



ELE 789 Special Topics in Electrical and Electronics Engineering:

SWITCH MODE POWER SUPPLIES (3 0 3)

2004-2005 Fall Semester

Time schedule: Mondays: 9:10 – 12:00

Prerequisite: ELE 454 Power Electronics

Textbook:

1. A.I. Pressman, Switching Power Supply Design, Mc Graw Hill Professional, 1997, 2nd Ed.
2. Mohan, Undeland, Robbins, Power Electronics: Converters, Applications, and Design, John Wiley and Sons, 2003, 3rd Ed. (Ch.7, Ch.10 and Ch.30)

Reference Books and Notes:

1. Power Electronics – Principles and Applications, by Joseph Vithayathil, Mc Graw-Hill, 1995.
2. M. Brown, Practical Switching Power Supply Design, Academic Press Inc., 1990
3. K. Billings, Switch Mode Power Supply Handbook, Mc Graw Hill, 1989.
4. Unitrode (TI) Power Supply Design Seminar Notes
5. ON Semiconductors Switchmode Power Supply Reference Manual, 1999
6. Phillips Semiconductors, ‘Power Semiconductor Applications’, Application Notes
7. Erickson, R.W., Fundamentals of Power Electronics – Lecture Notes
8. ST Microelectronics, Application Notes on ‘Topologies for Switched Mode Power Supplies’, 1999.

Goals:

This course is designed to equip graduate students with knowledge about operation characteristics and major applications of various switch-mode power supply topologies, and to give them an ability to design and choose such systems for various applications.

Course Outline:

1. Introduction

- 1.1 Linear versus Switch Mode Power Supplies
- 1.2 Overview of Switching Power Supplies
- 1.3 Functional Circuit Blocks of an Off-Line Switcher
- 1.4. Basic Switch Mode DC-DC Converters
 - 1.4.1. Step-down (Buck) Converter,
 - 1.4.2. Step-up (Boost) Converter
 - 1.4.3. Step-down/step-up (buck-boost) converter

2. Switch Mode Power Supply (SMPS) Topologies

- 2.1. Introduction on SMPS Converter Circuit Topologies
- 2.2. Comparison of Various Topologies
- 2.3. Asymmetrical Converters
 - 2.3.1. Flyback Converter
 - 2.3.2. Forward Converter
- 2.4. Symmetrical Converters
 - 2.4.1. Push-Pull Converter
 - 2.4.2. Half-Bridge Converter
 - 2.4.3. Full-Bridge Converter

- 2.5. Front-End Rectifiers
- 2.6. Examples
- 3. SMPS Transformer and Magnetics Design**
 - 3.1. Inductor/Transformer Design Relationships
 - 3.2. Magnetic Cores and Materials, Core Geometries
 - 3.3. Power Dissipation in Magnetic Devices
 - 3.3.1. Low frequency losses (copper loss, and core loss)
 - 3.3.2. High frequency losses (skin effect, proximity effect)
 - 3.4. Thermal Considerations
 - 3.5. Inductor Design Procedures
 - 3.6. Transformer Design Procedures
- 4. Control Methods in SMPS**
 - 4.1. Voltage Mode Control
 - 4.2. Current Mode Control
 - 4.1.1. Peak Current Mode Control
 - 4.1.2. Average Current Mode Control
 - 4.3. Closing the feedback loop – Stability
- 5. Soft Switching Methods**
 - 5.1. Quasi-resonant converters (ZVS, ZCS concepts)
 - 5.2. Resonant converters
- 6. Multiple Output Power Supplies**
 - 6.1. Cross Regulation
 - 6.2. Linear and Buck Post Regulators
 - 6.3. Magnetic Amplifiers
 - 6.4. Secondary-Side Post Regulators
- 7. EMC Considerations**
 - 7.1. Conducted EMI
 - 7.2. Radiated EMI
 - 7.3. EMI Standards
 - 7.4. EMI Filters, Shielding
 - 7.5. PCB Layout considerations
- 8. SMPS Examples**
 - 8.1. 50W, -48Vin, 5Vout Flyback
 - 8.2. 25W, Offline, 5V, +/- 12 Vout, Flyback
 - 8.3. 50W, 48Vin, 5Vout Forward Converter
 - 8.4. 500W, 400 Vin, 48Vout Full Bridge Zero Voltage Transition Converter
 - 8.5. Lead-Acid Battery Charger
 - 8.6. Active Power Factor Corrector

Each student will carry out practical/simulation work on switch-mode power supply design and implementation.

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