

Department of Electrical Engineering, Indian Institute of Technology Madras

Course title	Power Management Integrated Circuits									Course No	EE5325			
Department	Electrical Engineering	New Credits	L	T	P	C	O	E	TH	Old Credits	L	T	P	C
			4			12	8				4			4
Offered for	BTech (4th year), DD, MTech, MS, PhD									Status	New			
Faculty	Qadeer Ahmad Khan									Type	Theory			
Pre-requisite	Analog Circuits									To take effect from	01-01-2017			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
20-09-2016														

Objectives:

Course Objectives:

To develop understanding of why power management circuits are needed in a VLSI system. What are different components of a power management system with focus on dc-dc converters. How to design a chip level dc-dc converter from a given system level specifications.

Learning Outcomes:

By the end of this course, students should be able to understand the concept behind power management circuits and be able to design a dc-dc converter for a specific system using behavioral and circuit level simulators such as MATAB/Simulink and Cadence. Students should be able select various parameters such as switching frequency, inductor and capacitor values for best performance and efficiency.

Course Contents:

Unit-1: Introduction to Power Management and Voltage Regulators

Need of power management, power management applications, classification of power management, power delivery of a VLSI system, power conversion, discrete vs. integrated power management, types of voltage regulators (switching Vs linear regulators) and applications, converter's performance parameters (voltage accuracy, power conversion efficiency, load regulation, line regulation, line and load transient response, settling time, voltage tracking), local Vs remote feedback, kelvin sensing, Point-of-Load (POL) regulators.

Unit-2: Linear Regulators

Bandgap Voltage Reference, Low Drop-Out Regulator (LDO), Source and sink regulators, shunt regulator, pass transistor, error amplifier, small signal and stability analysis, compensation techniques, current limiting, power supply rejection ratio (PSRR), NMOS vs. PMOS regulator, current regulator.

Unit-3: Switching DC-DC Converters and Control Techniques

Types (Buck, boost, buck-boost), power FETs, choosing L and C, PWM modulation, leading, trailing and dual edge modulation, Losses in switching converters, output ripple, voltage Vs current mode control, CCM and DCM modes, small signal model of dc-dc converter, loop gain analysis of un-compensated dc-dc converter, type-I, type-II and type-III compensation, compensation of a voltage mode dc-dc converter, compensation of a current mode dc-dc converter, hysteretic control, switched capacitor dc-dc converters.

Unit-4: Top-down Design Approach of a DC-DC Converter

Selecting topology, selecting switching frequency and external components, sizing power FETs, segmented power FET, designing gate driver, PWM modulator, error amplifier, oscillator, ramp generator, feedback resistors, current sensing, PFM/PSM mode for light load, effect of parasitic on reliability and performance, current limit and short circuit protection, soft start control, chip level layout and placement guidelines, board level layout guidelines, EMI considerations.

Unit-5: Introduction to Advanced Topics in Power Management

Digitally controlled dc-dc converters, digitally controlled LDOs, adaptive compensation, dynamic voltage scaling (DVS), Single-Inductor Multiple-Outputs (SIMO) Converters, dc-dc converters for LED lighting, Li-ion battery charging circuits.

Text Books:

Text Books:

Switch-Mode Power Supplies: SPICE Simulations and Practical Designs
by Christophe P. Basso

Indian Edition:

Publisher: BPB Publications (1 December 2010)

Language: English

ISBN-10: 8183332919

ISBN-13: 978-8183332910

International Edition:

Publisher: McGraw-Hill Professional, (1 February 2008)

Language: English

ISBN-10: 0071508589

ISBN-13: 978-0071508582

Reference Books:

Reference Books:

1. Fundamentals of Power Electronics, 2nd edition
by Robert W. Erickson, Dragan Maksimovic

Indian Edition:

Publisher: Springer (India) Pvt. Ltd. (2005)

ISBN-10: 8181283635

ISBN-13: 978-8181283634

International Edition:

Publisher: Springer; 2nd edition (January 2001)

Language: English

ISBN-10: 0792372700

ISBN-13: 978-0792372707

2. Power Management Techniques for Integrated Circuit Design
By Ke-Horng Chen

Publisher: Wiley-Blackwell (29 July 2016)

ISBN-10: 1118896815

ISBN-13: 978-1118896815