GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Electrical Engineering

Course / Subject Code: ME01000161

Course / Subject Name: Power Quality

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	NA
Rationale:	The quality of electrical power can significantly impact industrial consumers. Recently, there has been a strong emphasis on revitalizing the industry through increased automation and the adoption of modern equipment. This often involves using electronically controlled, energy-efficient devices that are highly sensitive to deviations in supply voltage. Unfortunately, these sensitivities exacerbate power quality issues. This course raises awareness about power quality challenges. It equips students with techniques to improve power quality. This course aims to raise students' awareness of the various factors affecting power quality and introduce techniques available for improving it.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
01	To understand Power Quality Concepts.
02	To analyze Power Quality Parameters.
03	To design Mitigation Strategies for power quality issues.
04	To implement Custom Power Devices for enhancing power quality.
05	To apply Standards and Best Practices effectively to address power quality challenges.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial /Practical		
L	T	PR	C	ESE (E)	PA/ CA (M)	PA/CA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Power Quality**: Understanding the significance of power quality in electrical systems. Identifying power quality issues and their impact on industrial consumers.	6	12
2.	**Power Quality Standards and Monitoring**: Overview of international standards for power quality. Techniques for monitoring and assessing power quality parameters.	6	14
3.	**Passive Compensation Techniques**: Shunt and series compensation methods. Use of passive filters to improve power factor and voltage regulation.	6	12
4.	**Active Compensation Techniques**: Shunt active power filters, series active power filters, Hybrid active power filters, introduction to custom power devices (CPD). Operation and control of Distribution Static Compensator (DSTATCOM) for load compensation and voltage regulation. Dynamic Voltage Restorer (DVR) for series compensation.	14	34
5.	**Unified Power Quality Conditioner (UPQC)**: Shunt and series compensation using UPQC. Enhancing power quality through integrated solutions.	7	14
6	**Hybrid Custom Power Devices**: Combining active and passive techniques for optimal power quality improvement.	6	14
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	30	20	20	10	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques" (John Wiley & Sons Ltd., U.K., 2015).
2. C.Sankaran, "Power Quality" (CRC Press, 2002)
3. J. Schaefer, "Rectifier Circuits, Theory and Design" (John Wiley & Sons, New York, 1965).
4. T.J.E. Miller, "Reactive Power Control in Electric Systems" (John Wiley & Sons, Toronto, 1982).
5. R.M. Mathur, "Static Compensators for Reactive Power Control" (Contexts Publications, Winnipeg, Canada, 1984).
6. G. Seguier, "Power Electronic Converters-AC/DC Conversion" (McGraw-Hill, 1986).

(b) Open source software and website:

1.NPTEL (National Programme on Technology Enhanced Learning) course on

- Power Quality Improvement Techniques by Prof. G. Bhuvaneswari
- Power Quality by Prof. Bhim Singh

Suggested Course Practical List:

It is suggested to engage students in the following activities as per resources available.

1. Prepare simulation on Voltage Sag and swell.

2. Harmonic Analysis- Prepare simulation/ use a power quality analyzer to measure harmonics in electrical signals from various sources (like non-linear loads or renewable energy systems).

3. Power Factor Correction- Design and implement a small-scale power factor correction circuit using capacitors.

4. Transient Voltage Analysis- Use DSO to capture and analyze transient voltage spikes or surges.

5. Electromagnetic Interference (EMI) Investigation – Study electromagnetic interference generated by various electronic devices. Discuss mitigation techniques to reduce EMI and improve power quality.

6. Power Quality Monitoring-Set up a power quality monitoring system using a data logger or power quality analyzer. Collect data over time to analyze trends, identify disturbances, and propose solutions to improve power quality.

7. Power Quality Case Studies- Analyze real-world case studies where power quality issues have impacted industrial or residential systems. Discuss the root causes, diagnostic methods, and solutions implemented to resolve the issues.

8. Power Quality Standards and Regulations – Prepare presentation on international standards (e.g., IEEE, IEC) related to power quality. Discuss how these standards influence design, operation, and maintenance of electrical systems.

9. Field Trips or Guest Speakers- Organize visits to power plants, substations, or industries where power quality issues are actively managed.

10. Capstone Project on Power Quality Improvement- Assign a capstone project where students design and implement a solution to improve power quality in a specific scenario (e.g., residential area with voltage sags, industrial facility with harmonics).

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