GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Electrical Engineering
SUBJECT NAME: Power Electronics Converters and Applications
SUBJECT CODE: 3710713
M.E. 1st SEMESTER

Type of course: Core Course

Prerequisite: --

Rationale: The power electronic devices and some conventional power electronic converters are widely used in the domestic applications as well as industrial applications like electric drives, power systems, renewable energy based power generation etc. The course acts as a foundation block and provides exposure to operation, design, analysis and control of some of the fundamental power electronic converters.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	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	% Weightage
1	**Semiconductor Devices** Review of Semiconductor devices like Power BJT, SCR, MOSFET, IGBT, GTO, MCT; Static and dynamic characteristics of these devices; Single quadrant, Two quadrant and bid-directional switches.	3	
2	**AC-DC Converters** Single phase and three phase half wave and full wave, 1-phase and 3-phase half controlled and fully controlled converters, Analysis with R & RL load, Performance parameters for converters,, Operation in continuous and dis-continuous mode, Reactive power considerations, Operation in conversion and inversion mode, Effect of source inductance, Power factor improvement techniques, Dual Converters, Applications	9	
3	**Switching Voltage Regulators** Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations - Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; C'uk converter, Sepic Converter, Applications	6	
4	**DC-AC converters/Inverters** Classification; Review of line commutated inverters, Concept of Unipolar and Bipolar PWM, 120° and 180° conduction mode of inverter, Sine-triangular PWM, Effect or carrier frequency on the harmonics, Space Vector Pulse Width Modulation, Other PWM techniques, Current	9	

	Source Inverters, Impedance source inverter, Applications		
5	**Three phase AC voltage controllers and Cycloconverters** **AC voltage controllers**: Review of On-off and phase control; Single phase full wave controllers and their analysis with resistive loads; Three phase full wave controllers, Analysis with R-load, Three phase bi-directional delta-connected controllers **Cycloconverters**: single-phase to single-phase cycloconverter, 3-phase to 1-phase cyclo-converter, 3-phase to 3-phase cycloconverter circuits; circulating current operation; non-circulating current operation; mean output voltage and harmonics in supply current waveform	**9**	
6	**Driver circuits, protection and other design considerations** Preliminary design considerations for power electronic converters; DC coupled drive circuits with unipolar and bipolar outputs; Importance of isolation in driver circuits; Electrically isolated drive circuits; Some commonly available driver chips; Cascode connected drive circuits; Thyristor drive circuits; Protection in driver circuits; Blanking circuits for bridge inverters	**5**	

Reference Books:

1. Mohan, Undeland and Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2003.
3. P.C.Sen, "Modern Power Electronics ", S. Chand and Co. Ltd., New Delhi, 2012.
4. G.K. Dubey, S.R. Doradla, A. Joshi, and R.M.K. Sinha, "Thyristorised Power Controllers", New Age International Ltd. Publishers, 1986 (Reprint 2008).
5. P.T. Krein, "Elements of Power Electronics", Oxford University Press, 1998.
6. Joseph Vithayathil , "Principles of Power Electronics", Mc-Graw Hill
7. http://nptel.iitm.ac.in/coursecontents_elec.php

Course Outcome:

After learning the course the students is expected to have the:

- Ability to analyze the characteristics of Power electronics devices and to determine the suitable device for a particular application
- Ability to analyze and operate DC-DC converters, phase controlled converters, inverters and AC-AC converters.
- Ability to design of driver, protection and control circuits for power electronic devices

List of Experiments:

Few experiments are provided here as guidelines.

1. To study the factors affecting DCM and CCM mode operation of the Buck/Boost/Buck-Boost converter.
2. Design of a closed loop control scheme for regulating the output voltage of a DC-DC converter.
3. To study the performance of a fourth order dc-dc converter vis-à-vis second order dc-dc converter.
4. To study the inversion and conversion modes of operation of phase-controlled single-phase and three-phase ac-dc converters.
5. To compare the reactive power requirement and the range of operating voltage of half-controlled and fully controlled converters.
6. To compare the unipolar and bipolar pulse-width modulation techniques.
7. Sine-PWM control of inverter to control the speed of an induction motor.
8. SVPWM control of inverter.
9. Three-phase ac voltage control using the phase-controlled thee-phase AC-AC voltage controllers.
10. To design driver circuits/firing circuits for power electronic devices/converters.

Major Equipment:

Power electronic converters, oscilloscopes, current probe, circuit simulation tools like MATLAB/PSIM or open source software to simulate power electronic circuits and other basic equipment like meters, load, motors etc.

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology
   - website: ocw.mit.edu
2. Material on Fundamental of Power Electronics by Robert Erickson
   - website: ecee.colorado.edu/copec/book/slides/slidedir.html
3. Courses available through NPTEL.
   - website : nptel.ac.in