

Power Quality and Harmonics

4 Days, 3.2 CEUs

Today's energy grid is changing. We are seeing more renewable energy, the implementation of smart grid as well as the ever increasing use of high speed switching loads. These advances promise increased reliability but they also cause more and new power quality issues, which will only increase with time. Linemen and technicians will need to become familiar with power quality phenomenon. They will need to know their causes, impacts, how to locate them, analyze them and mitigate them. This course provides the information on standard power quality problems phenomenon as well as advanced power quality phenomenon.

This course is intended for engineers, electricians and technicians that install, maintain, repair and/or troubleshoot power and auxiliary systems.

Pre-Requisites:

The participant should have basic knowledge of AC/DC electricity, wiring and mathematics.

Lab and Classroom Attire:

AVO is committed to the personal safety of each participant and requires long pants and ANSI rated "safety toe" work shoes for lab activities. Lecture courses may involve a tour of a work or shop area and for this reason open toe shoes and shorts are not considered appropriate attire for classroom.

Learning Objectives:

Upon completion of this course and lab practice, the participant will demonstrate by attaining a minimum average grade of 80% (between lab and final exam), that he/she gained knowledge of the fundamentals of power generation and power quality problems, and is able to:

- Identify symptoms and causes of significant types of power quality problems.
- Classify power quality events according to IEEE, ITIC (CEBNA) and public utility standards.
- Explain proper application and interpret results of power quality monitoring equipment.
- Recommend viable solutions including UPS, line voltage regulators, transient (surge) suppressors, harmonic filters, line filters, power conditioners, k-rated, isolations and zig-zag transformers, proper wiring and grounding, etc.

SCOPE

Day 1*

I. Introduction

- A. Schedule
- B. Course outline

II. Introduction to Power Quality

- A. The power source
- B. Delivery of power
- C. The load
- D. Single-phase model
- E. Three-phase model
- F. Lab

III. Voltage and Current Disruptions

- A. Classifying interruptions, sags, and swells
- B. Power interruptions
- C. Undervoltage, overvoltage, sags, swells and flicker
- D. Transients
- E. Noise
- F. CBEMA (ITIC) curve
- G. Power line conditioners
- H. Lab

Day 2

IV. Power Factor

- A. Impedance, resistance, and reactance
- B. Ohm's law with complex impedances
- C. ELI the Ice Man
- D. Complex power
- E. Power factor
- F. Cost of low power factor
- G. Lab

Day 3

V. Unbalance

- A. Symptom 1: Counter-torque
- B. Symptom 2: Current on neutral wire
- C. Why do these symptoms happen?
- D. Unbalance - mathematical definition and standards
- E. Mitigating unbalance
- F. Lab

Day 4

VI. Harmonics

- A. Distortions due to semiconductors
- B. Skin effect

- C. Harmonics problems involving transformers
- D. Harmonics problems specific to three-phase systems
- E. Variable frequency drives
- F. THD and TDD
- G. Crest factor
- H. Displacement power factor
- I. Interharmonics
- J. Harmonic filters
- K. Lab

VII. Standards

- A. IEEE1159
- B. IEEE519
- C. ANSI C84.1
- D. IEC SC77A
- E. IEEE 1789
- F. IEC 61000
- G. IEEE 1250
- H. IEEE 1668

VIII. Conclusion

- A. Review
- B. Final exam

*Class scheduling times may vary based on discussions and size of class

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STANDARD EQUIPMENT LIST

Power Quality & Harmonics

REVISED: October 2017

COURSE NO. 313

BY: K. Elmore

DAYS: 4

TEXT (PER 1 STUDENT)	
1	POWER QUALITY & HARMONICS COURSE #313, REV. 1, AUGUST 2017

MATERIALS NEEDED (PER CLASSROOM)	
QUANTITY	ITEM
*1	PROJECTOR OR TV WITH PROJECTION CAPABILITIES
*1	DRY ERASE BOARD WITH MARKERS AND ERASERS
*10	STUDENT TABLES
*10	STUDENT CHAIRS

EQUIPMENT (PER 1 STUDENT)	
QUANTITY	ITEM
1	4 GB AVO logo USB flash memory (containing class files, provided and preloaded by instructor)
1	Scientific calculator
1 per 2 students	MPQ1000 Power Quality Meter
1 per 2 students	MPQ1000 Bronze Accessory Kit
1 per 2 students	MPQSIM Power Quality Simulator
1 per 2 students	Digital Multimeter (True RMS)

INSTRUCTOR EQUIPMENT (PER INSTRUCTOR)	
QUANTITY	ITEM
1	USB memory stick (containing MPQ1000 setup files for labs and supplemental class files)

STUDENT EQUIPMENT (PER STUDENT)	
QUANTITY	ITEM
1	Laptop (students can share laptops if they are from the same company)

FOR VIRTUAL CLASSES:

CONTENT MATERIAL WILL BE PROVIDED IN DIGITAL FORMAT

NOTE: All items indicated with an asterisk (*) must be supplied by the client on On-Site courses