



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Electrical Engineering)

Subject Code: 3720732

Semester – II

Subject Name: SWITCHED MODE POWER CONVERTERS

Type of course: Program Elective

Prerequisite: Power Electronics Converters and Applications (3710713)

Rationale: Starting from the basic configurations and the operating principle, various aspects related to the design of SMPS like selection of components, design of magnetic components, stability study, control strategies, protection etc. are covered in this subject. Thus, the subject is intended to provide the needed information and theory for understanding and design of switching power supplies.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Review of Basic SMPS topologies Linear regulator versus SMPS, Buck, Boost, Buck-Boost SMPS Topologies, Basic Operation-Waveforms - modes of operation -switching stresses, Switching and conduction losses, Optimum switching frequency, Practical voltage, current and power limits - design relation, Voltage mode control principles.	4
2	Isolated converters Push-Pull converter: Basic operation, Waveforms, Flux imbalance problem, coping with flux imbalance, transformer design, output filter design, switching stresses and losses, output filter design Forward Converter: Configuration, Basic operation and analysis, waveforms, voltage mode control, forward converter magnetics, transformer design, output filter design, double-ended and interleaved forward converters Half and Full Bridge Converters: Basic Operation and Waveforms. Magnetics, Output Filter, Blocking capacitance for coping up flux imbalance, power limit Flyback converter: Configuration, basic operation, and waveforms, discontinuous and continuous mode of operation, flyback magnetics, design relations and sequential steps for design, control strategy Study of PWM Control ICs SG 3525, TL 494, MC34060 etc.	10
3	Resonant Converters Classification of Resonant Converters., Basic Resonant Circuit Concepts, Load Resonant Converter, Resonant Switch Converters, Zero Voltage Switching Clamped Voltage	



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	Topologies, Resonant DC Link Inverters with Zero Voltage Switching. High Frequency Link Integral Half Cycle Converter.	7
4	Modeling and stability considerations DC Transformer, Small Signal Approximation- General Second Order Linear Equivalent Circuits, Voltage Mode SMPS Transfer Functions, General Control Law Consideration, Loop Gain and Stability Considerations, Error Amp- frequency Response and Transfer Function, Trans-conductance,	8
5	Current Mode Control of SMPS. Current Mode Control Advantages, Current Mode Vs Voltage Mode, Current Mode Deficiencies, Slope Compensation, Comparison of performance of various configurations for voltage control and current control modes of operation, Study of a typical Current Mode PWM Control IC UC3842.	7
6	Some Design Considerations EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS, Techniques to reduce Emissions, Shielding and Grounding, Power Circuit Layout for minimum EMI, EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control, Power factor correction and chips for power factor correction	6

Reference Books:

1. Abraham I Pressman, "Switching Power Supply Design," McGraw Hill Publishing Company, 2001.
2. Daniel M Mitchell, "DC-DC Switching Regulator Analysis," McGraw Hill Publishing Company-1988.
3. L. Umanand and S. Bhat, "Design of Magnetic Components for Switched Mode Power Converters", New Age International Ltd., New Delhi, 2001.
4. Keng C. Wu, "Switch-Mode Power Converters: Design and Analysis", Elsevier Academic Press, 2006.
5. George Chryssis, "High Frequency Switching Power Supplies: Theory and Design", 2nd ed., McGraw Hill Publishing Company-1989.
6. M. K. Kazimierzuk, 'Pulse-width Modulated DC-DC Power Converters', John Wiley and Sons, 2008.
7. Robert Ericksson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer (India) Pvt. Ltd., 2nd ed., 2005.
8. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.

Course Outcomes:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Analyse non-isolated and isolated hard-switched DC-DC converters.	40
CO-2	Design the control scheme for voltage-controlled and current controlled dc-dc converters	20



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CO-3	Design the soft-switched converters with a view to minimize the switching losses and stresses	15
CO-4	Design the filters, magnetic components and protection circuits for SMPS	15

List of Experiments:

Lab experiments shall be based on the course content. A list provided here is just to indicate the type of experiments that can be included.

1. Study of basic topologies of DC-DC Converters
2. To design transformer for forward converter/fly-back converter/ push-pull converter/ half bridge converter/ full bridge converter
3. Study of series loaded resonant converter in various operating modes
4. Study of parallel loaded resonant converter in various operating modes
5. Study of ZCS converter
6. Study of ZVS converter
7. Modelling of dc-dc converter (like buck, boost, buck-boost) and to study the frequency response for the transfer functions.
8. Develop closed loop control of buck/boost converter in voltage mode control.
9. Develop closed loop control of buck/boost converter in current mode control.
10. Develop PWM circuit using SG3525/TL494 Integrated circuit.

Major Equipment:

Simulation softwares like MATLAB, PSIM, SCILAB etc., Power Converter trainer kits, Power Oscilloscope, Voltmeter, Ammeter, DMM, Current Probe, Differential Voltage Probe

List of Open Source Software/learning website:

1. <https://www.nptel.ac.in>
2. <https://www.mathworks.com/>
3. <https://powersimtech.com>
4. <https://www.scilab.org/>