SCHEME OF COURSE WORK

Course Details:

Course Title	**:Power Quality Management**		
Course Code	**: 13EE2111**	**L T P C**	**:4 0 0 3**
Program:	**: M. Tech.**		
Specialization:	**: Power System Control and Automation**		
Semester	**: II**		
Prerequisites	**:** Basic knowledge in Electrical Networks, Machines, Power Electronics.		
Courses to which it is a prerequisite	**: --**		

Course Outcomes (COs): At the end of the course**,** the student will be able to:

1	Define different power quality issues and describe causes and mitigation of harmonics.
2	Describe Causes, effects of long and short interruptions
3	Analyze Sags and phase angle jumps in different types of faults.
4	Describe various equipment's behavior with voltage sags.
5	Discuss various interfacing devices to mitigate the sags and Interruptions.

Program Outcomes (POs):

The programme outcomes are achieved through the following means:

1	The graduate will be able to acquire in depth knowledge in the area of power system control and automation.
2	The graduate will attain the ability to think critically and analyze complex engineering problems related to power system control and automation.
3	The graduate will obtain the capability of problem solving and original thinking to arrive at feasible and optimal solutions considering societal and environmental factors.
4	The graduate will be able to extract information through literature survey and apply appropriate research methodologies, techniques and tools to solve power system problems.
5	The graduate will be able to use the state-of-the-art tools for modeling, simulation and analysis of problems related to power systems.
6	The graduate will attain the capability to contribute positively to collaborative and multidisciplinary research to achieve common goals.
7	The graduate will demonstrate knowledge and understanding of power system engineering and management principles and apply the same for efficiently carrying out projects with due consideration to economical and financial factors.
8	The graduate will be able to communicate confidently, make effective presentations and write good reports to engineering community and society.
9	The graduate will recognize the need for life-long learning and have the ability to do it independently.
10	The graduate will become socially responsible and follow ethical practices to contribute to the community for sustainable development of society.
11	The graduate will be able to independently observe and examine critically the outcomes of his actions and reflect on to make corrective measures subsequently and move forward positively by learning through mistakes.

Course Outcome versus **Program Outcomes:**

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**P11**
CO-1	S	S	S	S	M	W	W	M	M	W	M
CO-2	S	S	S	S	S	S	M	M	M	W	S
CO-3	S	S	S	S	S	M	W	W	W	M	W
CO-4	S	S	S	S	S	M	M	M	M	W	S
CO-5	S	S	S	S	S	S	W	M	M	W	M

S - Strongly correlated, *M - Moderately* correlated, *Blank - No correlation*

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample questions	TEACHING-LEARNING STRATEGY	Assessment Method & Schedule
1	UNIT-I: INTRODUCTION AND HARMONICS: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption	CO-1	Define the following terms: 1. Sag 2. Swell 3. Interruptions	▫ Lecture ▫ Discussion	Mid-Test 1 (Week 9) Seminar (Week 1)
2	Overview of power quality phenomenon. Harmonics: Definition, causes of voltage and current harmonics, individual and total harmonic distortion,	CO-1	Explain the causes of voltage and current harmonics	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 2)
3	effect of harmonics on power system devices, guidelines for harmonic voltage and current limitation, harmonic current mitigation. UNIT-II INTERRUPTIONS: Long Interruptions: Definition – Terminology – causes of Long Interruptions –	CO-1 & CO-2	Explain the causes for Long Interruptions	▫ Lecture ▫ Problem solving	Mid-Test 1 (Week 9) Seminar (Week 3)
4	Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation. Short Interruptions: Definition, origin of short interruptions.	CO-2	Explain the overview of reliability evaluation of Power Systems	▫ Lecture ▫ Problem solving	Mid-Test 1 (Week 9) Seminar (Week 4) Assignment (Week 4)
5	- basic principle, fuses saving, voltage magnitude events due to re-closing, voltage during the interruption; monitoring of short interruptions - difference between medium and low voltage systems, Multiple events;	CO-2	What is meant by fuse Saving?	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 5)
6	single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.	CO-2	Derive the voltage and current during fault period in a single phase tripping?	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 6)
7	UNIT-III VOLTAGE SAGS – CHARACTERIZATION – SINGLE PHASE AND THREE PHASES: Voltage sag – definition, causes of voltage sag, voltage sag magnitude - monitoring, theoretical calculation of voltage sag magnitude,	CO-3	Define Voltage Sag? Explain the theoretical calculations of voltage sag?.	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 7)
8	voltage sag calculation in non-radial systems, meshed systems; voltage sag duration.	CO-3	Calculate the voltage sag in Non-radial systems?	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 8) Assignment (Week 8)
9	Mid-Test 1				
10	Three phase faults- single phase, phase to phase, phase to ground faults;	CO-3	Calculate the voltage sag due to phase to ground fault of a three phase fault?	▫ Lecture ▫ Discussion	Mid-Test 2 (Week 18) Seminar (Week 9)
11	phase angle jumps- theoretical calculations; magnitude and phase angle jumps- phase to phase, single phase, two phase to ground	CO-3	Calculate the phase angle jump due to phase to phase fault?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 10)
12	for three phase unbalanced sags, load influence on voltage sags	CO-3	Explain the influence of load on voltage sags?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 11)
13	UNIT-IV VOLTAGE SAGS – EQUIPMENT BEHAVIOR: Voltage tolerance, computers, consumer electronics, adjustable speed AC drives and its	CO-4	Explain the voltage sag due to behavior of the computers, electronic loads, drives?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 12)

	operation. Mitigation methods of AC Drives,				
14	adjustable speed DC drives and its operation, mitigation methods of DC drives other sensitive loads.	CO-4	Explain the mitigation methods of Adjustable speed DC drives?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 13)
15	UNIT-V MITIGATION OF INTERRUPTIONS, VOLTAGE SAGS AND EMC STANDARDS: Overview and ways of mitigation methods, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller-	CO-5	Explain the Series voltage Controller?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 14)
16	basic principle active power injection; shunt controller, combined shunt and series controller.	CO-5	Explain the combined shunt and series controller?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 15)
17	Purpose of standardization, IEC Electromagnetic compatibility standards.	CO-5	Briefly explain the following? 1. Purpose of standardization 2. IEC Electromagnetic compatibility?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 16)
18	Mid-Test 2				
19/20	END EXAM				