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# EE320:

# Protective Relaying:

## Operation, Construction, Selection, International Standard, Maintenance and Programming

## Training Description:

Due to the complexity of electric power systems, nowadays faults occur frequently in all parts of the system. As producers and users of Electrical Energy, you must increase your awareness of present and future power system protection and excellent understand of protection relay, circuit breaker and instrument transformer. System integrity depends on a well-conceived and properly implemented protection philosophy. It is important to learn how to design a system where equipment or line removal and system restoration occur quickly and reliably. To do this, it is essential to understand how present mechanical, Solid-state and microprocessor-based relaying systems function, Operation, Construction, Selection, International Standard, Maintenance and Programming and how their performance can be analyzed and what are the future challenges.

Protection system's main function is to clear faults from the power system in high speed to enhance people's safety, minimize equipment damage, and maintain power system stability. Protection of power systems requires an understanding of system faults and their detection, and the safe isolation of the faulted device from the system.
This course covers the selection and configuration of Electro Mechanical, Solid-state and Microprocessor based protection relays. This will be followed by the basic protection functions and their applications to the protection of all elements of power systems.

At the end of the course, the attendees will have a solid background in digital and static microprocessor-based protection relays concepts. They will also be exposed to the state of the art in microprocessor-based protection.

## Training Objectives:

**By the end of the training, participants will be able to learn:**

- ✓ General Electrical analysis and protection issues
- ✓ Know what is a protective relay?
- ✓ Where are protective relays used?
- ✓ Basic operation (DAC, ADC, Input & Output Contacts)
- ✓ Understand the concepts of Selectivity & Coordination of relays
- ✓ Understand how the relay is applied in the power system
- ✓ Understand standard tests to be performed on the relay
- ✓ Perform specified tests on, and calibrate the following relays to manufacturer's - - Specifications (ANSI device number):
    - Instantaneous and Time Overcurrent (50/51)
    - Directional/Controlled Overcurrent (67)
    - Bus Differential (87B)
    - Transformer Percentage Differential with Harmonic Restraint (87T)
- ✓ Targets and Indicators
- ✓ Gain an in-depth understanding of instrument transformers (CT, PT, etc.) with their types (e.g. Core balance, split core, etc.), selection criteria (class, saturation, etc.) and perform on-hand test to identify their failures
- ✓ Introduction to IEC 61850
- ✓ Understand drawing symbols of protection relays as per IEC standard
- ✓ Work with Ref 542+, GE (G60, T60, F60,etc), SIMOCODE, & UMC22 relays

## Training Designed for:

This intensive course is intended for those Electrical Engineers, Electrical Supervisors, Maintenance Technicians, Managers in-charge of Instrument Installations and Project Engineers.

The technicians and maintenance staff will be able to comprehend the construction, operations, function of major electrical power system protection relay. This will enable them to carry out effective maintenance, installation, programing and selection activities.

## Training Requirement:

"**Hand's on practical sessions, equipment** and **software** will be applied during the course if required and as per the client's request." **Practical exercises and case studies** will be organized during the course for participants to practice the theory learnt.

Please note that the below **topics can be amended as per client's learning needs and objectives**. Further, it should be forwarded to us a month prior to the course dates.

## Training Program:

***DAY ONE:***

- Pre-Test
- Introduction
- Power System Basics component
- Role of each power system component
- Electrical Equipment Damage curve
- Standard Nominal System Voltages and Voltage Ranges IEC 60038
- Power System types of faults
  - Balanced Faults
  - Un balanced Faults
- Effects of Electrical Current in The Human Body
- Protection system Functions
- Power System Protection – Qualities
- Introduction to Symmetrical & Un Symmetrical Components
- Power system Protection component
  - Circuit breaker
  - Protection Relay
  - Instrument Transformer
  - DC / AC Wires
- Power system X/R Ratio Important
- Calculating Maximum / Minimum short-circuit currents with IEC 60909-0
- Causes of short-circuits
- Oil & Gas Dangerous of short circuit according to hazardous area Classification IEC 60079
- Selective Coordination is Defined by NEC Article 100
- Why is Selective Coordination important
- How is selective coordination achieved
- Typical Selectivity Methods (Current, Time and Both)
- Spectrum of Currents
  - Load Current
  - Overcurrent
  - Fault Current

*DAY TWO:*

- What is the protection relay and its roll in power system
- Location of protection relay in power system
- Classification of Protective Relays Based on Technology
  - Electromagnetic (Electromechanical) Relays
  - Solid state relay (Static Relays)
  - Microprocessor-Based Relays (Digital relay)
- Advantages for Using Protective Relays
- Electromechanical relays
- Solid State relays
- Digital or Microprocessor relay
  - idea of operation
  - Relay Construction
  - Input / output
  - Communication channel (introduction to IEC 61850 communication )
  - Relay Seating achieve selectivity and coordination
  - Typical Microprocessor relay
  - Maintenance, Check and test of Microprocessor relay
  - Instrument transformer functions
  - Current transformers
  - Connection of meter gauge or Protection relay with current transformer
  - Dangers with Open-Circuited Current Transformers
  - CT Terminal Markings
  - CT Magnetization curve
  - Protection CT
  - Measuring CT
  - The error for CT's according IEC 60044-1 (accuracy class , burden , saturation & safety factor )
  - Voltage transformers
  - Connection of meter gauge or Protection relay with Voltage transformer
  - Protection VT
  - Measuring VT
  - The error for VT's according IEC 60044-1 (accuracy class , burden , saturation & safety factor )
  - Practical exercise Schematic Drawing of differential Protection connection with CT
  - Practical exercise Connect CT with Microprocessor relay

*DAY THREE:*

- Relay Tripping ANSI curve
- ANSI/IEEE Standard Relay Device Numbers
  - Instantaneous and Time Overcurrent (50/50N/50G/51/51P/51G/51N)
  - Directional/Controlled Overcurrent (67/67G/67N)
  - Bus Differential (87B)
  - Transformer Percentage Differential with Harmonic Restraint (87T/87V)
- AC circuit breaker

- understand the different types of circuit breakers
- Circuit Breaker Function
- Important OF Circuit breaker
- Miniature Circuit Breaker (MCB)
- Molded Case Circuit breaker
- Molded Case Circuit breaker Trip unit
- Idea of operation Vacuum circuit breaker
- Construction of Large circuit breaker as Vacuum type
  - Charge coil
  - Trip coil
  - Close coil
- Large Circuit breaker auxiliary contact and auxiliaries
- Large Circuit breaker rated (Voltage, Current, Short circuit, impulse Voltage)
- Circuit breaker mechanism
- Circuit breaker selection guide
- DC circuit breaker
- Different between circuit breakers and relays
- Types of fuses
- Difference between fuses and circuit breakers
- Fuses selection guide

***DAY FOUR:***

- Generator safety circuit and protection system.
- Generator Grounding
- Generator Stator Protection
- Generator Rotor Ground Fault Protection
- Generator Excitation-Related Protection
- Transformer Electrical Protection
  - Short circuit
  - Undervoltage
  - Differential
  - Secondary side capacitors
  - Over current
  - Earth fault
  - Over voltage
- Motor Protection relay set points
- Motor circuit breaker
- Motor Thermal Overload Protection
  - Thermal Limit Curves
  - Cold Running Overload
  - Hot Running Overload
  - Cold Locked Rotor Curve
  - Hot Locked Rotor Curve
  - Acceleration curve @ 80% rated E voltage

- Acceleration curve @100% voltage

❖ Motor Starting protection
❖ Selection, installation, Operation Motor protection relays
❖ Motor Modern intelligent Protection relay
❖ Abnormal Operating Conditions
- Over & Under Voltage
- Under frequency
- Voltage and Current Unbalance
- Load Loss
- Jamming
- Jogging

*DAY FIVE:*

❖ Types of system earthing
❖ IEC types of earthing system
❖ Type TN earthing
❖ Type TT earthing
❖ Type IT earthing
❖ Working examples on
- ABB ( Ref 542 )
- GE (G60, T60, F60)
- Siemens (SIMOCODE)
- ABB (Universal Motor Controller UMC22)

❖ General Discussion
❖ Course Conclusion
❖ POST-TEST and EVALUATION

## Training Methodology:

This interactive training course includes the following training methodologies as a percentage of the total tuition hours:-

- 30% Lectures, Concepts, Role Play
- 70% Workshops & Work Presentations, Techniques, Based on Case Studies & Practical Exercises, Software & General Discussions
- Pre and Post Test

## Training Certificate(s):

Internationally recognized certificate will be issued to each participant who completed the course

## Training Fees:

As per the course location - This rate includes participant's manual, hand-outs, buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Note: The 5% VAT (Value Added Tax), will be effective starting 01st of January 2018 as per the new regulation from the UAE Government. The VAT applies for all quotation both for local and abroad.

## Training Timings:

Daily Timings:

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|---|---|
| 07:45 - 08:00 | Morning Coffee / Tea |
| 08:00 - 10:00 | First Session |
| 10:00 - 10:20 | Recess (Coffee/Tea/Snacks) |
| 10:20 - 12:20 | Second Session |
| 12:20 - 13:30 | Recess (Prayer Break & Lunch) |
| 13:30 - 15:00 | Last Session |

For training registrations or in-house enquiries, please contact:

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Training & Career Development Department