Line Diagram • Device Codes • Protection Elements
- Tripping Modes

Generator Protection Upgrade / 1.5 PDH / 1.5 CTD

- “Before” Protection • “After” Upgrade Protection • Sample Drawings Review

Capacitor Bank Fundamentals / 4.5 PDH / 4.5 CTD

- Understanding VARs • Capacitor Bank Function in a Power System
- Capacitor Bank Types, Configurations, Designs • Power Factor Correction Calculation
- Protection of a Capacitor Bank • Example Applications

Reactor Bank Fundamentals / 2.5 PDH / 2.5 CTD

- Reactor Banks in a Power System • Distribution Applications • Transmission Applications

Underfrequency Fundamentals / 2 PDH / 2 CTD

- Power and Load Balanced With Speed • Underfrequency Protection Function
- Power System Dynamic When Generation Doesn't Equal Load • NERC & Its Role
- Accomplishing Underfrequency Load Shedding • Historic Examples
- Introduction of Synchrophasor Technology

DC Systems / 4 PDH / 4 CTD

- History & Theory of Batteries • DC Systems Overview • Battery & Charger Sizing
- Types of Batteries • PPE For Battery Work • DC Systems Installation Examples

Distribution Systems / 4 PDH / 4 CTD

- Utility Distribution Systems Overview • Substation Equipment
- Substation Layouts for Reliability or Cost • Distribution Protection • IEEE C37.230-2007
- Coordinating Protection • Reclosing • Distribution Automation & “Smart Grid”

Overview of Electric Utility Communication Systems / 2 PDH / 2 CTD

- Communication Needs – Then and Now • Enterprise vs Mission Critical (IT vs OT) Applications
- Media Types • Fiber Communications • Wireless Communications • Leased Services



POWER SYSTEMS 102 CONT.

Relay Philosophies II Seminar

PGE's Power Systems 102 Seminar is a stand-alone class that has been specifically developed for engineers, engineering technicians, and field relay technicians. It aims to provide attendees with a strong basis of knowledge in relay protection philosophy and design theory.

Power Line Carrier Systems / 2 PDH / 2 CTD

- Power Line Carrier System View & Components • Common Applications
- Performance Considerations – IEEE 643-2004 • Design Considerations
- Exercise in System Performance • Performance – Beyond the Design

SCADA Systems / 2 PDH / 2 CTD

- SCADA Background & History • SCADA System Functional Component Overview
- Connecting the RTU to the SCADA Master • Field Sensors & Non Traditional Applications
- Common Protocols • Regulatory Influences

Fiber Systems – OSP & ISP / 2 PDH / 2 CTD

- What it Takes to Design a Successful Fiber Network • Outside Plant Considerations
- Inside Plant Considerations

NETA/PE Credits

Earn PDH credits to maintain your PE license or earn CTDs for NETA Certification. Visit page 10 for full details.

Relay Commissioning I Seminar

PGE's Power Systems 103 Seminar is a stand-alone class that is geared toward answering fundamental questions about field commissioning of protection and control equipment. This class is beneficial for hands-on field technicians, new protection and control engineers, and other utility company staff that want to know more about field testing.

Training Curriculum:

Power Systems 103 is an intense four (4) day course, eight (8) hours per day, which covers the following curriculum:

Introduction to Power Systems and Protective Relaying / 2 PDH / 2 CTD

- Power system faults and abnormal conditions • Basic fault calculations and relay settings
- Relay applications • Standards references and documentation

Technical Tools / 2.5 PDH / 2.5 CTD

- Trigonometry • Phasors in relay circuits • 3 phase power systems • Power system grounding

Instrument Transformers / 2 PDH / 2 CTD

- Potential transformers • Grounding and shielding of instrument transformer circuits
- Current transformer testing

Relay Design & Basic Elements / 2 PDH / 2 CTD

- Operational features • Ratings • 15 basic element characteristics

Control Circuits / 3 PDH / 3 CTD

- Contacts • Sneak circuits • Battery testing • Finding grounds

Transformer Protection & Control / 1.5 PDH / 1.5 CTD

- Testing overcurrent, differential and sudden pressure
- Testing voltage regulation and paralleling • Emergency replacement of transformers

Maintaining Relay Systems / 1 PDH / 1 CTD

- What tests to perform • Nuclear power plants • Reviewing relay operations

Analyzing Relay Events / 1 PDH / 1 CTD

- Troubleshooting • Case histories

Commissioning Tests; Safety, Manual and Automatic Testing of CTs and Relays / 3 PDH / 3 CTD

- Testing methodology • Field testing philosophies • Field checks on instrument transformers
- Relay programming and testing

Commissioning Tests; Testing Circuits, Wiring & Functional Tests / 4 PDH / 4 CTD

- Point to point drawing checkWire checking • AC circuit testing • Functional tests

Commissioning Tests; In service Readings / 4 PDH / 4 CTD

- Phasing tests • In Service readings

Commissioning Tests; Commissioning Numerical Relays / 1.5 PDH / 1.5 CTD

- Dynamic characteristics • Programmable logic • In Service readings
- Diagnosing abnormal conditions

Commissioning; Project Management / 1.5 PDH / 1.5 CTD

- Pre-job engineering • Critical path • Outage planning • Typical jobs

Testing Power Line Carrier / 2 PDH / 2 CTD

- Test procedures for line traps, tuners, transmitters and receivers

Redundant Systems / 1 PDH / 1 CTD

- Primary and backup • Dual trip coil • Dual battery • Physical isolation



“Very good overview that had enough depth to answer the questions I didn’t even know to ask.”

“Mr. Young makes tricky and complex concepts easy to understand without missing a single important detail.”

NETA/ PE Credits

Earn PDH credits to maintain your PE license or earn CTDs for NETA Certification. Visit page 10 for full details.



POWER SYSTEMS 104

Relay Commissioning II Seminar

PGE's Power Systems 104 Seminar is a stand-alone class that has been presented for over a decade. It also important to point out that this seminar was developed for Relay Technicians by a Relay Technician. While the seminar is aimed at Relay Technicians, engineers and technicians from many other disciplines have also taken this seminar and gained great insight into the world of protective relays. The Power Systems 104 Seminar provides the students with in-depth knowledge of how protective relays work so the Relay Technician can better understand how protective relay tests must work when executing testing & commissioning activities.



“Mr. Ashton is a very engaging and intelligent teacher, he is able to get the dry fundamental ideas of utility power and relays across. He is also adept at imparting the core concepts of relay testing across with clarity and confidence that can only be gained from being in the trenches for decades.”

“This was a very good class that provides valuable information to every Relay Protection and Control Technician. Even very technical concepts were taught in an understandable way.”

Earn PDH credits to maintain your PE license or earn CTDs for NETA Certification. Visit page 10 for full details.



Training Curriculum:

Power Systems 104 is an intense three (3) day course, eight (8) hours per day, which covers the following curriculum:

Applying Trig Functions to the World Of Relays / 1 PDH / 1 CTD

- Trig functions used for meter and relay calculations
- Law of sines used to find the boundary of a lens characteristic
- Law of cosines used to find “Delta-V” in Sync check relays

Introduction to Basic Logic Functions / 1 PDH / 1 CTD

- AND gate and its equivalent DC circuit
- OR gate and its equivalent circuit
- NOT gate and its equivalent circuit

Discovering Transformers / 2 PDH / 2 CTD

- Discovering the polarity of transformers
- Discovering current transformers
- Discovering that VA of transformers is the same on HV and LV sides
- 87T relay schemes need to compensate for equal VA on both sides of the transformer
- Delta-Y or Y-Delta transformers have a 30 degree shift, where does it come from?
- 87T relay schemes need to compensate for that 30 degree shift

Quadrant Diagrams, Math Operators and Directionality / 1 PDH / 1 CTD

- When to use X-Y diagrams
- When to use R-X diagrams
- When to use P-Q diagrams
- Discussion of power system events and faults

Converting Values for Relay Tests / 1 PDH / 1 CTD

- Primary ohms to secondary ohms conversion
- Polar coordinates to rectangular coordinates conversions

Reactance Changes Everything! / 2 PDH / 2 CTD

- Watts calculation
- VARS calculation (what is a VAR anyway?)
- Line angle and power factor
- Line constants, operating quantities, angle of max torque and operating characteristics

Calculating Phase-to-Phase Values / 4 PDH / 4 CTD

- Step distance concept
- Errors in protection systems
- When to use the square root of three (and when NOT to)
- Calculate any phase-to-phase value (without the square root of three)

Calculating Symmetrical Components / 4 PDH / 4 CTD

- Positive sequence calculation
- Negative sequence calculation
- Zero sequence calculation
- Fuse failure/ loss of potential circuits
- Forcing neutral current
- Directional units
- Zero sequence detector circuits

Calculating Apparent Fault Impedance / 2 PDH / 2 CTD

- Phase-to-phase fault calculation
- Introduction to zero sequence compensation factor coupling
- Phase-to-ground fault calculation
- 3-phase fault calculation

Impedance Plots / 2 PDH / 2 CTD

- Draw load vectors or fault vectors on X-Y diagram
- Perform the math from Ohm's Law
- Draw load Z or fault Z plot on R-X diagram

Views of a Fault / 2 PDH / 2 CTD

- Phase vectors on X-Y diagram
- Impedance plots on R-X diagram
- Symmetrical component vector comparisons
- Sine waves can be examined
- Harmonics can be examined

Relays by the Numbers / 2 PDH / 2 CTD

- Relays by IEEE device number
- Discussion of Mho circles and testing device 21 relay
- Discussion of 87T tests
- Discussion of generic testing requirements for other relays by IEEE device number
- Discussion of NERC PRC 5 requirements of microprocessor relays

POWER SYSTEMS SEMINARS

Instructor Biographies



Michael J. Wright, PE (Power Systems 101)
President of Power Grid Engineering

Mr. Wright is President and Principal of Power Grid Engineering, LLC. He is a Jacksonville, FL native and attended Trinity Christian Academy for 13 years. He graduated from the University of Florida where he received a Bachelor's of Science in Electrical Engineering in 1998. Michael received his MBA from Rollins College in 2004. Upon graduation from the University of Florida, Michael accepted a job with Florida Power Corporation (now known as Duke Energy) and was employed by them until 2007, when he left to start Power Grid Engineering, LLC. He gained vast industry experience in the Relay Engineering and Relay Construction divisions of Duke Energy where he offered support to field relay techs on construction projects. In 2005, Michael accepted a position in the Protection and Control Department as one of two Lead Engineers who were tasked with overseeing all technical functions of the department. Michael was responsible for all of Duke Energy's Florida Transmission System Protection and Control including ensuring quality control of all projects, setting policy, planning future projects, consulting best engineering practices, defining standards, and leading the teams to constant improvement of the engineered designs. In 2007, Michael founded Power Grid Engineering, LLC with partners Andre Uribe and William Glenn Durie. Michael has led his company for 10 years and currently has a staff of over 200 employees performing power engineering services throughout the United States.

In 2001, Michael began teaching protection & control philosophy classes at Duke Energy to relay technicians in training and to protection & control engineers. In 2003 Michael developed a 40 hour curriculum designed to explain the "big picture" of protection & control and this will be his 16th consecutive year teaching this class, with refinements and additions each year.



Adrian Zvarych, PE (Power Systems 102)
Field Services Regional Manager at Power Grid Engineering

The Power Systems 102 Seminar is taught by Adrian Zvarych, PE. Adrian began his career in 1982 as a field Protection & Control engineer, where he quickly began mentoring engineer interns. He has also contributed many innovative and strategic design solutions that span across substation design, P&C design, and utility telecommunications disciplines. Since that point, he is recognized as a bridge builder between IT-Telecom, Protection & Control, and Substation Design teams. He has developed training courses and presentation materials for the IEEE, the UTC, Georgia Tech, and Texas A&M Protective Relay Conferences, which have included topics in substation communications, power line carrier design and application, fiber optic network design, and grounding and bonding for communications equipment. He has prepared and delivered countless technical presentations to audiences including protection & control, SCADA, IT and Telecom engineers and technicians in formal classrooms and on-site settings. Adrian has actively contributed to the IEEE Working Group H09 and others related to substation communications. Adrian has served as PGE's principal communications engineer and is currently a Field Services regional manager.



POWER SYSTEMS SEMINARS

Instructor Biographies



Mike Young (Power Systems 103)
Technical Trainer at Power Grid Engineering

The Power Systems 103 Seminar is taught by Mike Young. Mr. Young received his MBA from Rollins College in 1983 and BSET from Purdue University in 1971. He began his testing career in 1969 and after graduation joined Wisconsin Electric Power Company as a Relay Engineer for two years, and Florida Power Corporation as a Relay Field Supervisor for 21 years. He authored the text “Protective Relaying for Technicians” currently being revised for reprinting. He worked as Principal Application Engineer for Basler Electric for 8 years, during which time he authored technical papers presented to numerous conferences and has been published by IEEE and NETA.

Since 2002 Mr. Young has been Owner and President of North Idaho Relay Consulting. He continues writing and presenting protective relay training programs, commissioning and testing of protective relaying systems, and performing engineering peer review for protective relay designs.



Rick Ashton (Power Systems 101 and 104)
Technical Trainer at Power Grid Engineering

In 1981, Rick moved from the world of maintaining numerical control machinery to the power systems world of Substations Maintenance. As a technician, for Tri-State Generation & Transmission Association (“Tri-State G&T”) in Colorado, Rick sought answers to the very same questions that so many technicians everywhere have had while on the job. In those thirty-five (35) years, Rick tackled increasingly challenging roles as a Relay Technician, Lead Relay Technician, Substations Maintenance Supervisor, and eventually became a mentor to many. Also, as a Substations Maintenance Supervisor for Tri-State G&T, Rick served on the NERC PRC-005 Protections Systems Maintenance and Testing Standard Drafting Team. In 1994 Rick first wrote a software application that led to his second career as a Relay Technician instructor through the company he founded, Relay Training Center (relaytech.com). As a result of those efforts, his “RELAYS 101” course was developed complete with an iOS App and lesson plan for his current three (3) day seminar. In 2016, Rick teamed with PGE and adapted his original Relays 101 course into the PGE Power Systems 104 Seminar.

As a Relay Technician instructor, Rick has reached hundreds of professionals around the country and plans to continue that effort by exclusively teaching through Power Grid Engineering moving forward.



POWER SYSTEMS SEMINARS

Benefits of Attendance

Courses have been specifically developed for engineers, engineering technicians, and field relay technicians and aim to provide attendees with a strong basis of knowledge in relay protection philosophy and design theory.

Who should attend the PGE Power Systems Seminars?

- Electric Power Utility Engineers
- Relay Technicians
- Test Engineers
- University Power System Educators
- Protection & Control Engineers
- Engineers Seeking PDHs & Graduate Students

What are the benefits of attending?

- Learn from subject matter experts
- Small class sizes of up to 50 attendees allows for dynamic classroom discussion
- Network with other industry professionals
- Discounted guest room rates at host hotels
- Course registration fees include electronic curriculum, breakfast, snacks, and evening social activities
- Earn PDH credits to maintain your PE license or earn CTDs for NETA Certification

PDH Credits	NETA CTDs
The Power Systems Seminars have been approved by the Florida Board of Professional Engineers for professional development hours. Power Systems 101, 102, and 103 have been approved for 32 professional development hours; Power Systems 104 has been approved for 24. For attendees seeking PE credits for other states, please check your state's PDH regulations.	The Power Systems 101, 102, and 103 courses are eligible for 32 NETA Continuing Technical Development Credits (CTDs) and Power Systems 104 is eligible for 24 NETA Continuing Technical Development Credits (CTDs). NETA Certified Technicians (Level III and Level IV) are required to earn a minimum of 48 CTDs every three years to maintain their certification. For more information about the CTD program and requirements, please contact the NETA office at neta@netaworld.org or 888-300-6382.

On-Site Programs

We can tailor our courses to your needs and bring them to a location of your choice.

If you are interested in this on-site program service, contact PGE Training at 321-244-0170 x-348 or seminars@powergridmail.com



POWER SYSTEMS SEMINARS

Testimonials



“Mr. Ashton is very good at explaining difficult material. He explained symmetrical components in a unique, made it understandable manner. I recommend this class for technicians and engineers not familiar with power calculations.”



“This class is excellent. It should be an absolute addition to any corporations’ training program. I had the recent privilege to experience Rick’s class, and after being in this field for 12 years, I was able to relate to the topics discussed, and learn some new information as well.”



“I enjoyed the bus differentials protection. This particular section helped bridge the gap between what I do daily at work and what was taught when in college.”



“Michael did a fantastic job of conveying the complex concepts in a manner that anyone can understand without boring the people who already have a solid understanding of the material.”



“It takes a somewhat overwhelming amount of information and breaks it down into easy steps to follow.”



“Very good overview that had enough depth to answer the questions I didn’t even know to ask.”



“Mr. Young is very knowledgeable on this subject. It is clear that this information is second nature to him.”



powergridengineering.com

For more information or to register visit:
powergridengineering.com/seminars
or for questions please contact PGE Training
at seminars@powergridmail.com
or 321-244-0170 x-348.

