

# GUJARAT TECHNOLOGICAL UNIVERSITY

## POWER ELECTRONICS (29)

POWER CONVERTERS-I

SUBJECT CODE: 2712908

SEMESTER: I

**Type of course:** Engineering

**Prerequisite:** Fundamental Knowledge of Calculus; Basics of Electrical Engineering; Concepts of Fourier Series, Solution of Integral-differential equations, Laplace Transformation

**Rationale:** This is the core subject accompanying laboratory, serves to introduce 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. It is also a prominent strength of the Power Electronics Engineering Department

### 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)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

### Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	<b>Review of Power Electronics Devices:</b> Overview Power Electronics Devices, Power Diodes, Thyristors, Power Bipolar Junction Transistors, MOSFET, IGBT, GTO, MCT Etc., static & dynamic Characteristics of Switching devices, Ratings, Driving And Protection Circuits For Different Devices, Control Methods For Various Power Converters.	6	15
2	<b>Line Commutated Converters:</b> Principle Of Phase Control Converters, Single-Phase & Three-Phase Converter With Different Load, Three Pulse And Six Pulse Converters, Mid-Point And Bridge Connections Average Load Voltage With R And RL Loads, Effect Of Source Inductance, Dual Converters.	8	15
3	<b>AC to AC controlled Converters:</b> Principle Of AC Voltage Controller, Integral Cycle Control, Phase Angle Control, Sequential Control, Various Configurations, Analysis With R And R-L Loads, PWM AC to AC Converter.	6	10
4	<b>Cyclo-Converters:</b> Principle Of Cyclo-Converter Operation, Single –Phase To Single-Phase Circuit, Step-Up Cyclo-Converter, Mid-Point Cyclo-Converter, Bridge-Type Cyclo-Converter, Single-Phase To Single-Phase Circuit-Step-Down Cyclo-Converter, Three-Phase Half-Wave Cyclo-Converters, Three-Phase To Single-Phase Cyclo-Converters, Three-Phase To Three-Phase Cyclo-Converters, Load-Commutated Cyclo-Converter.	6	10

5	<b>DC to DC Converters:</b> Principles Of Step-Down And Step-Up Converters, Pulse-Width Modulation, Analysis Of Buck, Boost, Buck-Boost And Cuk Converters, Time Ratio And Current Limit Control, Full Bridge Converter, Different Chopper Circuits, Chopper Circuits Design, SEPIC Converter.	8	20
6	<b>Inverter Circuits:</b> Principle Of Inverter, Basic Single Phase Inverter, Three Phase Inverter, Various Configurations, Analysis With R And R-L Loads, Series Inverter, Parallel Capacitor Inverter Bridge Inverter, Voltage Control Techniques For Inverters Like Pulse Width Modulation Techniques. 120°, 150° and 180° mode operation of three phase inverter.	8	20

### 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. Joseph Vithayathil, "Principles of Power Electronics", Tata Mc-Graw Hill, 2010.
4. R.W. Erickson, D. Maksimovic, "Fundamentals of Power Electronics", Kluwer Academic Publisher, 2nd ed., 2001.
5. G.K. Dubey, S.R. Doradla, A. Joshi, and R.M.K. Sinha, "Thyristorised Power Controllers", New Age International Ltd. Publishers, 1986 (Reprint 2008)
6. Rendall Shaffer, "Fundamentals Of Power Electronics With MATLAB", Charles River Media.
7. William Shepherd, Li Zhang, "Power Converter Circuits", Marcell Dekker, New York, 2005

### Course Outcome:

After learning the course the students should be able to:

1. Understand Basic Structure of Power Electronics Devices.
2. Analyze the operation of various power converters.
3. Understand concepts and operating principles of Power Electronics Circuits.
4. Design procedures and techniques of Power Electronics Converters.
5. Design the AC to AC converters.
6. Design the DC to DC converters.
7. Design and analyses the inverter circuits.
8. Organize and make technical presentations.

### List of Experiments: (with Open Ended Problems)

1. To study the turn on & turn off characteristics of power electronics devices.
2. To study the role of protection circuits for power electronics devices.
3. To design the gate/base driver circuits for power electronic device.
4. To study the Single-Phase & Three-Phase Line Commutated Converters.
5. To study the performance of single-phase AC-AC converters with different types of loads.
6. To study the performance of three- phase AC-AC converters with different types of loads.
7. To study the operation of Single phase & Three phase Cyclo-Converter.
8. To study the operation of Buck, Boost, Buck-Boost and Cuk Converters.
9. To study the performance of Single Phase & Three Phase Inverter with Various Loads.
10. To study the performance of Series Inverter, Parallel Capacitor Inverter Bridge Inverter
11. To study the performance of 120°, 150° and 180° mode operation of three phase inverter.

**Major Equipments:**

Digital Storage Oscilloscopes, Circuit Simulation Tools: open source software to simulate power electronic converter circuits, Basic equipment for measurement, Different loads: R, RL, and Motors etc.

**List of Open Source Software/learning website:**

[http://nptel.iitm.ac.in/coursecontents\\_elec.php](http://nptel.iitm.ac.in/coursecontents_elec.php)