

ECE 528 – Understanding Power Quality
University of Idaho
Course Syllabus – Spring 2023
Instructor: Paul Ortmann, P.E.

Primary Text: Electrical Power Systems Quality, Third Edition by Dugan, McGranaghan, Santoso, and Beaty. (McGraw-Hill, 2012, ISBN 978-0-07-176155-0). (**Abbreviated PSQ in class**)

Secondary Text: Fundamentals of Electric Power Quality by Surya Santoso. Available at Amazon.com (**Abbreviated FPQ in class**) Note: the ISBN number 978-1440491023 is the same for all editions. The 2010 or 2012 editions are both suitable.

Note: This syllabus may be modified slightly during the course.

Course Outline:

1. (4 lessons) Power Quality Fundamentals (PSQ and FPQ, Ch. 1 and 2, Review of Prerequisites)

What is Power Quality? What is Power Quality Engineering?

Why is Power Quality important?

Review: AC Circuit Theory, Fourier Series, Power Electronics Basics

Vocabulary and Definitions

Planning Power Quality Investigations

2. (5 lessons) Voltage Sags and Short Interruptions (PSQ Ch. 3, FPQ Ch. 3 and 4)

Sources

Range and Impact on Sensitive Circuits

Standards

Fundamental Principles of Protection

Solutions and Mitigation

Equipment and Techniques

Case Studies in Motor-Starting Sags

Case Studies in Fault-Clearing

3. (5 lessons) Harmonics (PSQ Ch. 5 and 6, FPQ Ch. 6 and 7)

Sources

Definitions and Terms

Standards and Measures

System Response, Resonant Effects

Calculation and Simulation

Mitigation and Control Techniques

Filtering (passive and active)

Examples and Case Studies

Harmonic Studies

The midterm exam will follow the harmonics lessons; approximately lesson 14.

4. (3 lessons) Transients (PSQ Ch. 4, FPQ Ch. 5)

Origin and Classification

Impact on Users

Principles of Protection

Hardware for Mitigation

Case Studies in capacitor switching transients, lightning protection, and load switching

5. (3 lessons) Longer Duration Voltage Variations (PSQ Ch. 7)

Causes

Voltage Regulators

Uninterruptible Power Supplies

Utility Side Support

Reliability Indices

Case Studies

6. (1 lesson) Benchmarking and Indexing (PSQ Ch. 8)

Indices

Measurement Techniques

Contracts and Insurance Concepts

State Estimation

Use in Planning

7. (2 lessons) Distributed Generation Issues (PSQ Ch. 9)

What is Distributed Generation?

Interface to Utility

Power Quality Issues

Examples

Interconnection Standards

8. (1 lesson) Introduction to Industrial control systems (Supplementary material)

Overview of Industrial Control Systems

Ladder logic and programmable logic controllers

9. (5 lessons) Wiring and Grounding (PSQ Ch. 10)

Definitions and Terms

Reasons

NEC Requirements

Standards

Missing and Multiple Ground Connections

Ground Loops

Neutral Sizing

Common Errors

Resonant Effects

Solutions to Grounding Problems

Case Studies

10. (1 lesson) Instruments and Analyzers (PSQ Ch. 11)

What is available?

How does it operate?

What to expect

Safety

Case studies

Students are expected to be familiar with the material in both texts for each subject area, as described above.

References – (Thanks to Dr. Hess for his many excellent suggestions in this list)

Power Electronics:

N. Mohan, T.M. Undeland, and W.P. Robbins, *Power Electronics: Converters, Applications, and Design: Third Edition* New York, John Wiley & Sons, 2003. This is the text currently used in ECE427, Power Electronics and Drive Systems. The most popular text on the subject.

M.S. Rashid, *Power Electronics: Circuits, Devices, and Applications* (New York: Prentice-Hall, 2003). Also a popular textbook on the subject.

J. Agrawal, *Power Electronic Systems* (New York: Prentice-Hall, 2001). Dr. Agrawal is a power systems expert, so his examples tend toward power systems.

P.R. Krein, *Elements of Power Electronics* (New York: Oxford, 1999). This is an increasingly popular text in power electronics. Phil Krein is excellent in introducing a difficult subject.

D. Hart, *Introduction to Power Electronics* (New York: Prentice-Hall, 1996). This is the best text to learn the basics of power electronics. Dr. Hart explains things clearly and concisely.

J. Kassakian, M. Schlecht, and G. Verghese, *Principles of Power Electronics* (Boston: Addison-Wesley, 1991). This was the MIT definitive work, a graduate text in power electronics.

Power Electronics and Utilities

N. Hingorani, L. Gyugyi, *Understanding FACTS : Concepts and Technology of Flexible AC Transmission Systems*, (New York: Wiley, 1999). The first word in power electronics applied to utilities from those who pioneered the field.

Power Systems

A.R. Bergen and V.J. Vittal, *Power System Analysis, Second Edition*, (New York: Prentice-Hall, 2000).

W. Grainger and W. Stevenson, *Power System Analysis*, (New York: McGraw-Hill, 1994). Latest edition of Dr Stevenson's text, which was the text for my first power systems course (third edition, 1975).

C.A. Gross, *Power System Analysis, Second Edition* (New York: Wiley, 1986). Excellent, well written text on introduction to power systems. It's an older text, but still the best to learn the basics.

W. Elgerd, *Electric Energy Systems Theory: An Introduction* (New York: McGraw-Hill, 1982). The classic theoretical text in the subject.

Power Quality

G.T. Heydt, *Electric Power Quality*, 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994). A more in-depth, theoretical approach than our course text.

M.H.J. Bollen, *Understanding Power Quality Problems: Voltage Sags and Interruptions* (New York: IEEE Press, 1999).

J. Arrillaga, N.R. Watson, S. Chen, *Power System Quality Assessment* (New York: Wiley, 1999).

J. C. Das, *Power System Harmonics and Passive Filter Designs* (New York: Wiley, 2015).

Power Quality Bookshelf – In addition to our class texts, these are the references I keep within reach at my desk...

Soares Book on Grounding and Bonding, Latest Edition, (Richardson, TX: International Association of Electrical Inspectors)

NEC Handbook, M.W. Early, Editor, (Massachusetts, National Fire Protection Association) (Note: topics may be addressed by several different parts of the NEC, so the electronic access via subscription is useful for quick searches.)

Handbook of Power Signatures: Second Edition Revised and Expanded, Dranetz-BMI, 2000, (This is a nice encyclopedia of waveforms you might come across, with an explanation of their causes.)

Charles R. Miller, Ugly's Electrical References, Latest Edition (Burlington, MA: Jones and Bartlett Learning).

An IEEE membership including membership in the Power and Energy Society and the Industrial Applications Society; This provides online access to numerous technical articles.