

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BRANCH NAME: POWER ELECTRONICS (24)**

**SUBJECT NAME: Advanced Power Electronics Devices & Interface Circuits**

**Subject Code: 2172408**

**BE SEMESTER VII**

**Type of Course:** Engineering Science (Power Electronics)

**Prerequisite:** 1) 2132404: Principles of Power Electronics

2) 2142405: Analog Electronics and Its Applications

3) 2142406: Digital Electronics and Its Applications

4) 2152407: Power Electronics Circuits-I

5) 2162408: Power Electronics Circuits-II

**Rationale:** This subject focuses on the study of new upcoming materials for power semiconductor devices and their applications, various ICs for interfacing power and logic level circuits and study & use of various test and measurement instruments.

**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)		
PA	ALA	ESE		OEP						
3	0	0	3	70	20	10	0	0	0	100

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; E- Exam; M- Mid Semester; V- Viva; I- Internal; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP- Open Ended Problems; ALA- Active Learning Assignments.

**Learning Objectives:**

- Review of various power semiconductor devices.
- To study the concept of WBG devices, their applications & advantages.
- To study various non-isolated Gate/Base driver ICs with and without protection.
- To study various isolated Gate/Base driver ICs with and without protection.
- To study and understand Galvanic Isolation.
- To study voltage, current and frequency measurement using various techniques.
- To study the measurement & interfacing of analog signals.
- To study interfacing of digital signals.
- Understanding of various logic levels and their interfacing.
- To study and understand various test & measurement instruments.
- To study the measurement of voltage and current using various types of measurement probes.
- To study the use of Power Scope for power electronics applications.

**Content:**

Sr. No.	Topic With Details	Teaching Hours	% Weigh tage
1	<b>Advanced Power Semiconductor Devices:</b> <ul style="list-style-type: none"> <li>Review of power semiconductor devices</li> <li>Overview and Concept of Wide Band Gap (WBG) Power Semiconductor Devices – SiC and Gallium Nitride Devices</li> <li>Comparison of WBG (SiC, GaN) and Si devices – Their Merits and Demerits, Applications</li> </ul>	6	15% - 20%
2	<b>Driver IC Study (Datasheet and Application Note):</b> <ul style="list-style-type: none"> <li>Non-isolated Driver ICs: Single Switch Unprotected Driver IC (e.g.UCC27531) – Half Bridge Driver IC (e.g.IR2110) – Half Bridge Driver IC with SC Protection (e.g. IR2114) – Single Switch Driver IC with SC Protection (e.g. MC33153)</li> <li>Isolated Driver ICs: TRIAC driver IC (e.g. MOC302x, MOC304x) – SCR Driver IC (e.g. MOC3002), Single Switch Driver IC (e.g. TLP250), Single Switch Driver IC (e.g. HCPL316J) with SC Protection</li> <li>Relay driver-ULN 2803, DRV120</li> </ul>	10	25% - 30%
3	<b>Measurement Systems &amp; Interfacing with Digital Systems:</b> <ul style="list-style-type: none"> <li>Galvanic Isolation – Interfacing of Signals Using Galvanic Isolation – Linear Opto coupler (e.g. IL300), Isolation Amplifier</li> <li>Measuring and Interfacing Analog Signals – ADC – Removing Common Mode Signals – Hall Effect Current Sensors, Current Transformer – DC Current Measurement (DC-Shunt, Allegro ACS7xx) –Voltage Measurement (LEM LV 25-P, Using Discrete Components like Op-Amp, R, C, Isolator Circuits, etc.) – Principle of Frequency &amp; Speed Measurement – F to V Converter (FVC Using LM331)</li> </ul>	12	25% - 30%
4	<b>Digital Interface with I/O:</b> <ul style="list-style-type: none"> <li>Interfacing Digital Signals – Interfacing Different Logic Families – Interfacing Digital Signals of Different Voltage Levels – Interfacing Slow Signals (Large Rise/Fall Time) – Signal Conditioning</li> </ul>	6	20% - 25%
5	<b>Test &amp; Measurement Instruments:</b> <ul style="list-style-type: none"> <li>Study and applications of Logic Analyzer, Oscilloscope, Grounding Considerations for Power Circuits</li> <li>Power Scope, Differential Voltage Probe, Current Probe</li> </ul>	6	15% - 20%

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks				
Remembrance R Level	Understanding U Level	Application A Level	Analyse N Level	Evaluate E Level
15%	30%	15%	20%	20%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

## References:

1. Datasheets and Application Notes for various ICs as mentioned in the syllabus from Learning Websites as given below.
2. IEEE, IEC, ECPE and other conference/journal papers.
3. A review of WBG power semiconductor devices by José Millán, CAS 2012 (International Semiconductor Conference) (Volume:1), IEEE

## Course Outcome:

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

1. Understand the WBG (SiC and GaN) power semiconductor devices and its advantages over conventional devices.
2. Understand datasheets and use of various Gate/Base driver ICs.
3. Understand Galvanic Isolation & its importance.
4. Understand various measurement systems (Voltage, Current, Frequency) and be able to select and use proper ICs for various measuring applications, as required.
5. Understand various logic levels, and their interfacing with other signals.
6. Understand and be able to use various measurement equipment like CRO, Logic Analyzer, Power Scope, etc. for power electronics applications

## List of Learning Websites:

- DC Shunt: <https://openenergymonitor.org/emon/buildingblocks/dc-shunt>
- <http://www.datasheetcatalog.com>
- <http://www.epe-association.org/epe/index.php>
- <http://www.ecpe.org/>
- [www.electronicdesign.com](http://www.electronicdesign.com)
- <http://nptel.iitm.ac.in/courses.php>
- <http://ocw.mit.edu>
- <http://www.ti.com>
- <http://www.st.com>
- <http://www.ni.com>
- <http://www.irf.com>
- <http://www.allaboutcircuits.com>
- <http://www.vishay.com>
- <http://www.lem.com>
- <http://www.motorola.com>
- <http://www.onsemi.com>
- <http://www.nxp.com>
- <http://www.toshiba.com>
- <http://www.linear.com>
- <http://www.infineon.com>
- <http://www.yokogawa.com>
- <https://www.agilent.com>
- <http://www.tek.com/>