GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (09)
POWER QUALITY AND MANAGEMENT
SUBJECT CODE: 2180911
B.E. 8th SEMESTER

Type of course: Power Quality and Management, Electrical Engineering

Prerequisite: Fundamentals of Power Systems and Power Electronics

Rationale: Quality of power can have direct impact on many industrial consumers**.** There has recently been a great emphasis on revitalizing industry with more automation and more modern equipment. This usually means electronically controlled, energy-efficient equipment that is often much more sensitive to deviations in the supply voltage. This worsens the quality of power. The electric utility is concerned about power quality issues as well. This course would make the students aware about the various issues affecting the power quality as well as techniques available to improve the quality of power

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs.	% Wtg.
1.	**Introduction to Power Quality:** Definition of power Quality, power quality terminology, power quality issues, Susceptibility Criteria, Responsibility of supplier and users of elect power, Standards	**3**	**8**
2.	**Power Frequency Disturbance:** Common power frequency disturbances, voltage sags, cures of low frequency disturbances, voltage tolerance	**3**	**10**
3.	**Electrical Transients:** Transient system model, Examples of models & response, Types and causes of transients, Examples of transient wave forms	**4**	**10**
4.	**Harmonics:** Definition , number, odd and even harmonics, causes of harmonics, Individual & total distortion, Harmonics signatures, Effect of harmonics, Guide lines for harmonic voltage & current limitation, Harmonic current mitigation	**6**	**12**
5.	**Grounding & Bonding:** Introduction, National electric code grounding requirements, Essentials of grounding system, Ground electrodes, Earth resistance tests, Earth ground grid system, Power Ground system, Signal reference ground, Signal reference ground methods, Single and multi-point grounding, Ground loops	**5**	**12**
6.	**Power Factor:** Introduction, Active and Reactive power, Displacement and true power factor, power factor improvement, correction, penalty, voltage rise due to capacitance, application of synchronous condensers and static VAR compensators	**3**	**8**

7.	**Electromagnetic Interference:** Electric and magnetic fields, Electromagnetic interference terminology, Power frequency fields, High frequency interference, EMI Mitigation, Cable shielding to minimize EMI, Health concerns of EMI	**6**	**14**
8.	**Power Quality Measurement:** Power quality measurement devices, power quality measurements, Number of test locations, Test duration, Instrument set-up, Instrument set up guidelines.	**6**	**14**
9.	**Distributed Generation and Power Quality:** Resurgence of DG, DG technologies, Interface to the utility system, Power quality issues, Operating conflicts,	**6**	**12**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
10	40	30	10	10	-

Reference Books:

1. Power Quality by C.Sankaran, CRC publication
2. Electrical Power Systems Quality by Roger C.Dugan , TMH publication
3. Harmonics and Power Systems by Francisco C. De La Rosa, CRC Publication

Course Outcome:

After learning the course the students will be able to

- Understand the major power quality problems.
- Use equipment that are required to measure the quality of power
- Apply and analyze/compare techniques available to mitigate power quality problems.

Suggested list of experiments:

1) Study and calculation of THD and IHD of various types of non-linear loads
2) Power factor improvement using static VAR compensators
3) Measurement of current harmonics using current probe
4) Measurement of high frequency noise with oscilloscopes having high sampling rates
5) Measurement of true RMS value of voltage and current using true RMS meters
6) Measurement of magnetic and electric field using low frequency electromagnetic field meter
7) Study of harmonic distortion limits in agreement with IEEE 519
8) Study of power quality monitoring standards such as IEEE 1159 and IEC 61000-4-30

Design based Problems (DP)/Open Ended Problem

Students can carry out analysis of harmonics generated due to non-linear loads. The analysis of harmonics may be also simulated using MATLAB or PSCAD.

Major Equipments:

1) Current probe for measuring current harmonics
2) True RMS meter
3) Spectrum analyzer

4) Oscilloscope with high sampling rate
5) Data loggers and chart recorders
6) Low frequency electromagnetic field meter
7) MATLAB for simulation of harmonics generated by non-linear loads

List of Open Source Software/learning website:

Learning resource by nptel, http://nptel.ac.in/courses/108106025/ Power quality in power distribution systems, Dr. Mahesh Kumar, IIT Madras

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.