



Electrical Engineering

## Harmonics in power systems: causes, effects and elimination methods

## Course Introduction

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**This 5-day boost training course** will introduce the concept of harmonics production and their effects on different equipment supported with practical examples problems of harmonics in industrial plants are considered among the biggest issues in industrial distribution systems. Understanding harmonic recommendation IEEE 519 will be presented. AC drives, PWM and inverters will be covered in detail. Effect of equipment loading on harmonic currents and total harmonic current distortion will be illustrated with examples using SOLV software. Harmonics mitigation techniques; reactors, commutation reactors, special reactors passive LC filters, phase shifting, phase staggering, active filters, hybrid active/passive filters and active front ends will also be covered. As a practical part of the course, local site measurements using harmonic measurement equipment will also be done.

## Target Audience

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- Circuits Engineer
- Design Engineer
- Electrical Controls Engineer
- Electrical Design Engineer
- Electrical Engineer
- Electrical Project Engineer

## Learning Objectives

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- Sources of harmonics and AC drive types
- Line notching, inter-harmonics
- The relationship between harmonic currents and power factors
- Harmonics effects on complete range of equipment

- Resonance in AC drives and PFC equipment
- PWM, DC, AC load commutated inverter and AC cycloconverters

## Course Outline

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### • DAY 01

#### Introduction to Power Quality

- The power source
- Delivery of power
- The load
- Three-phase model
- Voltage and Current Disruptions
- Classifying interruptions, sags, and swells
- Power interruptions
- Undervoltage, overvoltage, sags, swells and flicker
- Transients
- Noise
- CBEMA (ITIC) curve
- Power line conditioners
- Power

### • Day 02

#### Power Factor

- Impedance, resistance, and reactance
- Ohm's law with complex impedances
- ELI the Ice Man
- Complex power
- Power factor
- Cost of low power factor
- Sources of harmonics and AC drive types
- PWM, DC, AC load commutated inverter and AC cycloconverters
- Question and answer session.
- Effect of equipment loading on harmonic currents and total harmonic current distortion.

- Effect of source kVA, impedance and sub transient reactance ( $X_d''$ ) on harmonics
- Illustrating Examples using SOLV software.

### • Day 03

#### Harmonics

- Distortions due to semiconductors
- Skin effect
- Harmonics problems involving transformers
- Harmonics problems specific to three-phase systems
- Variable frequency drives
- THD and TDD
- Crest factor
- Displacement power factor
- Interharmonics
- Harmonic filters

### • Day 04

#### Harmonic mitigation techniques (for three wire and four 3 phase distribution systems and for standard 3 phase systems) – including neutral current eliminators,

- reactors (AC line and DC bus), commutation reactors, special reactors {Lineator wide spectrum and duplex reactors},
- Passive L-C filters, phase shifting (multi-pulse), phase staggering (quasi-multi-pulse), active filters, hybrid active/passive filters and active front ends (sinusoidal rectifiers).
- Question and answer session.
- Understanding harmonic recommendation IEEE 519 (1992).

### • Day 05

#### Simple harmonic calculation summary

- Example of harmonic calculation software (SOLV) and sample calculations.
- Harmonic survey techniques and safety issues.
- Local site measurements using harmonic measurement equipment
- Information required from vendors (e.g. drive suppliers) to solve harmonics problems
- Question and answer session.
- Conclusion

# Confirmed Sessions

FROM	TO	DURATION	FEEs	LOCATION
April 7, 2025	April 11, 2025	5 days	5950.00 \$	switzerland - Geneva
Aug. 11, 2025	Aug. 15, 2025	5 days	4250.00 \$	UAE - Dubai
Sept. 15, 2025	Sept. 19, 2025	5 days	4250.00 \$	UAE - Abu Dhabi