



# GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3732908

Semester – III

**POWER ELECTRONICS**

**Subject Name: High Power Converters for Power Quality & Drives**

**Type of course: Program Elective V**

**Prerequisite: Understanding of Power devices and Power Electronics converters at UG level.**

**Rationale:** The power electronic converters are widely used in electric drives, power systems, renewable energy based power generation etc. The course acts as a foundation block and provides exposure to the use of power electronics at high power requirements.

**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	0	3	70	30	0	0	100

**Content:**

Sr. No.	Content	Total Hrs
1	<b>Power Quality:</b> Introduction, Terms and definitions: Linear & Non Linear Loads, Power Quality Indices, under voltage, over voltage, Concepts of transients, short duration variations such as interruption, long duration variation such as sustained interruption, voltage sag, voltage swell, voltage imbalance, voltage fluctuation, power frequency variations, Computer Business Equipment Manufacturers Associations (CBEMA) curve.	5
2	<b>Harmonics:</b> Harmonic sources, Harmonics vs transients, Effect of harmonics - voltage and current distortion - inter harmonics, resonance. - IEEE and IEC standards, Effects of harmonics on capacitors, Transformers, Rotating machines, Lighting Devices, cables, relays etc.	5
3	<b>Active and Passive Filters:</b> Introduction, Classification of Passive Filters, Principle of Operation of Passive Power Filters, Analysis and Design of Passive Power Filters, Limitations of Passive Filters. General types of active filters, principle of operation and control of shunt active power filter & Series active filter, types of Shunt Active filters & Series active power filters, Hybrid active filters, comparison with pure active filters, Combined series and shunt power conditioners, Unified Power Flow Controller (UPFC), Unified Power Quality Controller (UPQC)- basic concepts	6
4	<b>Multi-pulse Rectifiers:</b> Introduction, Principle of operation of Multi-pulse Converter, Phase-Shifting Transformers, various transformer connections for multi-pulse converters, Six-Pulse Diode	8



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	Rectifier, Series-Type Multi-pulse Diode Rectifiers, Separate-Type Multi-pulse Diode Rectifiers, Six-Pulse SCR Rectifier, 12-Pulse SCR Rectifier, 18- and 24-Pulse SCR Rectifiers, , Harmonic Current Cancellation.	
5	<b>Multi-level Inverter and Matrix Converters:</b> Introduction, Topologies of Multi-level inverters, Two-Level Voltage Source Inverter. Cascaded H-Bridge Multilevel Inverters, Diode-Clamped Multilevel Inverters, NPC/H-Bridge Inverter, Multilevel Flying-Capacitor Inverters. Comparisons. Principle of Matrix converter, Power switches used for Matrix converters, Topologies, Control and Modulation techniques for Matrix converters, Protection issues for Matrix converters.	7
6	<b>PWM Inverters and Rectifiers:</b> Introduction, PWM Current Source Inverter, Trapezoidal Modulation, Selective Harmonic Elimination, Space Vector Modulation, Parallel Current Source Inverters, Load-Commutated Inverter (LCI), Single-Bridge Current Source Rectifier, Dual-Bridge Current Source Rectifier, Power Factor Control, Active Damping Control,	5
7	<b>Inverter Fed Drives:</b> Introduction, Two-Level VBSI-Based MV Drives, Neutral-Point Clamped (NPC) Inverter-Fed Drives, Multilevel Cascaded H-Bridge (CHB) Inverter-Fed Drives, NPC/H-Bridge Inverter-Fed Drives, CSI Drives with PWM Rectifiers, Transformer less CSI Drive for Standard AC Motors, CSI Drive with Multi-pulse SCR Rectifier, LCI Drives for Synchronous Motors. Principle of Field-Oriented Control (FOC), Direct and Indirect Field-Oriented Control, Direct Torque Control.	6

### Reference Books:

1. Roger C. Dugan, "Electrical Power Systems Quality", 2nd Edition, Tata Mcgraw Hill Publication.
2. C. Sankaran, "Power quality", CRC Press, 2002.
3. William Shepher, Li Zhan, "Power Converter Circuits", 1 edition, CRC Press, 2004.
4. Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, "Instantaneous Power Theory and Applications to Power Conditioning", John Wiley & Sons, 2007.
5. Bin Wu, Mehdi Narimani "High-Power Converters and AC Drives", 2nd Edition, Wiley-IEEE Press, 2017.

### Course Outcomes:

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

Sr. No.	CO statement	Marks % weightage
CO-1	Understand various issues related to power quality in power system.	15
CO-2	Understand the passive and active filters for Harmonics mitigation.	15
CO-3	Understand the principle of operation of Multi-level converters & Matrix converters and its applications.	25
CO-4	Understand the PWM based inverter and rectifier circuits.	25
CO-5	Understand PWM inverter based drive system	20



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

E-materials available at the website of NPTEL- <http://nptel.ac.in/>