EENG 573: Electric Power Quality
Dr. Salman Mohagheghi
Lecture 00, 01/12/2017

COLORADOSCHOOLOFMINES
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Basic Information

Contact:	smohaghe@mines.edu
	(303) 273 3501
Time:	Tuesday/Thursday 5:00 – 6:15 pm
Location:	Hill Hall, room 211
Office Hours:	Tuesday/Thursday 4:00 – 5:00, or by appointment

Electric power quality concerns the ability of the power network to deliver electric power of sufficiently high quality to the end-use consumers so that the electric equipment can operate within their design specifications. This would require that the voltages and currents be provided with nearly sinusoidal waveforms at near-rated magnitude and frequency. Clearly, the quality of the supplied power can be largely affected by the type of loads connected to the network. In the recent years, electric power quality has gained more attention, mainly due to the increased number of sensitive electric appliances and equipment in household, commercial and industrial applications. In this course, the most common power quality issues will be analyzed in-depth, and their causes and the corresponding mitigation techniques will be studied.

References

Recommended Sources:

[1] R.C. Dugan, M.F. McGranaghan, S. Santoso, and H.W. Beaty, *Electrical Power Systems Quality*, New York, NY: McGraw Hill, 3rd Ed., 2012.
[2] IEEE Std. 1159, "IEEE Recommended Practice for Monitoring Electric Power Quality," *IEEE Power & Energy Society*, 2009.

More Resources Related to Power Quality:

[3] Voltage Sags and Interruptions: M.H.J. Bollen, *Understanding Power Quality Problems*: *Voltage Sags and Interruptions*, Piscataway, NJ: Wiley-Interscience, 2000, ISBN 0780347137.
[4] Harmonics: F.C. De la Rosa, *Harmonics and Power Systems*, CRC Taylor & Francis, 2006.
[5] Harmonics: G.J. Wakileh, *Power System Harmonics*: *Fundamentals*, *Analysis and Filter Design*, Berlin, Germany: Springer-Verlag, 2010.
[6] Filter Design: B. Singh, A. Chandra and K. Al-Haddad, Power Quality Problems and Mitigation Techniques, West Sussex, UK: John Wiley, 2015.
[7] Transients: L. Van der Sluis, *Transients in Power Systems*, John Wiley & Sons, 2001.
[8] General Power Quality Concepts: E.F. Fuchs and M.A.S. Masoum, *Power Quality in Power Systems and Electric Machines*, Elsevier Academic Press, 1st Ed., 2008.

For Further Reading:

[9] Introduction to Power Electronics: D. Hart, *Power Electronics*, McGraw-Hill, 1st Ed., 2010.
[10] Fourier Analysis: A.V. Oppenheim and A.S. Willsky, *Signals and Systems*, Prentice Hall, 2nd Ed., 1996.

Prerequisites

The students should be familiar with the fundamentals of analyzing power circuits and power electronics circuitry (rectifiers, inverters), and should also be very comfortable with the concepts of Fourier series and sequence components. Having taken both Power System Analysis (EENG 480) and Introduction to High Power Electronics (EENG 470), or the instructor's approval is required for this course.

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Software

No specific software is selected for this course, and the students can use the software of their choice. In general, MATLAB/Simulink is preferred. However, any other power system analysis software/toolbox such as PSCAD can also be used.

Course Project

This is a group project (up to 3 students in each group), in the form of initial literature review, solution development, and proof-of-concept simulations. The topic will be assigned by the Professor during **week 7**, upon completion of the Harmonics module. Groups will meet with the Professor once during the semester (**week 10**). During this meeting, they will discuss their initial ideas, proposed designs, and preliminary results (if any). During the meeting, the Professor will provide the team with a qualitative assessment of the work in progress and, if possible, will make suggestions for further improvement.

Project Grading:

Clear and justified problem statement	30%
Breadth/depth of survey	10%
Novelty of proposed solution	20%
Solution effectiveness and simulation results	30%
Quality of writing/presentation	10%

Grading

Item	Weight
Homework – 6 total	30%
Quizzes – 5 total, in-class, closed book/notes	30%
Course Project	40%

Disability Support

The Colorado School of Mines is committed to ensuring the full participation of all students in its programs, including students with disabilities. If you are registered with Disability Support Services (DSS), please contact me so we can discuss your needs in this course. For questions or other inquiries regarding disabilities, I encourage you to visit disabilities.mines.edu.

Title IX at Mines

Title IX is a federal law that protects individuals from discrimination based on sex and gender in educational programs or activities. Colorado School of Mines is committed to providing a campus community free from gender-based discrimination. Gender-based discrimination, including sexual harassment, sexual violence, stalking, and domestic violence, is prohibited within the Mines campus community. If these issues have impacted you or someone you know, you can appropriate resources at: http://inside.mines.edu/POGO-Title-IX.

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Week	Date	Day	Lecture		Comments
1	01/12/17	R	L00	Outline	
2	01/17/17	T	L01	Power Quality Terms	
	01/19/17	R	L02	Fourier Series	
3	01/24/17	T	L03	Sequence Networks	
	01/26/17	R	L04	Intro to Power Electronics	
4	01/31/17	T	L05	Fundamentals of Harmonics	HW1 Due
	02/02/17	R	L06	Harmonic Indices	Q1 [L01–L04]
5	02/07/17	T	L07	Harmonic Sources 1	
	02/09/17	R	L08	Harmonic Sources 2	
6	02/14/17	T	L09	Effects of Harmonics	HW2 Due
	02/16/17	R	L10	Mitigating Harmonics 1	
7	02/21/17	T	No Class – Presidents' Day Break		
	02/23/17	R	L11	Mitigating Harmonics 2	Project Introduced
8	02/28/17	T	L12	Interruptions	HW3 Due
	03/02/17	R	L13	Voltage Sag	Q2 [L05–L11]
9	03/07/17	T	L14	Voltage Sag Examples	
	03/09/17	R	L15	Voltage Sag Calculations	
10	03/14/17	T	L16	Stochastic Sag Calculations	
	03/16/17	R	L17	Load Behavior during Sag	
11	03/21/17	T	L18	Voltage Sag Mitigation	HW4 Due
	03/23/17	R	L19	Lightning	Q3 [L12–L18]
12	03/28/17	T	No Class – Spring Break		
	03/30/17	R			
13	04/04/17	T	L20	Basic Switching Circuits	
	04/06/17	R	L21	Switching Transients	
14	04/11/17	T	L22	Ferroresonance	
	04/13/17	R	L23	Mitigating Transients	HW5 Due
15	04/18/17	T	L24	Long Duration Voltage Variations	Q4 [L19–L23]
	04/20/17	R	L25	Mitigating Voltage Variations	
16	04/25/17	T	L26	Flicker	
	04/27/17	R	L27	DG and Power Quality	
17	05/02/17	T	L28	Open Topic	HW6 Due
	05/04/17	R	Project Presentations		Q5 [L24–L27]