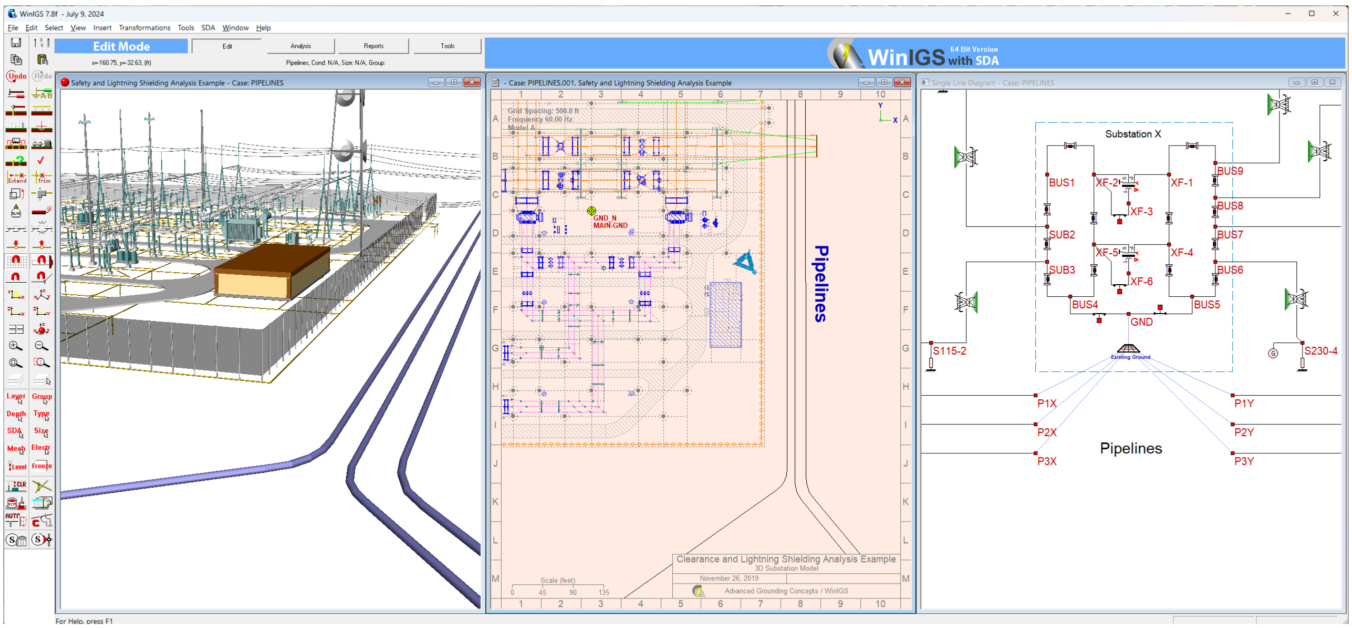
Ground Design for Safety and Influence Mitigation: Principles and Practice

Course Date: October 8-10, 2025



Course Objectives

The objective of this training session is to provide comprehensive coverage of grounding design principles, lightning shielding systems, insulation coordination studies, interactions of power system grounding with other utility systems such as pipelines, cathodic protection systems, and many other electromagnetic compatibility studies. The required procedures for evaluation of industry and specific utility standards will be discussed. The training will also cover testing procedures to verify designs after the grounding system has been installed, or existing substation grounding system to assess whether they meet industry standards, via a ground audit procedure.

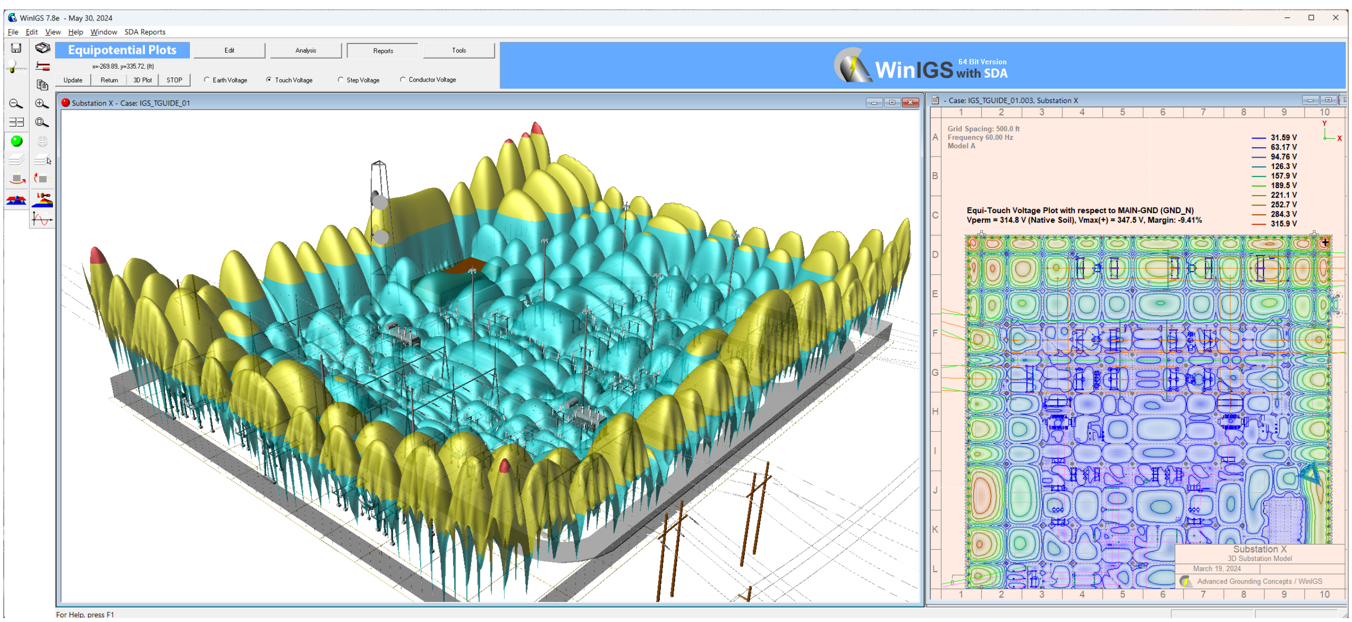
Industry standards such as the IEEE Std 80, the IEC 60471, the IEEE Std 998, the IEEE Std 81 and others will be covered. The use of computer programs to implement the design procedures will also be presented with many examples from the WinIGS program. Numerous examples will be worked in class using the program ***WinIGS***, which is a software package to model the relevant systems and perform the above referenced investigations. Participants will receive a temporary one-month license of the program *WinIGS* to continue exercises.

Scope

Power systems keep on increasing in size with commensurate increases of fault currents. High fault currents generate concerns for the safety of personnel as well as concerns about damage vulnerability of the systems. In addition, power systems are exposed to weather phenomena such as lightning and must be protected against the lightning overvoltages and designed to withstand these voltages. They are also in the vicinity of other systems, such as communication systems, pipeline systems, railroads, cathodic protection systems, metallic fences and other man-made systems. Power systems must be grounded for safety, provide reference for protection and communications and protection against lightning. They must also mitigate influence on other systems, such as pipelines, cathodic protection systems, metallic fences, railroads, etc. Because these systems are geographically extensive, their design presents challenges in meeting standards at reasonable costs.

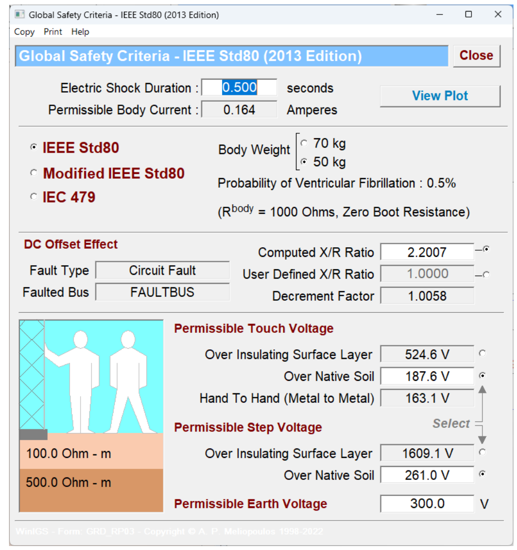
This course will comprehensively cover grounding system design procedures for safety and lightning shielding as well as insulation coordination protection for electrical power installations, such as substations, generating plants, renewables and other systems. It will start with a coverage of the basic principles in grounding design and follow with a step-by-step design procedure. It will explore soil characterization, modeling requirements, and data preparation and model development procedures for substations, generating plants, renewables, lightning shielding systems, and other systems in the vicinity such as pipelines, railroads, cathodic protection systems, communication circuits and other. Once the model is constructed, many problems and design issues can be investigated with ease. You will have the opportunity to discuss practical examples and see demonstrations of design procedures. Furthermore, options will be discussed for controlling ground potential rise, touch, and step voltages, as well as quantify the influence of grounding systems on nearby pipes, fences, and buildings with the use of the WinIGS program. By the end of the course, you will be able to perform the above reference studies with the use of the program WinIGS.

The course is taught by the developers of the program WinIGS.



Who Should Attend

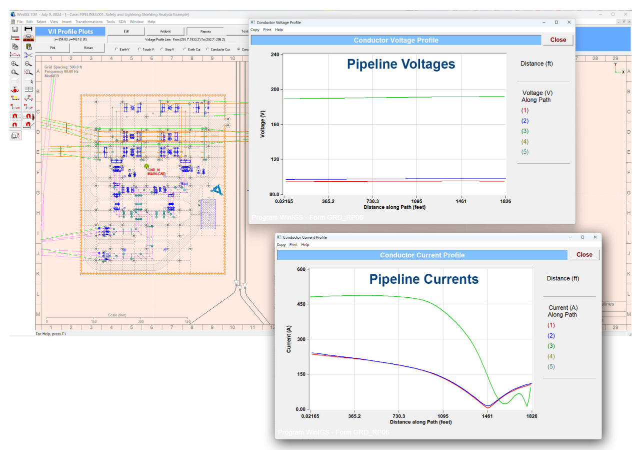
This course is designed for electric power utility engineers involved in the design of substations and electrical installations. It is also intended for consulting and manufacturing engineers and engineers with substation equipment supply companies. University power system educators and graduate students will also benefit from exposure to these important topics. **Prerequisites**: Participants should have an engineering degree or equivalent experience.



Course Topics

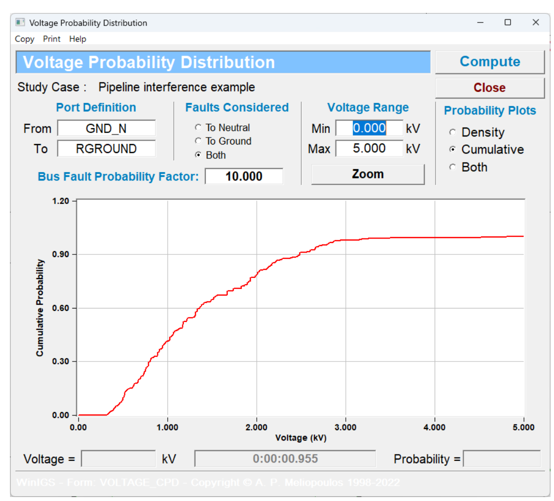
Grounding System Design Principles
- Basic Concepts
- Accidental Electrocution Circuit Parameters
- Safety Criteria
- IEEE Std 80 – 2013 Edition
- IEC-60479-1
- Lightning and EMC
- Integrated 3-D Design Procedures

Grounding System Performance
- Ground Potential Rise
- Fault Current Distribution
- Transferred Voltages
- Touch and Step Voltages
- Influence on Comm/Control Circuits
- Influence on Pipelines
- Influence on corrosion systems
- Influence on railroads
- Influence on metallic fences
- Analysis Methods



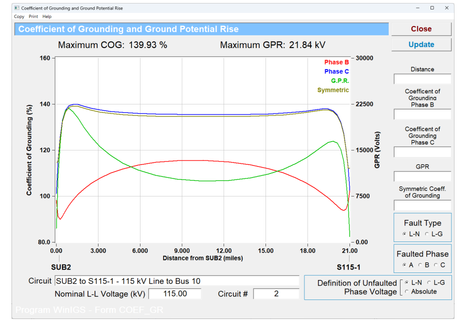
Ground Construction & Design Procedures
- Conductor and Joint Selection
- Recommended Design Procedures
- Special Points of Danger
- Comparison of IEEE Std 80 and IEC-60479-1

System Modeling for Grounding Design
- General Principles
- Modeling Requirements for GPR
- Design Options for GPR Reduction
- Modeling Requirements for Shielding Analysis
- Workshop

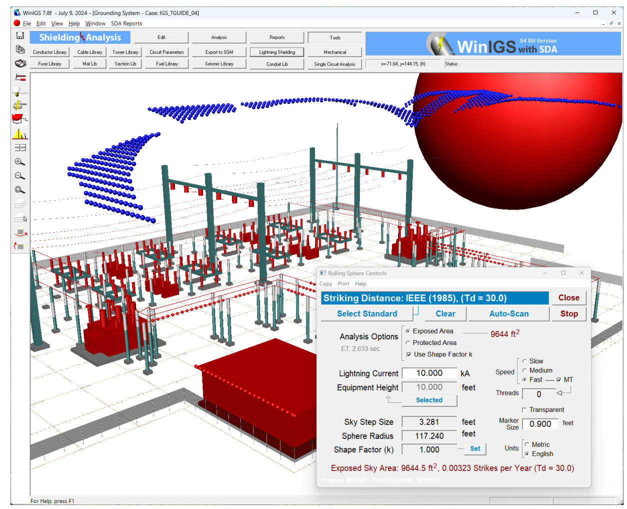


Ground Mat Design for Safety
- Touch/Mesh/Step Voltages
- Metal to Metal Touch Voltages
- Design Options for Touch Voltage Control
- Safety Assessment

Integrated Grounding System Design



- Integrated Design Evaluation
- Transfer Voltages (Pipelines, Buildings, etc.)
- Electric Railroads - Influence evaluation and mitigation
- Pipelines - Influence evaluation and mitigation
- Cathodic Protection Systems: Influence evaluation and mitigation
- Control Cable Shielding and Grounding
- Wind Farm Grounding
- PV Plant Grounding
- Cost/Benefit Analysis & Design Optimization

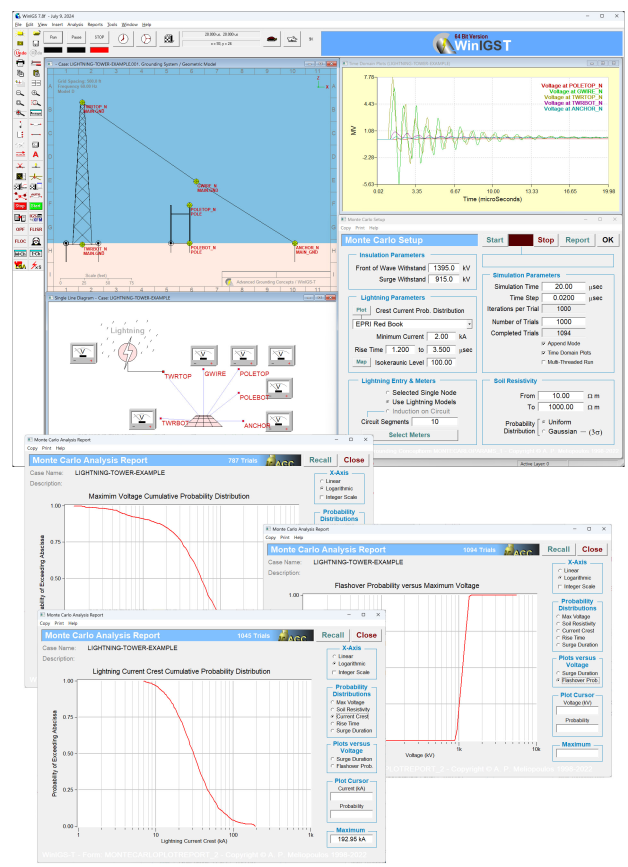


Substation Lightning Shielding

- Basic Principles
- Shielding Angle
- The Rolling Sphere Method
- The EGM Method
- Risk Assessment
- Design Procedures

Ground Design for Lightning

- Ground Surge Impedance
- Lightning Points of Entry
- Lightning Overvoltage and Propagation
- Transfer Voltages to Control Circuits
- Wind Turbine Protection
- Mitigation Methods



Insulation Coordination

- Basic Principles
- Insulation Coordination Against Lightning
- Probability of Flashovers
- Risk Assessment by Monte Carlo Simulation
- Mitigation Methods
- Computer Example

Integrated 3-D Substation Design

- Assessment of Clearances
- Bus Design Evaluation
- EMF Computations

Soil Characterization

- Soil Structures
- Basic Characteristics

Soil Resistivity Measurements

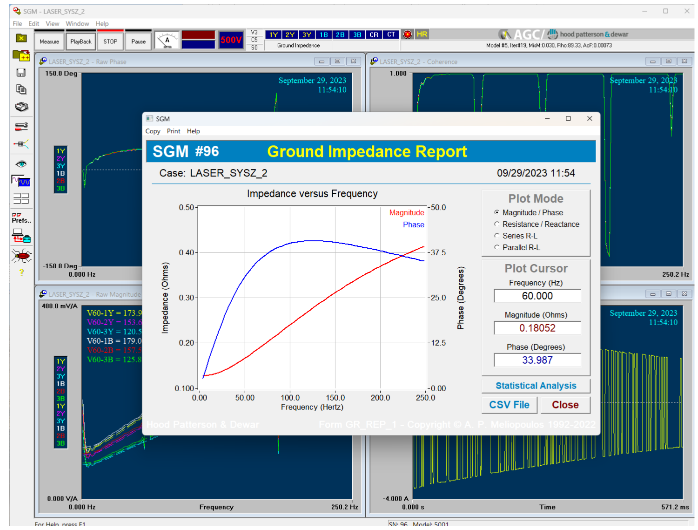
- Measurement Techniques
- (Samples, Wenner, Three Pin, …)
- Measurement Interpretation – Multi-Layered Soils
  - Theory and Limitations

Ground Impedance Measurements

- Fall of Potential method
- Theory and Limitations
- Factors Affecting Test Accuracy

Ground System Testing (SGM Method)

Ground Impedance Measurements
Ground Mat Measurements
Soil Resistivity Measurements
Tower Ground Resistance Measurements
Point to Point Ground Impedance Measurement
Ground Integrity Tests
Touch and Step Voltage Measurements
Transfer Voltage Measurement
Probe Calibration
Measurement Confidence Level



Ground System Audit

Verify Design
Verify Construction
Verify Model
Safety assessment

Demonstration and Workshop

Demonstration of: Ground Impedance, Soil Resistivity, and Tower Ground Measurements

Course Materials

The following material will be used during the short course presentations:

- Extensive class notes.
- Meliopoulos, *WinIGS Training Guide,* September 2024.
- Meliopoulos, WinIGS Manual, September 2024, electronic copy.

A copy of the class notes and the training guide will be given to all participants. The WinIGS manual will be provided in electronic form within the WinIGS program.

Continuing Education Units

Participants who successfully complete this program will earn 2.4 Continuing Education Units (CEUs). An official transcript of CEUs earned will be provided within 45 days of the completion of the course.

Instructors

A. P. (Sakis) Meliopoulos, Professor of Electrical & Computer Engineering at Georgia Tech, is the course administrator. He joined the Georgia Tech faculty in 1976. His special expertise is in the areas of fault analysis, protection and control, advanced instrumentation for monitoring and protection of power systems, electromagnetic transients, multi-physics modeling and stress analysis, harmonics, grounding and surge protection. He is the leader in the development of the Harmonic Measurement System, which is based on synchronized measurements, the principal inventor of the Smart Ground Multimeter, the WinIGS program and its extensions, the Fault Distance Indicator and the Open Conductor Detector. These software and hardware products are presently used by the industry. He is the author of the books *Power System Grounding and Transients*, Marcel Dekker, Inc, 1988, *Application of Time-Synchronized Measurements in Power System Transmission Networks*, Springer, 2014, Section 27, *Lightning and Overvoltage Protection*, of the Standard Handbook for Electrical Engineers, McGraw Hill, 1993, holds three patents and published over 450 technical papers. Dr. Meliopoulos is the Chairman of the Georgia Tech Protective Relaying Conference and a Fellow of the IEEE.

George Cokkinides obtained a Ph.D. degree at the Georgia Institute of Technology in 1985. He joined the faculty of Electrical and Computer Engineering at the University of South Carolina in 1985. He has been with Georgia Institute of Technology since 2000. His research interests are focused in power system grounding and protection, multi-physics modeling and stress analysis, power electronics applications, power system harmonics, and measurement instrumentation. He is the co-principal inventor of the Smart Ground Multimeter and the co-developer of the program WinIGS.

Course Fee and Registration

The course is offered at early registration rate of **$1,800.00 prior to September 5, 2025**. **After September 5, 2025 the course fee is $1,950.00.** Training, course materials and a one-month software license of **WinIGS** are included in the course fee.

Three Ways to Register

☎ **CALL** (512) 636-1448 between 8:00AM – 5PM, Eastern Time

EMAIL your registration to deeanne@ap-concepts.com

MAIL registration request and payments to:
Advanced Power Concepts
P. O. Box 49116
Atlanta, Georgia 30359

Please be prepared to provide your name, address, affiliation, email and phone contact information.

Payment

Payment Options: (1) check, (2) direct deposit. In case of **direct deposit**, you will receive information for a direct transfer upon registration. Make **checks payable** to Advanced Power Concepts.

You will receive an email confirming your registration.

Registration Questions?

DeeAnne Abernathy
APC Event Coordinator
Email: deeanne@ap-concepts.com
Phone: (512) 636-1448

Course Dates

October 8-10, 2025
9:00AM – 5:00 PM daily EST

Online Instruction

The course will be taught online. Course delivery details will be provided to attendees in registration phase.

Course Substitutions, Cancellations, and Refund Policy

Substitutions

Substitutions can be made prior to the beginning of the course. Please contact DeeAnne Abernathy, APC Event Coordinator, to make the substitution and to provide contact information for the substitute.

Cancellations

All cancellation requests by the attendee must be received more than 10 business days prior to the event start date to be eligible for a refund less a $100 processing fee. Substitutions may be made prior to the beginning of the seminar. “No shows” are not eligible for a refund. If the course is cancelled due to low enrollment or for some other administrative reason, you will receive an e-mail notification and a full refund.