Training Course on Power System Harmonics Analysis, Mitigation, and Solution Strategies

Professional Development Training Course Outline

Category	Development	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

In today’s rapidly evolving electrical and industrial landscape, the analysis and control of power system harmonics have become essential for maintaining system reliability, efficiency, and compliance with global power quality standards. As modern power systems integrate more nonlinear loads, renewable energy sources, and advanced electronic devices, the risk of harmonic distortion has dramatically increased. **Training Course on Power System Harmonics Analysis, Mitigation, and Solution Strategies** empowers engineers and technical professionals with the knowledge and skills to analyze, mitigate, and resolve power system harmonics using state-of-the-art tools, methods, and real-world strategies.

Our cutting-edge training combines theoretical principles with hands-on case studies, ensuring practical understanding and industry relevance. Participants will explore core topics such as harmonic sources, harmonic resonance, filters (passive and active), IEEE 519 compliance, and digital simulation techniques. The program is ideal for professionals seeking to enhance grid performance, optimize system protection, and implement cost-effective harmonic solutions across diverse power networks.

Programme Curriculum

Training Course on Power System Harmonics Analysis, Mitigation, and Solution Strategies

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Course Objectives

1. Understand **harmonic distortion** and its impact on **power quality.**
2. Identify common **sources of harmonics** in modern power systems.
3. Learn to model and analyze harmonics using **ETAP, MATLAB,** and other **digital simulation tools**.
4. Examine the role of **IEEE 519-2022** standards in harmonic compliance.
5. Evaluate **harmonic resonance** and system stability issues.
6. Develop strategies for **active and passive filter** design and application.
7. Analyze the effects of **renewable integration** and **inverter-based systems** on harmonics.
8. Apply **Total Harmonic Distortion (THD)** and **voltage/current waveform** analysis.
9. Design and implement **power factor correction** without increasing harmonics.
10. Utilize **data-driven analysis** for harmonic detection and forecasting.
11. Explore **real-time monitoring systems** for harmonic mitigation.
12. Create **customized harmonic mitigation plans** for various industrial facilities.
13. Conduct **cost-benefit analysis** for harmonic solution strategies.

Target Audience

1. Electrical Engineers
2. Power System Analysts
3. Industrial Maintenance Managers
4. Utility Engineers
5. Energy Consultants
6. Project Engineers
7. Technical Trainers
8. Renewable Energy Specialists

Course Duration: 10 days

Course Modules

Module 1: Introduction to Power System Harmonics

- Definition and classification of harmonics
- Fundamental vs. non-fundamental frequencies
- Impact on system performance
- Power quality standards overview
- Measurement metrics (THD, TDD)
- **Case Study**: Harmonics in commercial building networks

Module 2: Harmonic Sources and Their Characteristics

- Non-linear loads and equipment
- Variable frequency drives (VFDs)
- UPS systems and lighting systems

- Industrial process controllers
- Renewable energy systems
- **Case Study**: Wind farm impact on rural utility grid

Module 3: Harmonic Distortion and Power Quality

- Current vs. voltage distortion
- Load flow vs. harmonic flow
- Frequency spectrum analysis
- Power quality indices
- Equipment sensitivity to harmonics
- **Case Study**: Hospital equipment malfunction due to THD

Module 4: Harmonic Measurement and Data Analysis

- Harmonic analyzers and PQ meters
- Real-time data acquisition systems
- Waveform recording and FFT
- Harmonic spectrum plotting
- Time-varying harmonic monitoring
- **Case Study**: Smart meter data reveals THD trend in factory

Module 5: Standards and Compliance (IEEE 519)

- Overview of IEEE 519-2022
- Utility vs. customer obligations
- Limit values for voltage and current
- Point of Common Coupling (PCC)
- Compliance reporting
- **Case Study**: IEEE 519 audit of water treatment plant

Module 6: Harmonic Resonance Analysis

- Resonance conditions and types
- Parallel and series resonance
- System impedance scanning
- Simulation techniques
- Practical mitigation methods
- **Case Study**: Resonance in a data center due to capacitor banks

Module 7: Passive Filter Design and Implementation

- Types of passive filters (single-tuned, band-pass)
- Design methodology
- Filter tuning and losses
- Filter placement strategies
- Installation considerations
- **Case Study**: Passive filter success in metal processing plant

Module 8: Active Filter Technology

- Principle of active harmonic filters (AHFs)
- Comparison with passive filters
- Real-time compensation methods
- Multi-level inverter-based filters
- Application in dynamic load environments

- **Case Study**: AHF performance in office tower HVAC system

Module 9: Mitigation Techniques for Industrial Loads

- Load balancing and phase correction
- Derating of transformers
- Use of isolation transformers
- Equipment specification for low harmonics
- Reactive power compensation
- **Case Study**: Harmonic reduction in cement manufacturing plant

Module 10: Renewable Energy Integration Challenges

- Inverter-induced harmonics
- Solar PV systems and grid codes
- Harmonics in battery storage systems
- Grid synchronization issues
- Control strategy optimization
- **Case Study**: Harmonics in hybrid solar-diesel microgrid

Module 11: Simulation Tools and Software for Harmonic Studies

- Introduction to ETAP, DIgSILENT, MATLAB/Simulink
- Building harmonic models
- Network impedance and harmonic flow
- What-if scenario simulation
- Software-based mitigation testing
- **Case Study**: Simulation-based design for airport grid

Module 12: Real-Time Harmonic Monitoring and IoT Solutions

- Embedded harmonic sensors
- SCADA and cloud-based monitoring
- Event-triggered analysis
- Predictive analytics
- Cybersecurity in power quality data
- **Case Study**: IoT harmonic monitoring in smart factory

Module 13: Economic Implications of Harmonic Distortion

- Equipment derating and premature failure
- Utility penalties and energy loss
- Lifecycle cost modeling
- ROI on mitigation solutions
- Preventive vs. corrective strategy
- **Case Study**: Energy savings after harmonic filter deployment

Module 14: Custom Mitigation Planning and Implementation

- System-specific assessment
- Site surveys and harmonic audit
- Design-to-installation workflow
- Training and documentation
- Long-term monitoring and review
- **Case Study**: Integrated solution for city metro stations

Module 15: Future Trends and Emerging Technologies

- Artificial Intelligence in power quality
- Smart grids and adaptive filtering
- DC microgrids and harmonic behavior
- Blockchain in harmonic data sharing
- Advanced simulation platforms
- **Case Study**: Predictive harmonic control using AI in smart grid

Training Methodology

- Interactive instructor-led sessions with live Q&A
- Hands-on simulations and practical software demos
- Group workshops for filter design and system modeling
- Real-world industrial case studies for each module
- Pre- and post-training assessments for knowledge validation
- Access to online learning materials, tools, and templates

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

Ready to enroll or request a customized program? Book online or contact us:

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