

GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: POWER ELECTRONICS
SUBJECT NAME: SWITCHED MODE AND RESONANT CONVERTERS
SUBJECT CODE: 3712915
M.E. 1st SEMESTER

Type of course: Engineering

Prerequisite:

Power Electronic Converters at UG level. Fundamental Knowledge of calculus; basics of Electrical Engineering; concepts of Fourier Series, solution of integro-differential equations, Laplace Transformation

Rationale:

This is the core subject accompanying laboratory, serves to introduce advanced power electronics on analysis point of view to the post graduate students who will use the concepts from this course during their graduate studies. Power Electronics is a rapidly growing field within electrical engineering as the enabling technology for most of the industry.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs	% Weight
1	<ul style="list-style-type: none">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 relations.Voltage mode control principles.Push-Pull and Forward Converter Topologies - Basic Operation, Waveforms. Flux Imbalance Problem and Solutions	6	10
2	<ul style="list-style-type: none">Transformer Design. Output Filter Design. Switching Stresses and Losses.Forward Converter Magnetics. Voltage Mode Control.Half and Full Bridge Converters. Basic Operation and Waveforms.Magnetics, Output Filter, Flux Imbalance, Switching Stresses and Losses,Power Limits, Voltage Mode Control.	8	20
3	<ul style="list-style-type: none">Classification of Resonant Converters. Basic Resonant Circuit Concepts.	6	10

	<ul style="list-style-type: none"> • Load Resonant Converter, Resonant Switch Converter, • Zero Voltage Switching Clamped Voltage Topologies. • Resonant DC Link Inverters with Zero Voltage Switching. • High Frequency Link Integral Half Cycle Converter. • Fly back Converter- discontinuous mode operation, waveforms, control. • Magnetics- Switching Stresses and Losses, Disadvantages - • Continuous Mode Operation, waveforms, control, design relations. 		
4	<ul style="list-style-type: none"> • Voltage Mode Control of SMPS- Loop Gain and Stability Considerations. • Error Amp– frequency Response and Transfer Function. • Trans-conductance, Current Mode Control of SMPS. • Current Mode Control Advantages, Current Mode Vs Voltage Mode. 	8	20
5	<ul style="list-style-type: none"> • Current Mode Deficiencies.Slope Compensation. • Study of a typical Current Mode PWM Control IC UC3842. Modeling ofSMPS. • Small Signal Approximation- General Second Order Linear EquivalentCircuits. • Study of PWM Control ICs (SG 3525,TL 494,MC34060 etc.) 	8	20
6	<ul style="list-style-type: none"> • DC Transformer, Voltage Mode SMPS Transfer Function. • General Control Law Consideration. • EMI Generation and Filtering in SMPS - Conducted and RadiatedEmission Mechanisms in SMPS. • Techniques to reduce Emissions, Control of Switching Loci. • Shielding and Grounding, Power Circuit Layout for minimum EMI. • EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control 	8	20

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. Ned Mohan, 'First Course on Power Electronics and Drives', John Wiley & Sons, 2011.
4. Ned Mohan, Tore M. Undeland, William P. Robbins, 'Power Electronics: Converters, Applications, and Design', 3rdEdition, John Wiley & Sons, 2002
5. L. Umanand, 'Power Electronics: Essential and Application', Wiley India Pvt. Ltd., 2009
6. M. K. Kazimierczuk, 'Pulse-width Modulated DC-DC Power Converters', John Wiley and Sons, 2008.

Course Outcome:

After learning the course, the students should be able to:

1. acquire knowledge about the principles of operation of non-isolated and isolated hard-switched DC-DC converters.
2. acquire knowledge on various loss components in a switched mode converter and choice of switching frequency with a view towards design of such converters.

List of Experiments:

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. Output filter design and study of its frequency response
4. Study of series loaded resonant converter
5. Study of parallel loaded resonant converter
6. Study of ZCS converter
7. Study of ZVS converter
8. Study of resonant DC link converters
9. Develop closed loop control of buck/boost converter in voltage mode control.
10. Develop closed loop control of buck/boost converter in current mode control.
11. Develop PWM circuit using SG3525/TL494 Integrated circuit.

Major Equipment:

Power Oscilloscope with necessary probes, Voltmeter, Ammeter, DMM, PC with necessary simulation software, Current Probe, Differential Voltage Probe, DC/DC converter trainer kits

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/>