Name of Faculty	:	Faculty of Engineering & Technology
Name of Program	:	Master of Technology (M. Tech)
Course Code	:	2MPS03
Course Title	:	Power Quality
Type of Course	:	Programme Elective (PE)
Year of Introduction	:	2023-24

Prerequisite	:	Power Quality Management
Course Objective	:	The short-duration transient disturbances, along with the stationary harmonics have become very common due to the increased use of power electronic switches. The proliferated use of such devices worsens the quality of power further. Both utility and consumers are equally responsible for poor power quality and hence power quality parameters need to be monitored, assessed, and mitigated based on data acquired. This course would make the students aware of the various issues affecting the power quality as well as techniques available to improve the quality of power.
Course Outcomes	:	At the end of this course, students will be able to:
	CO1	**To Remember** the harmonics, harmonic introducing devices, and the effect of Harmonics on system equipment and loads.
	CO2	**To Understand** the active power factor correction based on static VAR compensators and their control techniques.
	CO3	**To Analyse** series and shunt active power filtering techniques for harmonics.
	CO4	**To Create** analytical modelling skills needed for modelling and analysis of harmonics in networks and components.

Teaching and Examination Scheme

Teaching Scheme (Contact Hours)			Credits	Examination Marks				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	SEE	CIA	SEE	CIA	
3	0	2	4	70	30	30	20	150

*Legends: **L**-Lecture; **T**–Tutorial/Teacher Guided Theory Practice; **P** – Practical, **C** – Credit, **SEE** – Semester End Examination, **CIA** - Continuous Internal Assessment (It consists of Assignments/Seminars/Presentations/MCQ Tests, etc.))*

Course Content

Unit No.	Topics	Teaching Hours	Weightage	Mapping with CO
1	**Introduction to Power Quality:** Introduction-power quality-voltage quality-overview of power Quality phenomena	10	22%	CO1

	classification of power quality issues. Power quality measures and standards-THD-TIF-DIN-C-message weights. Responsibility of supplier and users of elect power Quality Susceptibility Criteria. Flicker factor transient phenomena-occurrence of power quality problems. Power Quality Standards and recommended practices.			
2	**Transient Disturbances:** Modelling of networks and components under non-sinusoidal conditions. Transmission and distribution systems. Transient system model. Examples of models & responses.	07	15%	CO2
3	**Harmonics**: Types and causes of transients Harmonics-individual and total harmonic distortion, Triple harmonics, effect of harmonic distortion. Causes and Effects of harmonics. Important harmonic introducing devices; SMPS, three phase power converters, arcing devices, saturable devices, other nonlinear loads. Guidelines for harmonic voltage & current limitation, Harmonic current mitigation. Harmonic Signatures of Non-linear Loads; fluorescent lamps, LED lamps, controlled & uncontrolled rectifiers	10	22%	CO1
4	**Harmonic Mitigation** Harmonic Filters, Devices for Controlling Harmonic Distortion, Standards of Harmonics, Active Harmonic Filters, Passive Harmonic Filters, Types, Ac network impedance, Design of filters – single tuned, double tuned & damped filter, filter component ratings Dynamic Voltage Restorers for sag, swell and flicker problems	06	14%	CO3, CO4
5	**Power Factor Improvement** Effects of poor Power Factor, Power factor penalty, voltage rise due to capacitance, Power factor improvement- Passive Compensation, Passive Filtering, Harmonic Resonance, Impedance Scan Analysis. Active Power Factor Corrected Single Phase Front End. Control Methods for Single Phase APFC. Three Phase APFC and Control Techniques. PFC based on Bilateral Single Phase and Three Phase Converter.	06	14%	CO2
6	**Grounding & Bonding** Grounding and wiring introduction, NEC grounding requirements-reasons for grounding, Typical grounding and wiring	06	13%	CO4

	problems solutions to grounding and wiring problems, Ground electrodes, Earth resistance tests, Earth ground grid system, Power Ground system, Signal reference ground and methods, Single and multi-point grounding, Ground loops			

Suggested Distribution of Theory Marks Using Bloom's Taxonomy						
Level	Remembrance	Understanding	Application	Analyse	Evaluate	Create
Weightage	**30**	**20**	**10**	**20**	**10**	**10**

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

Suggested List of Experiments/Tutorials

Sr. No.	Name of Experiment/Tutorial	Teaching Hours
1	Evaluate the impact of various non-linear loads on utility by using simulation software	02
2	Analysis of input current in rectifier with and without capacitor at output of rectifier.	02
3	Harmonics analysis of input current in induction motor with and without load.	02
4	Power Factor improvement by using passive filter.	02
5	Determine input displacement and true power factor in non-linear load	02
6	Comparison of input power factor in case of AC- DC converter	02
7	Transient Response Analysis of RLC circuits.	02
8	Simulate the phenomena of voltage sag due to sudden starting of large induction motor.	02

Major Equipment/ Instruments and Software Required

Sr. No.	Name of Major Equipment/ Instruments and Software
1	Power Quality Analyzer
2	True RMS Meter
3	Digital Storage
4	Clamp-on Power meter
5	Oscilloscope
6	MATLAB

Suggested Learning Websites

Sr. No.	Name of Website
1	NPTEL- http://nptel.ac.in/
2	https://pqs.schaffner.com

Reference Books

Sr. No.	Name of Reference Books
1	J. Arrillaga, "Power System Quality Assessment", John wiley, 2000
2	Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000.
3	G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
4	J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley, 1997