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 Electrical Engineering, Power Systems, Power Electronics & Drives.		
Courses to which it is a prerequisite	**: --**		

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

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	Develop in depth knowledge in the areas of "Static Power Electronics Converters", "Power Electronic Converter fed Electrical Drives" and "Power Quality"
2	Apply soft computing techniques for Power Electronic Systems and Electric Drives
3	Understand large scale Power Electronic Converter Systems, Electric Drives and issues involved through Modeling, Analysis and Simulation
4	Apply present day techniques and tools to solve Power electronic and electric drives problems relevant to India and other countries
5	Use state-of-the-art simulation tools such as PLEXIM, SABER, OPAL-RT Lab, DSPACE, MULTISIM, LABVIEW and other Tools
6	Contribute positively to collaborative and multidisciplinary research to achieve common goals
7	Demonstrate knowledge and understanding of power engineering and management principles and apply the same for efficiently carrying out projects with due consideration to economical and financial factors
8	Communicate confidently, make effective presentations and write good reports to engineering community and society
9	Recognize the need for life-long learning and have the ability to do it independently
10	Acquire knowledge on social issues and shall contribute to the community for sustainable development
11	Predict and examine critically the outcomes of actions, 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**	**P11**
CO-1	S	M	M	M	M		M	M	M	M	
CO-2	S	M	M	M	M		M	M	M	M	
CO-3	S	M	M	M	M		M	M	M	M	
CO-4	S	M	M	M	M		M	M	M	M	
CO-5	S	M	M	M	M		M	M	M	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 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 sag, swell, harmonics, spikes, transcients,etc	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 1)
2	overview of power quality phenomenon, purpose of standardization	CO-1	Explain the purpose of standardization.	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 2)
3	IEC electromagnetic compatibility standards, European voltage characteristics.	CO-1	Explain briefly about the European voltage characteristics	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 3)
4	UNIT-II Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption	CO-2	Define Interruption and explain the origin of interruptions	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 4)
5	Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation. Short interruptions – definition, origin of short interruptions,	CO-2	Write a brief note on Reliability evaluation to power quality.	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 5)
6	Basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems.	CO-2	Why single phase tripping is necessary? Describe briefly about the voltage during and after the fault on a power system?	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 6)
7	Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period,	CO-2	Explain briefly about stochastic prediction of short interruptions.	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 7)

	stochastic prediction of short interruptions.				
8	UNIT-III Voltage sag – definition, causes of voltage sag, voltage sag magnitude and monitoring, theoretical calculation of voltage sag magnitude,	CO-3	What are the causes of voltage sag? Explain how sag is calculated theoretically.	○ Lecture ○ Discussion	Mid test-I (Week-9) Seminar (Week – 8)
9	Mid Test – I				
10	voltage sag calculation in non-radial systems, meshed systems and Voltage sag duration.	CO-3	Explain how voltage sag is calculated in non-radial system.	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 10)
11	Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags	CO-3	What is phase angle jump and what are its effects?	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 11)
12	Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors,	CO-4	What are the effects of various equipments on voltage sag?	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 12)
13	computers, consumer electronics, adjustable speed AC drives and its operation.	CO-4	Explain the effect of voltage sag on adjustable speed AC drives and its operation.	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 13)
14	Mitigation methods of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.	CO-4	Explain the mitigation methods of AC and DC drives.	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 14)
15	Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system,	CO-5	How the fault clearing time can be reduced?	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 15)
16	installing mitigation equipment, improving equipment immunity, different events and mitigation methods.	CO-5	How equipment immunity can be improved?	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 16)
17	System equipment interface – voltage source converter, series voltage controller, shunt Controller, combined shunt and series controller.	CO-5	What is voltage source converter? What is the purpose of it? Explain briefly about series voltage controller?	○ Lecture ○ Discussion	Mid test-II (Week-18) Seminar (Week – 17)
18	Mid Test – II				
19/20	END EXAM				