ECE6615PD: Design and Applications of DC/DC Converters

COURSE INSTRUCTOR:

Dr. Mehrdad Kazerani
Professor
Department of Electrical & Computer Engineering
University of Waterloo
200 University Avenue West
Waterloo, Ontario, Canada N2L 3G1
Tel: 519-888-4567, Ext. 33737
Fax: 519-746-3077
mkazeran@ecemail.uwaterloo.ca
http://www.power.uwaterloo.ca

Course Objectives:

The objective of this course is to expand the knowledge and expertise of the practicing engineer in the area of DC/DC converters. The course covers analysis, modeling, design, control and industrial applications of different DC/DC converter topologies.

Study Material:

- Detailed lecture slides will be made available for download before the live on-line lectures.
- Other related material (research papers, *etc.*) will also be made available to participants.

Lectures:

- There will be 12 lecture sessions in the course.
- Each Lecture Session will consist of a 2 to 3-hour lecture.

Marking Scheme:

- Written final exam: 60%
- Assignments and Project: 40%

DETAILED PLAN: 12 LECTURE SESSIONS

Topic	No. of Lecture Sessions	Sub-Topics
Overview of Electronic Switches, Waveform Quality, and Low-Pass Filters	**1 Week 1**	• Characteristics of Diodes and Controllable Switches, Switch Losses • Waveform Distortion and Harmonics • Waveform Quality Indices • Input and Output Low-Pass Filter Design
Non-Isolated DC/DC Converter Topologies and Control Techniques	**5 Week 2 to Week 6**	• Buck Converter • Synchronous Buck Converter • Introduction to PSIM • Boost Converter • Buck-Boost Converter • Cuk Converter • SEPIC • Interleaved Converters • Non-Idealities and Discontinuous Conduction • Bidirectional Buck-Boost Converter • Full-Bridge (H-Bridge) DC/DC Converter • Examples/Applications • Unidirectional DC/DC Converter Comparison
DC/DC Converter Modeling	**1 Week 7**	• Average Modeling Technique • State-Space and Transfer Function Representations of Buck, Boost and Buck-Boost DC/DC Converters in Continuous and Discontinuous Conduction Modes • Stability Issues
Isolated DC/DC Converter Topologies and Control Techniques, DC Power Supply Control	**3 Week 8 To Week 10**	• Flyback Converter • Forward Converter • Push-Pull Converter • Half-Bridge DC/DC Converter • Full-Bridge DC/DC Converter • Multi-Output DC/DC Converters • DC Power supply Controller Design • Examples/Applications
Snubber Design and Soft Switching	**1 Week 11**	• Hard-Switching: Practical Issues • Snubber Circuits: Benefits and Design • Soft-Switching: Benefits and Limitations

Other Design Aspects of DC/DC Converters	**1 Week 12**	• Thermal Management • Switch Drivers • Series/Parallel Connection of Switches • Magnetic Design

REFERENCES:

1. Mohan, Undeland and Robbins, *Power Electronics: Converters, Applications, and Design*, 3rd Edition, John Wiley & Sons, Inc., 2003.
2. D.W. Hart, *Introduction to Power Electronics*, Prentice Hall, 1997or D.W. Hart, *Power Electronics*, McGraw-Hill, 2011.
3. J.G. Kassakian, M.F. Schlecht and G.C. Verghese, *Principles of Power Electronics*, Addison-Wesley Publishing Company, Inc., 1992.
4. P.T. Krein, *Elements of Power Electronics*, Oxford University Press, Inc., 1998.
5. R.P. Severns and G.E. Bloom, *Modern DC-To-DC Switch Mode Power Converter Circuits*, Van Nostrand Reinhold, 1985.
6. K. Kit Sum, *Switch Mode Power Conversion: Basic Theory and Design*, Marcel Dekker, Inc., 1984.
7. Conference and Journal papers.

PREREQUISITES:

Basic understanding of circuit analysis and control theory is required. Familiarity with magnetic circuits and electric machinery is desirable.