SCHEME OF COURSE WORK

Course Details:

Course Title	**:Power Quality**		
Course Code	**: 13EE2214**	**L T P C**	**:4 0 0 3**
Program:	**: M. Tech.**		
Specialization:	**: Power Electronics And Drives**		
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 have knowledge in:

1	Define and understand different power quality issues.
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 a professional workforce in the areas of "Static Power Electronics Converters", "Power Electronic Converter fed Electrical Drives" and "Power Quality".
2	The graduate will be able to apply soft computing techniques for Power Electronic Systems and Electric Drives
3	The graduate will be trained to understand large scale Power Electronic Converter Systems, Electric Drives and issues involved through modeling, analysis and simulation
4	The graduate will be able to apply present day techniques and tools to solve Power electronic and electric drives problems relevant to India and other countries
5	The graduate will be able to use state-of-the-art simulation tools such as PLEXIM, SABER, OPAL-RT Lab, DSPACE, MULTISIM, LABVIEW and other Tools
6	The graduate will be capable of contributing 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 aware of social issues and shall 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/her actions and apply corrective measures subsequently and move forward positively through a self corrective approach

Course Outcome versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S	S	S	S	M	W	W	M	M	M	M
CO-2	S	S	S	S	M	S	M	M	M	S	M
CO-3	S	S	S	S	M	M	W	W	W	S	S
CO-4	S	S	S	S	M	M	M	M	M	S	S
CO-5	S	S	S	S	M	S	W	M	M	S	S

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 EMC STANDARDS: 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. purpose of standardization, IEC electromagnetic compatibility standards, European voltage characteristics	CO-1 & CO-5	Briefly explain the following? 1. Purpose of standardization IEC Electromagnetic compatibility?	▫ Lecture	Mid-Test 1 (Week 9) Seminar (Week 2)
3	UNIT-II LONG INTERRUPTIONS AND SHORT 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 PQ CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS: Voltage sag – equipment behavior of Power	CO-4	Explain the voltage sag due to behavior of the computers, electronic loads, drives?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 12)

	electronic loads, induction motors, synchronous motors, computers, consumer electronics				
14	Adjustable speed AC drives and its operation. Mitigation methods of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.	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: Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods.	CO-5	Explain the Series voltage Controller?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 14)
16	System equipment interface – voltage source converter,	CO-5	Explain the voltage source converter?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 15)
17	Series voltage controller, shunt controller, combined shunt and series controller.	CO-5	Explain the combined shunt and series controller?	▫ Lecture	Mid-Test 2 (Week 18) Seminar (Week 16)
18	Mid-Test 2				
19/20	END EXAM				