GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (07)
DIGITAL SIGNAL PROCESSING FOR POWER ELECTRONICS
SUBJECT CODE: 2720726
SEMESTER: II

Type of course: Analysis of Various Power Converters, Simulations and Applications

Prerequisite: Basics of Power Electronics, digital signal processing fundamentals

Rationale: The aim of this course is to understand the various power semiconductor switches and their applications in designing of dc-dc or dc-ac power converters. Students will learn about various converter topologies with Digital Signal Processing control algorithms. Key topics covered in this course are overview of power semiconductor switches, dc-dc switched mode converters, dc-ac switched mode converters, pulse width modulation switching scheme, single phase inverters, TI 2000 series DSP processors and their applications in power electronics. The course also prepares the students to integrate solar photovoltaic systems with power converters and various applications of switched mode power converters.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% weightage
1	Overview of Power Semiconductor Switches: Introduction of Power diodes, Desirable characteristics in controllable switches, bipolar junction transistors, Metal oxide semiconductor field effect transistors, Insulated gate bipolar transistors. Drive and snubber circuits.	8	12
2	DC-DC switched mode converters: Control of dc-dc converters, step down (buck) converter, step up (Boost) converter, Buck-boost converter, Cuk converter, Half bridge converter and Full-bridge converter.	12	25
3	Switched mode dc-ac inverters: Basic concept of switched mode inverters, Single phase inverters, Different switching schemes for dc-ac inverters.	12	25
4	TMS320F2x DSP controller: TI 2000 DSP core architecture, instruction set, addressing modes, GPIO functionality, Interrupts, ADC channels, Event managers for pulse	16	30

	width modulation and capture unit.		
5	Applications of DSP controllers in power electronics: Design of Power converters based on renewable energy sources like Solar Photovoltaic Energy. Battery charger units, switched mode power supplies.	4	8

Reference Books:

1. **Power Electronics: Converters, Applications, and Design** Mohan, Undeland, Riobbins, Wiley India; Third Edition
2. **Switching Power Supply Design** Abraham I. Pressman, Keith Billings, Taylor MoreyMcGraw-Hill Professional; Third Edition
3. **DSP Based Electromechanical Motion Control** Hamid A. Toliyat, Steven G. Campbell CRC Press
4. **Power Electronics: Circuits, Devices and Applications** Muhammad H. Rashid Pearson Education; Third Edition

Course outcomes:

After learning the course, students should be able to understand the basics of power diodes, power bipolar junction transistors, metal oxide semiconductior field effect transistor, insulated gate bipolar transistors. Students will get the idea of various power converter topologies like buck, boost, buck-boost, cuk, half bridge and full bridge. Students will be able to generate pulse width modulated output using TMS320F2407/28335 high performance DSP. Students will also get familiar with various applications of power electronics and integration of solar photovoltaic system with power converters to produce electrical energy from light

List of Experiments:

1. Design a buck converter using continuous conduction mode.
2. Design a boost converter using continuous conduction mode.
3. Design a buck-boost converter using continuous conduction mode.
4. Design a cuk converter.
5. Design a half-bridge dc-dc converter.
6. Design a full bridge dc-dc converter.
7. Design a full-bridge dc-ac converter.
8. Write a program to blink LED with 1 Hz and 0.5 Hz frequency on GPIO using TMS320F28335 DSP
9. Write a program to generate PWM sequence using continuous up and continuous up-down counting mode using TMS320F28335 DSP for DC-DC converter.
10. Write a program to generate sinusoidal PWM using TMS320F28335 DSP for DC-AC inverter.

Open Ended Problems:

1. Design high efficiency DC-DC converter using rated solar photovoltaic module.
2. Maximum power point tracking from solar photovoltaic module.
3. Design high efficiency DC-AC inverter using rated solar photovoltaic module.
4. Design high efficiency DC-DC power converters for LED lighting systems.
5. Design high efficiency power converters for cell phone charging.
6. Design high efficiency power converters for laptop charging.

7. Design switched mode power supply.
8. Design power supply for car battery charger.
9. Design uninterrupted power supply.
10. Design closed loop control system for power converters

Major equipments and software:

1. High performance simulation software like Orcad Capture PsPICE, MULTISIM, MATLAB
2. Digital Signal Processing development board of Texas Instruments 2407, 2812 or 28335
3. At least 2channel 1GS/s digital storage oscilloscope with 1x-10x probes.
4. Digital Multimeter
5. Regulated DC power supply with higher current ratings.

List of Open Source Software/learning website:

1. www.nptel.ac.in
2. www.ti.com

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website