



PROJACS ACADEMY  
by @egis

# Electrical Fault Analysis, Causes, Detection and Remedies

تحليل الأخطاء والاعطال الكهربائية واصلاحها

11 – 15 September 2023

Istanbul / Turkey

## Introduction

It is essential to know the effects of electrical faults that the electrical system may facing and will carry under different fault conditions and at different points in the system. The faults may be single line to ground, double line to ground, three-line fault or line to line fault. Selection of circuit breakers, protective devices are mainly required information about the short circuit current. Moreover, fault analysis is essential in order to have safety operation of the power systems and to know the fault causes. It is important for engineers and technicians to be aware by fault causes, fault detection, fault protection and fault analysis.

## Objectives

This course is designed to provides the participants with complete knowledge about fault calculations, fault detection and protective relays used for power systems and networks. This includes the overcurrent, impedance, voltage, directional, differential relays. Generators, motors and transformer faults and protection are also included. External fault causes such as lightning, pollution, switching, harmonic and transients are also outlined. Some study cases will be presented using computer application.

## Who Should Attend?

The course is designed to electrical engineers and highly qualified technicians whom working in electrical distribution, transmission, operation and protection of the electrical power systems Managers of a strategic and/or portfolio management office.

## Course Outline

### Day One

#### 1. Power System Sources and Configurations

- Electrical engineering basic concepts,
- Voltage levels,
- One line and three line diagram,
- Generation system layout,
- Transmission layout,
- Distribution layout,
- Substation layout,
- Case study

#### 2. Utility Load Classifications

- Residential loads
- Commercial loads
- Power factor
- Power factor correction
- Utility factor
- Losses in lines

#### 3. The Per Unit System

- General
- Single-Phase System
- Three phase system
- Transformer Representation in the Per Unit System
- System Analysis in the Per Unit System
- Transformers with Off-Nominal Turns Ratios
- Summary
- Case study

### Day Two

#### 4. Symmetrical Components and Fault Analysis

- General
- Transformation of Phase Quantities to Sequence Quantities
- Line and Cable Sequence Impedances
- Transformer Sequence Networks
- Rotating Machine Sequence Networks
- Sequence Filters
- Case Study

#### 5. Faults Analysis in Electrical Power System

- Abnormal operating conditions

- Electrical Faults
  - Type of faults
  - Generator faults
  - Motor faults
  - Transformer faults
  - Cables faults
  - Feeders faults
- 6. External Faults Analysis**
- Lightning
  - Pollution
  - Switching
  - Transients
  - Harmonics
- 7. Short Circuit Calculations and Circuit Interruption**
- General
  - The per unit system
  - Symmetrical components
  - Symmetrical and Asymmetrical Fault Currents
  - Three phase Faults
  - Line to Line Faults
  - Line to Line to Ground Faults
  - Line to Ground Faults
  - Line to Ground Faults through Impedance
  - Equivalent System Impedance
  - Current-Limiting Inductors
  - Short circuit level
  - Effect of induction machines on short circuit level
  - CB rupture capacity
  - Numerical Examples of Short-Circuit calculations
- 8. Computer Programs for Short Circuit Faults Calculation**
- Power system representation
  - EMTP program
  - ATP program

### Day Three

- 9. Types of Earthing and Fault Current Level**
- Introduction
  - Selection of Grounding Method
  - Selection of Grounding System
  - Understanding Ground Resistance
  - Ground Resistance Values
  - Ground Resistance Measurements



- Ground Grid Integrity Measurements
  - Effect of type of earthing on fault current level
- 10. Protective Equipment and Relaying Principles**
- Fuses,
  - Auto-reclosers,
  - Automatic sectionalizer,
  - Breakers,
  - Isolators,
  - Load switches,
  - Relays,
  - Thermal relays,
  - Electromagnetic relays,
  - Static relays,
  - Digital relays

#### Day Four

**11. Feeders Fault Analysis and Protection.**

- Introduction
- Transmission lines faults
- Transmission line protection
- Defiant minimum time relays
- Inverse time delay over current relays
- Relay time-current characteristics
- Setting rules
- Pick up setting
- Time delay setting
- Case study
- Relays coordination
- Male and false operation considerations
- Case study

**12. Instantaneous Over Current Relays**

- Application
- Setting rules
- Case study
- Earth Fault Relay
- Male and false operation considerations

**13. Directional over Current Relays**

- Introduction
- Application
- Directional control
- Directional overcurrent
- Polarizing signals

- Power directional relays
- Fault directional relays
- Male and false operation considerations
- Case study

## **Day Five**

### **14. Power Transformers Fault Analysis and Protection**

- Types of faults,
- Through faults,
- Internal faults,
- Gas actuated relays,
- Buchholz relays,
- Sudden pressure relays, Electrical relays,
- Earth fault relays,
- Restricted earth fault relays
- Differentials relays,
- Transformer with grounded neutral,
- Generator transformer unit protection,
- Case study.

### **15. Motor and Generators Fault Analysis and Protection**

- Stator faults,
- Phase fault,
- Ground fault,
- Rotor faults,
- Unbalance current,
- Overload,
- Over speed,
- Abnormal voltage and frequency,
- Over voltage, under voltage,
- Over frequency, under frequency,
- Loss of excitation
- Over fluxing

## Training Method

- Pre-assessment
- Live group instruction
- Use of real-world examples, case studies and exercises
- Interactive participation and discussion
- Power point presentation, LCD and flip chart
- Group activities and tests
- Each participant receives a 7” Tablet containing a copy of the presentation, slides and handouts
- Post-assessment

## Program Support

This program is supported by interactive discussions, role-play, case studies and highlight the techniques available to the participants.

## Schedule

The course agenda will be as follows:

- |                     |                  |
|---------------------|------------------|
| • Technical Session | 08.30-10.00 am   |
| • Coffee Break      | 10.00-10.15 am   |
| • Technical Session | 10.15-12.15 noon |
| • Coffee Break      | 12.15-12.45 pm   |
| • Technical Session | 12.45-02.30 pm   |
| • Course Ends       | 02.30 pm         |

## Course Fees\*

- **3,200 USD**  
*\*VAT is Excluded If Applicable*

## المقدمة

من الضروري معرفة آثار الأعطال الكهربائية التي قد يواجهها النظام الكهربائي وسيحملها في ظل ظروف أعطال مختلفة وفي نقاط مختلفة في النظام. قد تكون الأعطال من خط واحد إلى الأرض، أو خط مزدوج إلى الأرض، أو خطأ من ثلاثة خطوط، أو خطأ من خط إلى خط. اختيار قواطع الدائرة، أجهزة الحماية هي معلومات مطلوبة بشكل أساسي حول تيار الدائرة القصيرة. علاوة على ذلك، يعد تحليل الأعطال أمراً ضرورياً من أجل التشغيل الآمن لأنظمة الطاقة ومعرفة أسباب الأعطال. من المهم للمهندسين والفنيين أن يكونوا على دراية بأسباب الخطأ، واكتشاف الأعطال، وحماية الأعطال وتحليلها.

## الأهداف

تم تصميم هذه الدورة لتزويد المشاركين بمعرفة كاملة حول حسابات الأعطال واكتشاف الأعطال والمرحلات الواقية المستخدمة لأنظمة وشبكات الطاقة. وهذا يشمل التيار الزائد، والمقاومة، والجهد، والاتجاهي، والمرحلات التفاضلية. كما يتم تضمين المولدات والمحركات وأعطال المحولات والحماية. كما تم توضيح أسباب الخطأ الخارجي مثل البرق والتلوث والتبديل والتناسق. سيتم عرض بعض حالات الدراسة باستخدام تطبيقات الكمبيوتر.

## الحضور

تستهدف الدورة المهندسين الكهربائيين والفنيين المؤهلين تأهيلاً عالياً الذين يعملون في توزيع الطاقة الكهربائية ونقلها وتشغيل وحماية أنظمة الطاقة الكهربائية.