

# PROTECTION OF ELECTRIC POWER SYSTEMS

## INTRODUCTION

The Protective Relay Application workshop will provide personnel with an understanding of protective relay applications for medium and high voltage AC systems, and associated equipment. Using actual case studies, trainees will become familiar with concepts that will aid them in expanding or updating an existing system, designing a new system or in troubleshooting. Practical approaches rather than strict theoretical concepts are highlighted. Familiarity with basic short circuit and coordination fundamentals is required for attending this seminar.

## OBJECTIVES

The workshop presents an introduction to subject of protection of power systems. All Principles are presented and various applications are discussed. Protection engineers should benefit from the course as new applications (e.g. use of Artificial Intelligence in protection) are also presented.

## PRESENTER

### Ahmed Faheem Zobaa

Ahmed Faheem Zobaa is an Assistant Professor in the Department of Electrical Power & Machines, at Faculty of Engineering, Cairo University. His areas of research include harmonics, compensation of reactive power, power quality, photovoltaics, wind energy, education and distance learning.

Dr. Zobaa is a Senior Member of the IEEE Power Engineering / Industry Applications / Industrial Electronics / Power Electronics / Education Societies, the Institution of Engineering and Technology and the International Solar Energy Society.

## PROGRAM

### DAY ONE

#### INTRODUCTION TO PROTECTION ENGINEERING

- Short Circuit Calculations
- System Arrangements
- Coordination Fundamentals
- NEC Requirements
- Overview of Relaying Concepts
- Phasor Fundamentals
- Relaying Principles

#### POWER SYSTEM GROUNDING

- Symmetrical Components
- Ungrounded Systems
- Solidly Grounded Systems
- Line to Ground Fault Calculations
- Low Resistance Grounded Systems
- High Resistance Grounded Systems
- Reactance Grounded Systems
- Ground Fault Detection and Protection

### DAY TWO

#### CURRENT TRANSFORMERS

- Types of Current Transformers
- CT Connections
- Accuracy Class
- Application Examples

#### LINE PROTECTION

- Fuse Protection
- Overcurrent Protection
- Tie-line Protection
- Reclosers
- Coordinating Reclosers with Fuses
- Pilot Wire Protection
- Distance Relaying
- Application Examples

### DAY THREE

#### GENERATOR PROTECTION

- Generator Capability Curves
- Generator Decrement Curves
- Short Circuit Protection

- Generator Differential Protection
- Unbalance Relays
- Loss of Field Relays

#### INTERCONNECTING GENERATORS WITH A UTILITY

- Interface Problems
- Synchronization
- Harmonics
- Grounding
- Directional Power Relays

### DAY FOUR

#### MOTOR PROTECTION

- Motor Characteristics
- Motor Inrush
- Overload Protection
- Short Circuit Protection using Instantaneous Devices
- Motor Differential Protection
- In-class Exercises
- Under-voltage Protection
- Induction Versus Synchronous Motors
- Voltage Unbalance Protection
- Current Unbalance Protection
- Determining Settings for Some Popular Motor Protection Relays

#### BUSBAR PROTECTION

- Current Balance Schemes
- Differential Protection Schemes
- High Impedance Busbar Protection

### DAY FIVE

#### TRANSFORMER PROTECTION

- Transformer Withstand Capability
- Transformer Inrush
- Overcurrent Protection
- Instantaneous Protection
- Transformer Differential Protection
- Transformer Differential Protection
- Harmonic Restraint Units

#### IN-RUSH CURRENT AND HARMONICS

#### MODERN TRENDS IN PROTECTIVE SCHEMES OF POWER SYSTEMS, USE OF COMPUTERS AND NEUTRAL NETWORKS