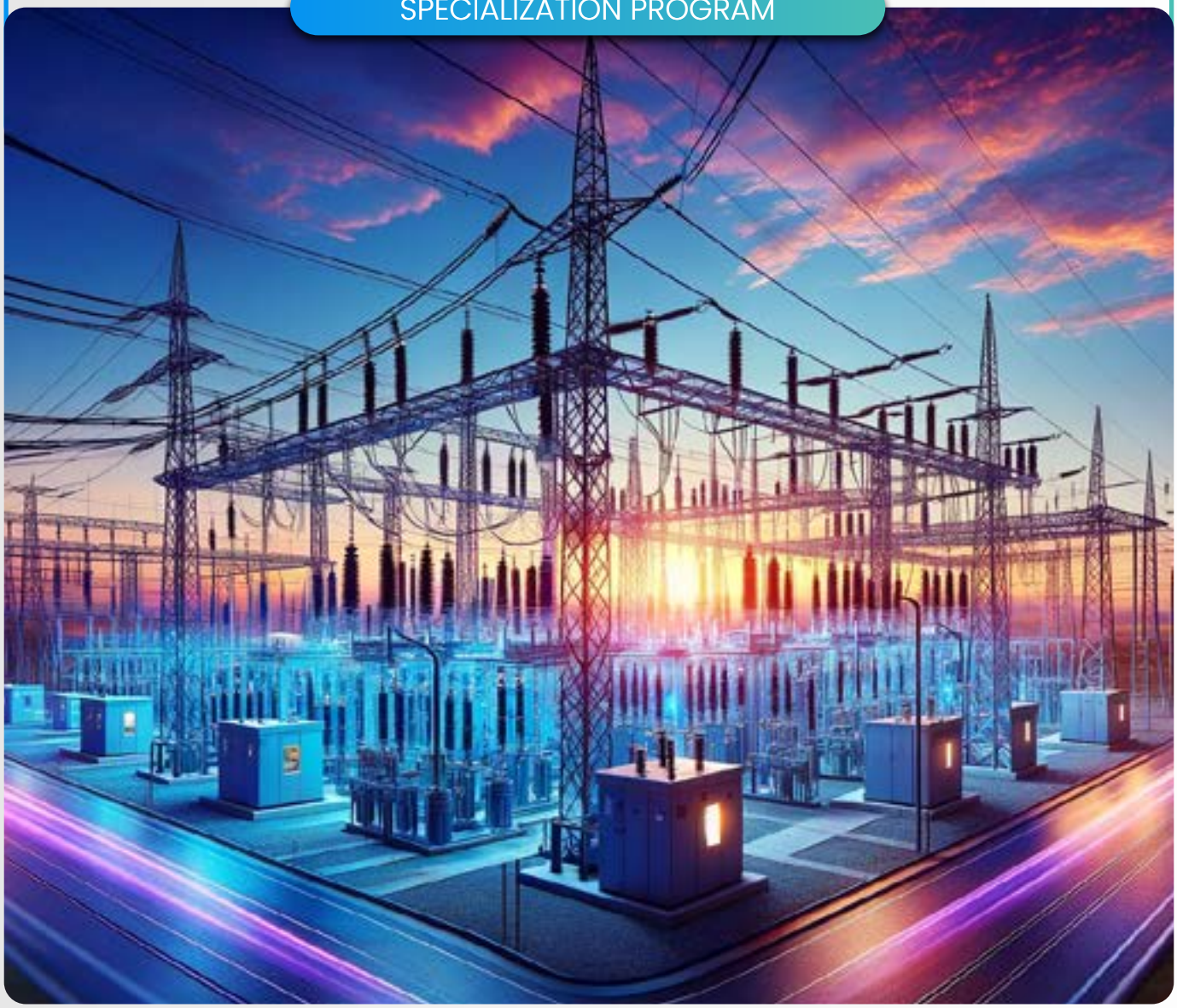
PROTECTION OF

ELECTRICAL POWER SYSTEMS

SPECIALIZATION PROGRAM



ABOUT THE PROGRAM

Did you know that traveling wave-based relays can detect faults in as little as 1 to 5 milliseconds, much faster than traditional relays?

According to Lewis Blackburn, protection is the science, skill, and art of applying and configuring relays to provide maximum sensitivity to faults and undesirable conditions while avoiding their operation under all permissible or tolerable conditions.

Learning this discipline is crucial for maintaining grid stability, ensuring safety, preventing equipment damage, improving operational efficiency, complying with regulations, and responding to abnormal conditions.

Inel has created this program to provide students and professionals with a deep understanding of the principles, technologies, and practices that underpin the protection of electrical systems. Enroll now and boost your professional growth in this exciting area!

There are no prerequisites for this program, although basic knowledge of power systems is recommended.

The training will be carry out using PowerFactory software version 2022 a video manual will be provided for the DEMO version.

START | **November, 23rd**

SCHEDULE | Saturdays and Sundays: 14:00– 16:10 (UK time)

DURATION | 50 chronological hours

MODALITY
100% Online
Synchronous

VALUE PROPOSAL

OBJETIVES

Upon completion of the program, the student will be trained to:

1. Learn about the fundamentals of protections
2. Learn about the equipment associated with protection systems
3. Learn to carry out protection coordination studies for synchronous generators and power transformers
4. Learn to carry out protection coordination studies for transmission lines and busbars
5. Learn to carry out protection coordination studies for power reactors and capacitor banks
6. Learn to carry out systemic protection studies

WHO IS IT FOR?

The specialization program is aimed at the following professionals:

Protection engineers, senior and junior study engineers with responsibility for performing, coordinating, and reviewing protection studies for their company.

Independent consultants, operations engineers, maintenance engineers, and project engineers.

Technical profiles who wish to become specialists in power system electrical protection.

CURRICULAR STRUCTURE

Module I: Protection Fundamentals
(2 chronological hours)

Learn the fundamentals of power system protection

Session 1

- Introduction and generalities
- Types of protection relays
- ANSI nomenclature and codes
- Objectives of a protection system
- Protection zones
- Applications in power systems
- Application in real project in standard grids
  - *Protection zones*

Module II: Equipment Associated with the Protection System
(4 chronological hours)

Learn about equipment associated with the protection

Session 2

- Graphic symbols and device identification
- Power circuit breakers
- Current transformers
- Voltage transformers
- Communication links
- Auxiliary power supplies
- Control wiring
- Application in real project in transmission lines protection
  - *Creation of instrumentation transformers in PowerFactory*

Module III: Protection of synchronous generators
(10 chronological hours)

Learn to perform protection coordination studies for synchronous generators

Session 3

- Technical fundamentals
  - *Synchronous machine*
  - *Operating principle*
  - *Generator characteristics*
  - *Generator short-circuits current*
  - *Generator grounding*

- International standards and regulations
  - *IEEE C37.101-2006*
  - *IEEE C37.102-2006*
  - *IEEE C37.106-2006*
  - *Complementary standards (IEEE, IEC, NERC)*
- Protection schemes
- Application in real project for IEEE grid for GENSET

Session 4

- Criteria for protection adjustment and coordination
- Generator differential protection 87G
- Stator ground fault protection (51V, 21)
- Application in real project for IEEE grid for GENSET

Session 5

- Over-excitation protection (24)
- Loss of synchronism protection (78)
- Development of a protection study for synchronous generators
  - *Process flowchart*
  - *Study objectives*
  - *Methodology and criteria*
  - *Required data and information*
  - *Information gathering*
  - *Modeling*
  - *Model validation*
  - *Results and reports*
  - *Final report*
- Application in real project for IEEE grid for GENSET

Session 6

- Loss of excitation protection (40)
- Reverse power protection (32)
- Protection 27/59, 81 U/O, 59N, 50BF, 49, 67, 25
- Application in real project for IEEE grid for GENSET

Session 7

- Ground fault protection (64G, 64F)
- Negative sequence protection (46)
- Field ground protection
- Application in real project for IEEE grid for GENSET

Session 8

- Application in real project for IEEE grid for GENSET
  - *A real case study: North America/ European generation grid*

Module IV: Protection of power transformers
(8 chronological hours)

Learn to perform protection coordination studies for power transformers

Session 9

- Technical fundamentals
  - *Classification of power transformers*
  - *Technical characteristics of transformers*
  - *Transformer faults*
- International standards and regulations
- Protection schemes
- Criteria for protection adjustment and coordination
- Phase and ground overcurrent protection (50/51, 50N/51N, 50G/51G)

Session 10

- Transformer differential protection 87T and 87G
- Negative sequence protection (46)
- Over-excitation protection (24)
- Overload protection (49)
- Transformer mechanical protection
  - *Gas accumulation relay*
  - *Gas detector relay*
  - *Pressure relay*
- Protections 64G, 27/59, 81 U/O, 50BF

Session 11

- Development of a power transformer protection study
  - *Process flowchart*
  - *Study objectives*
  - *Methodology and criteria*
  - *Required data and information*
  - *Information gathering*
  - *Modeling*
  - *Model validation*
  - *Results and reports*
  - *Report writing*
- Application in real project for IEEE grid for GENSET - Part 1
  - *A real case study: North America/ European generation grid*

Session 12

- Application in real project for IEEE grid for GENSET - Part 2
  - *A real case study: North America/ European generation grid*

Module V: Protection of transmission lines
(10 chronological hours)

Learn to perform protection coordination studies for transmission lines

Session 13

- Technical fundamentals
- International standards and regulations
- Protection schemes
- Criteria for protection adjustment and coordination

Session 14

- Phase and ground distance protection (21, 21N)
- Application in real project
  - *Setting guide lines for phase and ground elements*

Session 15

- Partial Feedback of the Final Project

Session 16

- Line differential protection (87L)
- Directional ground overcurrent protection (67N)
- Power swing protection (68)
- Reclosing protection (79)
- Switch onto fault (SOTF)
- Development of a transmission line protection study
  - *Process flowchart*
  - *Study objectives*
  - *Methodology and criteria*
  - *Required data and information*
  - *Information gathering*
  - *Modeling*
  - *Model validation*
  - *Results and reports*
  - *Report writing*

Session 17

- Protections 74, 59/27, 25, 78, LF, PMU, RF, DP, 85, STUB
- Teleprotection schemes
- Protection of lines with series compensation
- Application in real project of differential protection of transmission lines

Session 18

- Application in real project of network protection

Module VI: Bus protection
(4 chronological hours)

Learn to perform bus protection studies

Session 19

- Technical Fundamentals
- Norms and International Standards
- Protection Schemes
- Criteria for protection adjustment and coordination
- Bus Differential Protection 87B
- Breaker Failure Protection (50BF)

- Phase and Ground Overcurrent Protection (50/51, 50N/51N)
- Application in real project of high impedance differential protection
  - *Calculations*

Session 20

- Development of a bus protection study
  - *Process Flowchart*
  - *Study Objectives*
  - *Methodology and Criteria*
  - *Required Data and Information*
  - *Information Gathering*
  - *Modeling*
  - *Model Validation*
  - *Results and reports*
  - *Report Writing*
- Application in real project of high impedance differential protection in PowerFactory

Module VII: Protection of power reactors
(2 chronological hours)

Learn to perform protection studies for power reactors

Session 21

- Technical Fundamentals
- Norms and International Standards
- Protection Scheme
- Criteria for Protection Adjustment
- Reactor Differential Protection 87B
- Phase and Ground Overcurrent Protection (50/51, 50N/51N)
- Protections 49, 27/59, 67N, 59, 63
- Development of a power reactor protection study
  - *Process Flowchart*
  - *Study Objectives*
  - *Methodology and Criteria*
  - *Required Data and Information*
  - *Information Gathering*
  - *Modeling*
  - *Model Validation*
  - *Results and Reports*
  - *Report Writing*
- Application in real project
  - *Reactor protection study*

Module VIII: Protection of capacitor banks
(2 chronological hours)

Learn to perform protection studies for capacitor banks

Session 22

- Technical Fundamentals
- Norms and International Standards
- Protection Scheme
- Criteria for protection adjustment and coordination
- Protections 50/51, 51N, 27, 59, 59N
- Development of a capacitor bank protection study
  - *Process flowchart*
  - *Study objectives*
  - *Methodology and criteria*
  - *Required data and information*
  - *Information gathering*
  - *Modeling*
  - *Model validation*
  - *Results and reports*
  - *Report writing*
- Application in real project
  - *Capacitor protection study*

Module IX: Systemic protections
(4 chronological hours)

Learn to perform systemic protection studies

Session 23

- Protection Schemes for System Integrity
- Load Shedding/Disconnection Scheme for Underfrequency
- Load Shedding/Disconnection Scheme for Undervoltage
- Generation Disconnection Scheme
- Application in real project for under voltage and under frequency protection

Session 24

- Power Swing Blocking and Loss of Synchronism Tripping Scheme
- Overvoltage Protection Scheme
- Development of a Systemic Protection Study
  - *Process Flowchart*
  - *Study Objectives*
  - *Methodology and Criteria*
  - *Required Data and Information*
  - *Information Gathering*
  - *Modeling*
  - *Model Validation*
  - *Results and Reports*
  - *Report Writing*
- Application in real project of network protection coordination

Session 25

- Final Feedback of the final Project

INSTRUCTORS

Ahmed Othman

Specialist in Power System Protection

B. Sc. and M. Sc. in Electrical Engineering by Zagazig University, Egypt. With **Ph. D. Degree in Electrical Engineering** by Aalto University, Finland.

Specialist with more than 20 years of work experience in electrical engineering, electric power systems operation, power system reliability, control systems, problem solving and modeling.

Advanced experience in power system studies, distribution system operation and planning, design of AC & DC power distribution systems, and MV/HV voltage power transmission.

Currently instructor of Inel - Escuela Técnica de Ingeniería and Senior Electrical Lead of SunGrid Solutions Inc. (SGS), Toronto, Ontario.

Muzamil Faiz

Specialist in Power System Protection

M. Sc. in Engineering in Electrical Power by Mehran University of Engineering & Technology Jamshoro, Pakistan. **With an Executive MBA** in Finance by University of Sialkot, Pakistan.

Specialist with more than 14 years of work experience of power system planning, analysis, maintenance and management; preparation of electrical studies of the power system.

Advanced experience in power system and relays testing equipment and instalation from world's leading manufacturers, protection setting calculation.

Currently instructor of Inel - Escuela Técnica de Ingeniería and Lead Engineer - HV Power System at Arup, London.

METHODOLOGY AND REQUIREMENTS

The participant will be accompanied throughout the program by teachers and support staff who will resolve all their doubts and queries.

ONLINE MODE
Synchronous or in real time

Methodology
Practical / Theoretical

Virtual classroom
Recorded sessions and additional resources

Final project with advice from the instructor(s)

Certification
for 50 hrs. chronological
valid internationally

REQUIREMENTS

Internet with Wi-Fi or cable (preferably) with a minimum speed of 8 Mbps download and 4 Mbps upload.

Operational headphones and microphone.

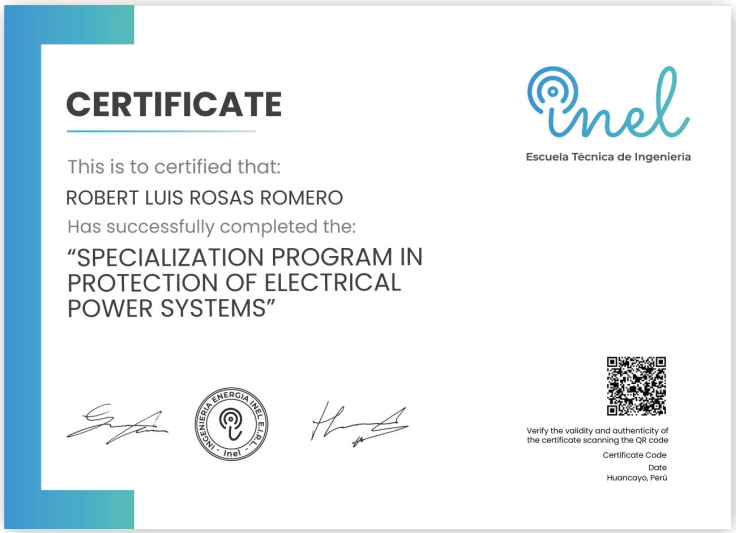
Use of webcam and dual screen optional, but recommended.

DOUBLE CERTIFICATION

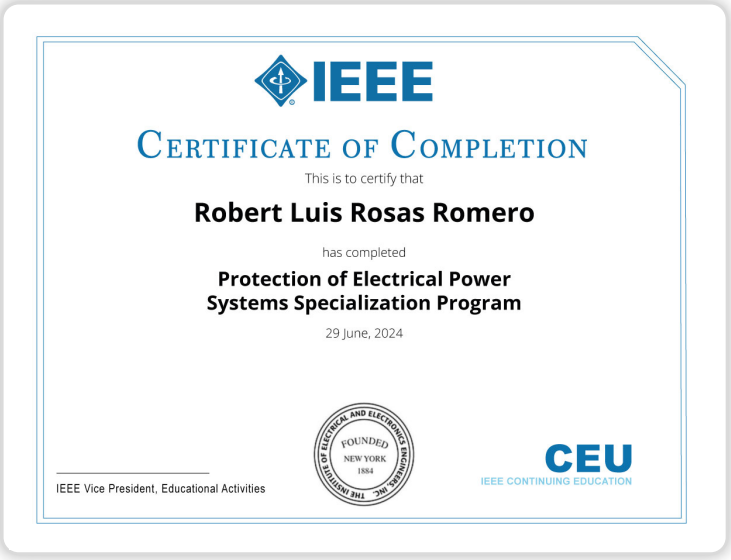
Upon successful completion of the specialization program, the student will receive double certification, one from Inel - Escuela Técnica de Ingeniería and another from IEEE (Institute of Electrical and Electronics Engineers).

Requirements to access double certification:

- Minimum attendance of 70% to live classes.
- Final score of 14 or more.
- Presentation of the final project.



Certification valid internationally that accredits 50 chronological hours



IEEE will provide a PDH/CEU certificate for this course. IEEE awards 5.0 CEUs

INVESTMENT

Dollars	Euros
US$	€
1,550	1,390

Discounts apply for cash payment

FINANCING IN PARTS

WITHOUT DISCOUNT

Note: Consult for additional financing options.

CONTACT

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Phone: +51 943 834 149

INSCRIPTION

1. Send proof of payment to inel@inelinc.com when making the payment.

2. Enter your personal and billing information at **https://bit.ly/INEL_Inscripción_PE_EI_31_24_1**

3. You will receive instructions for accessing the virtual classroom, the content of the program will be available on the start day.

CORPORATE TRAINING

Keeping top talent engaged is key to ensuring they don't quit or leave for a competitor. The #1 reason employees leave companies is lack of professional development.

For this reason, at Inel we are committed to companies. We are your long-term strategic partners in the continuous training of professionals, demanded by the current context.

BENEFITS

Online mode synchronous, asynchronous or inhouse.

Personalized training in accordance with the requirements of the organization.

Increase profitability and opening new lines of business

Improve and retain talent of your company

Increased productivity, efficiency and quality of work.

CONTACT

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