EIT ENGINEERING INSTITUTE OF TECHNOLOGY

LIVE, INTERACTIVE CLASSES OVER THE INTERNET

PROFESSIONAL CERTIFICATE OF COMPETENCY IN

# ELECTRICAL POWER SYSTEM PROTECTION

## 12 MODULES OVER 3 MONTHS

For upcoming commencement dates, please view our course schedule at:
http://www.eit.edu.au/schedule

Keep you and your company one step ahead with this comprehensive overview of Electrical Power System Protection

Bring yourself up to speed in the latest trends and technologies

## COURSE OBJECTIVES

By the end of this course you will be able to:

- Understand the fundamentals of electrical power protection and applications
- Recognise the different fault types
- Perform simple fault and design calculations
- Understand protection system components
- Perform simple relay settings
- Choose appropriate protective devices for different equipment
- Interpret the protection systems existing in your plant, understand their functions, detect any shortcoming and explain any undesired or uncoordinated relay operation
- Make more informed decisions on electrical power system protection
- Significantly improve the safety of your site

Presented by

G. Vijayaraghavan

ENROL NOW: Fax the enrolment form to us, or email enquiries@eit.edu.au

# BENEFITS OF LIVE E-LEARNING

- Attend lessons in an online classroom with your instructor and fellow students
- Upgrade your skills and refresh your knowledge without having to take valuable time away from work
- Receive information and materials in small, easy to digest sections
- Learn while you travel - all you need is an Internet connection
- Have constant support from your course instructor and coordinator for the duration of the course
- Interact and network with participants from around the globe and gain valuable insight into international practice
- Learn from international industry experts, based around the globe
- Live interactive webinars, not just a 'book on the web'
- Receive a certificate of completion for CPD purposes

## PRESENTATION FORMAT

The certificate program features real-world applications and use a multi-pronged approach involving self-study, interactive on-line webinars and homework assignments with a mentor on call. The course consists of 12 modules, over a period of 3 months.

Some modules may involve a practical component or group activity. For each module there will be an initial reading assignment along with coursework or problems to be handed in and practical exercises in some cases. Participants will have ongoing support from their instructor and course coordinator.

Course reading material will be delivered in electronic (PDF) format in advance of on-line presentations. Presentations and group discussions will be conducted using a live interactive software system. Assignments will be submitted electronically and wherever possible, practical exercises will be conducted using simulation software and remote labs.

## LIVE WEBINARS

During the program you will participate in 6 live interactive sessions with the instructor and other participants from around the world. Each webinar will last approximately 60 to 90 minutes, and we take student availability into consideration wherever possible before schedule webinar times. Contact us for details of webinar session scheduling. All you need to participate is an adequate Internet connection, speakers and a microphone. The software package and setup details will be sent to you prior to the course.

## PRESENTED BY
## G. VIJAYARAGHAVAN

G. Vijayaraghavan is an electrical engineer with over 35 years experience in the Steel Industry and Engineering Consultancy.

He is the author of several of IDC's technical books including Practical Earthing, Bonding, Shielding and Surge Protection which has been published and sold internationally by Elsevier(UK).

He regularly designs training workshops for IDC and lectures on their behalf to engineers and technicians world-wide.

He is a very knowledgeable instructor and his courses are extremely interesting with many ideas, anecdotes and tips drawn from his rich experience.

# 12 MODULES OVER 3 MONTHS

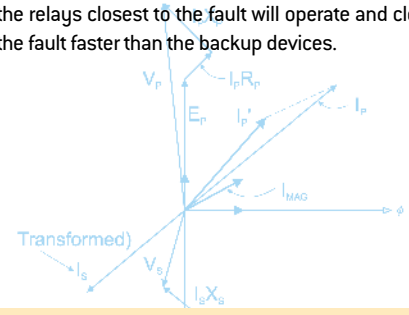
## OVERVIEW

Any power system is prone to 'faults', (also called short-circuits), which occur mostly as a result of insulation failure and sometimes due to external causes. When a fault occurs, the normal functioning of the system gets disturbed. The high current resulting from a fault can stress the electrical conductors and connected equipment thermally and electro-dynamically. Arcs at the fault point can cause dangerous or even fatal burn injuries to operating and maintenance workers in the vicinity. Faults involving one phase and ground give rise to high 'touch' and 'step' voltages posing danger of electrocution to personnel working nearby. It is therefore necessary to detect and clear any fault quickly.

The first device used in early electrical systems was the fuse, which acted both as the sensor and the interrupting device. With larger systems, separate devices became necessary to sense and interrupt fault currents. In the beginning these functions were combined in a single assembly; a circuit breaker with in-built releases. This practice is still prevalent in low voltage systems. In both high systems and low voltage systems of higher capacities, the sensing is done by more sophisticated devices called relays. Relays were initially electro-mechanical devices but static relays and more recently digital relays have become the norm.

With more complex systems, it is necessary to detect the point of fault precisely and trip only those sections affected by the fault while the rest of the system can continue to function normally. In the event of the nearest circuit breaker failing to operate, the next breaker in the upstream (feeding) side has to be tripped as a 'back up' measure. Another requirement is to minimise the time for which a fault remains in the circuit; this is necessary to reduce equipment damage and the danger to operating personnel. These requirements necessitate different forms of relaying apart from the simple current sensing relays. Equipment such as generators, transformers and motors also need special forms of protection characterised by their design and operating principles.

This course will explain all of these points in detail and provide you with the skills and knowledge necessary to calculate fault currents, select relays and associated instrument transformers appropriate to each typical system or equipment. You will also learn how to adjust the setting of the relays so that the relays closest to the fault will operate and clear the fault faster than the backup devices.




## INCLUDES 4 FREE REFERENCE MANUALS

### VALUED AT OVER US$400

YOU WILL RECEIVE 4 OF OUR UP-TO-DATE TECHNICAL E-BOOKS TO ADD TO YOUR LIBRARY.

- Power System Protection for Engineers and Technicians
- Motor Protection, Control and Maintenance Technologies
- Earthing, Bonding, Lightning and Surge Protection
- Distribution and Substation Automation (incl. Communications) for Electrical Power Systems

Over 1400 pages of tables, charts, figures and handy hints

Received upon completion.

All materials required for the course will be provided electronically, in smaller, easy-to-read sections.

*Please Note: e-Books are available in hard copy at 50% of the recommended retail price. Contact us for pricing details.*

# COURSE OUTLINE

## MODULE 1: Power System Overview

- Electrical distribution system
- Reading single line diagrams
- LV, MV AND HV equipment
- Function and types of electrical switchgear
- Basic circuit breaker design

## MODULE 2: Basics of Power System Protection

- Need for protective apparatus
- Basic requirements and components

## MODULE 3: Types of Faults and Short Circuit Current Calculations

- The development of simple distribution systems
- Faults-types, effects and calculations
- Equivalent diagrams for reduction of system impedance
- Calculation of short circuit MVA
- Unbalanced faults and earth faults
- Symmetrical components

## MODULE 4: System Earthing and Earth Fault Current

- Phase and earth faults
- Comparison of earthing methods
- Protective earthing
- Effect of electric shock on human beings
- Sensitive earth leakage protection
- System classification

## MODULE 5: Fuses and Circuit Breakers with Built-in Protection

- Fuse operating characteristics, ratings and selection
- Energy 'let through'
- General rules of thumb
- IS-limiter
- Circuit breakers - types, purpose and arc quenching
- Behavior under fault conditions
- Protective relay-circuit breaker combination
- Circuit breakers with in-built protection
- Conventional and electronic releases

## MODULE 6: Instrument Transformers

- Transformer ratio and errors of ratio and phase angle
- 'Class' of instrument transformers
- Voltage and current transformers
- Applications

## MODULE 7: Relays and Auxiliary Power Equipment

- Principle of construction and operation of protective relays
- Special focus on IDMTL relays
- Factors influencing choice of plug setting
- The new era in protection - microprocessor, static and traditional
- Universal microprocessor overcurrent relay
- Technical features of a modern microprocessor relay
- Future of protection for distribution systems
- The era of the IED
- Substation automation
- Communication capability
- Need for reliable auxiliary power for protection systems
- Batteries and battery chargers
- Trip circuit supervision
- Why breakers and contactors fail to trip
- Capacity storage trip units

## MODULE 8: Protection Grading and Relay Coordination

- Protection design parameters on MV and LV networks
- Coordination - basis of selectivity
- Current, time and earth fault grading
- Time-current grading
- Grading through IDMT protection relay
- Coordination between secondary and primary circuits of transformers
- Current transformers - coordination
- Importance of settings and coordination curves

## MODULE 9: Unit Protection and Applications

- Protective relay systems
- Main, unit and back-up protection
- Methods of obtaining selectivity
- Differential protection
- Machine, transformer and switchgear differential protection
- Feeder pilot-wire protection
- Time taken to clear faults
- Unit protection systems - recommendations and advantages

## MODULE 10: Protection of Feeders and Lines

- Over current and earth fault protection
- Application of DMT/IDMT protections for radial feeders
- Directional over current relays in line protection
- DMT and IDMT schemes applied to large systems
- Unit and impedance protection of lines
- Use of carrier signals in line protections
- Transient faults and use of auto reclosing as a means of reducing outage time
- Auto-reclosing in circuits with customer-owned generation
- Auto-reclosing relays for transmission and distribution lines

## MODULE 11: Protection of Transformers

- Winding polarity
- Transformer connections and magnetising characteristics
- In-rush current
- Neutral earthing
- On-load tap changers
- Mismatch of current transformers
- Types of faults
- Differential protection
- Restricted earth fault
- HV overcurrent
- Protection by gas sensing and pressure detection
- Overloading

## MODULE 12: Protection of Rotating Machinery

- Motor protection basics
- Transient and steady state temperature rise
- Thermal time constant
- Motor current during start and stall conditions
- Stalling of motors
- Unbalanced supply voltages and rotor failures
- Electrical faults in stator windings earth fault phase-phase faults
- Typical protective settings for motors
- An introduction to generator protection

# HARDWARE AND SOFTWARE REQUIREMENTS

All you need to participate is an adequate Internet connection, PC, speakers and a microphone. The software package and setup details will be sent to you prior to the course.

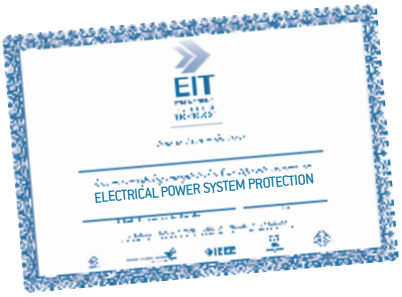
# PRACTICAL EXERCISES

Throughout the course you will participate in hands-on exercises using simulation software, which will help you put theory to practice immediately.

- Module 2: Calculation of fault currents - problems on resolving fault level
- Module 4: System earthing - problems dealing with calculation of earth fault current in different types of systems and determination of reactor value for tuned earthed systems
- Module 6: Problems on selection of current transformers for overcurrent protection and differential protection
- Module 8: Relay coordination
- Project work: Selecting protection relays for a typical transformer fed MV substation and integrating a number of such stations into a plant-wide electrical automation system

# CERTIFICATION

Participants completing all the assignments, and achieving 60% or more for their final mark, will receive the Engineering Institute of Technology Professional Certificate of Competency in Electrical Power System Protection.




# ON-SITE TRAINING

We can provide our training at the venue of your choice. On-site training can be customised and by bringing the trainer to site the dates can be set to suit you!

"The Customer is Always Right" – so tell us what you need and we will design a training solution at your own site.

For a FREE detailed proposal please contact Kevin Baker via e-mail: training@idc-online.com