INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**Power Quality**			
Course Code	**BPE210**			
Regulation	**2017 - 2018**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	-	-	3
Course Coordinator	**Dr. P.M.Sarma Professor**			
Team of Instructors	**Dr. P.M.Sarma Professor**			

I. COURSE OVERVIEW:

The course provides basic understanding of importance of power quality, nonlinear loads and methods of improvement of power quality.

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
PG	3	3	Knowledge of voltage fluctuations, frequency variation problems, balanced and unbalanced loads.

III. COURSE ASSESSMENT METHODS:

Marks distribution:

Session Marks	University end Exam Marks	Total Marks
There shall be two continuous internal assessment (CIA). Each continuous internal assessment is for 30 marks, with subjective exam for 25 marks (duration of 2 hours) and 5 marks for technical paper and term paper. Subjective test of each CIA in the semester shall contain Part-A with 5 compulsory question to answer of one mark each and Part-B with 5 questions each carrying 5 marks and to be answer any four questions. The average of two CIA is the final internal marks.	30	100
The external question paper approved by COE contains 5 internal choice questions each carrying 14 marks giving an total of 70 marks and to be answer all 5 questions	70	100

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I CIA examination	2 Hours	25
2	I technical paper and term paper	--	05
3	II CIA examination	2 Hours	25
4	II technical paper and term paper	--	05
5	External examination	3 hours	70

V. COURSE OBJECTIVES:

At the end of the course, the students will be able to:

1. Classify power quality problems
2. Understand the nature of non linear loads
3. Apply time domain and frequency domain methods to analyze steady state and transient error

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Operate and maintain Gas insulated Substation
2. Analyze various Power Quality problems
3. Apply techniques to mitigate Power Quality disturbance and transients
4. Apply techniques to mitigate harmonics

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PO1	**General Knowledge**: An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of Electrical Engineering.	S	Discussion
PO2	**Problem Analysis**: An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.	H	Assignments
PO3	**Design / Development of Solutions**: To develop Broad theoretical knowledge in Electrical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving electrical power.	H	--
PO4	**Conduct Investigations of Complex Problems**: An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/commission complete systems involving generation, transmission and distribution of electrical energy.	S	Discussion
PO5	**Modern tool usage:** An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions.	H	Discussion ,Assignment
PO6	**The Engineer and Society:** An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs.	N	--

PO7	**Environment and Sustainability:** An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability	S	--
PO8	**Ethics:** To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources.	N	--
PO9	**Individual and Team Work:** An Ability to design schemes involving signal sensing and processing leading to decision making for real time electrical engineering systems and processes at individual and team levels	S	Discussion ,Assignment
PO10	**Communication:** an Ability to work in a team and comprehend his/her scope of work, deliverables , issues and be able to communicate both in verbal ,written for effective technical presentation.	N	--
PO11	**Life-long Learning:** An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	S	Discussion ,Seminar
PO12	**Project Management and Finance**: To be familiar with project management problems and basic financial principles for a multi-disciplinary work.	S	Discussion ,Seminar

N= None S=Supportive H=Highly related

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	N	--
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	S	Discussion ,Assignment, seminar
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	S	Discussion ,Assignment, seminar

N – None **S - Supportive** **H- Highly Related**

IX. SYLLABUS:

UNIT I
INTRODUCTION

Introduction: Characterization of electric power quality, transients, short duration and long duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power frequency variation, power acceptability curves; Power quality problems: Poor load power factor, non linear and unbalanced loads, DC offset in loads, notching in load voltage, disturbance in supply voltage, power quality standards.

UNIT II
NONLINEAR LOADS

Non linear loads: Single phase static and rotating AC / DC converters, three phase static AC / DC converters, battery chargers, arc furnaces, fluorescent lighting, pulse modulated devices, adjustable speed drives.

UNIT III
MEASUREMENT AND ANALYSIS METHODS

Measurement: Voltage, current, power and energy measurements, power factor measurements and definitions, event recorders, Measurement. Error Analysis: Analysis in the periodic steady state, time domain methods; Frequency domain methods: Laplace's, Fourier and Hartley transform, the Walsh transform, wavelet transform

UNIT IV
ANALYSIS AND CONVENTIONAL MITIGATION METHODS

Analysis of power outages, analysis of unbalance, symmetrical components of phasor quantities, instantaneous symmetrical components, instantaneous real and reactive powers; Analysis of distortion: Online extraction of fundamental sequence components from measured samples, harmonic indices; Analysis of voltage sag: Detroit Edison sag score, voltage sag energy, voltage sag lost energy index (VSLEI), analysis of voltage flicker, reduced duration and customer impact of outages; Classical load balancing problem: Open loop balancing, closed loop balancing, current balancing, harmonic reduction, voltage sag reduction.

UNIT V
AC POWER SUPPLIES

Power quality improvement: Utility, customer interface, harmonic filters, passive, active and hybrid filters; Custom power devices: Network reconfiguring devices, load compensation using DSTATCOM, voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC; Control strategies: P-Q theory, synchronous detection method, custom power park, status of application of custom power devices.

Text books:

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 1st Edition, 2002.
2. G.T.Heydt, "Electric Power Quality", Stars in Circle Publications, 2nd Edition, 1994.
3. Jos Arrillaga, Neville R. Watson, "Power system harmonics", Wiley, 2nd Edition, 2003.

References:

1. R.C. Duggan, Mark F. McGranaghan, "Electrical Power Systems Quality", Wiley, 3rd Edition, 2012.
2. Derek A. Paice, "Power electronic converter harmonics", Wiley, 1st Edition, 1999.

X. COURSE PLAN:

The course plan is meant as a guideline. There may be probably be changes.

Lecture No.	Topics to be Covered	Course Learning Objectives	Reference
1	Introduction of power quality, Characterization of electric power quality	Understand power quality	T1T2
2	Transients, short and long duration voltage variations	understand Characterization of power quality	T1T2
3	voltage imbalance, waveform distortion, voltage fluctuations	Analyse of waveform distortion, voltage fluctuations	T1T2
4	power frequency variation, power acceptability curves	Understand the power acceptability curves	T1T2
5	Power quality problems	Analyse Power quality problems	T1T2
6	Poor load power factor	Problems of Poor load power factor	T1T2
7	non linear and unbalanced loads, DC offset in loads	Understand non linear loads and unbalance conditions	T1T2
8	notching in load voltage, disturbance in supply voltage	Analyse of notching and disturbances in supply voltage	T1T2
9	power quality standards	Understand power quality standarda	T1T2
10	Non linear loads	Understand Behavior of non linear loads	T1T2
11	Single phase static and rotating AC / DC converters	Understand single phase static and rotating converters	T1T2
12	three phase static AC / DC converters	Understand three phase static and rotating converters	T1T2
13	battery chargers	Knowledge of battery chargers	T1T2
14	arc furnaces	Analyse Types of arc furnaces	T1T2
15	fluorescent lighting	Advantages of fluorescent lighting	T1T2
16	pulse modulated devices	Understand working of pulse modulated devices	T1T2
17	adjustable speed drives	Application of adjustable speed drives	T1T2
18	Measurement of Voltage, current	Understand the Measurement of Voltage, current	T1T2
19	power and energy measurements	Understand the power and energy measurements	T1T2
18,19	power factor measurements and definitions	Understand power factor and its measurement	T1T2

20	event recorders, Error Analysis	Knowledge of event recorders and error analysis	T1T2
21	Error analysis in the periodic steady state	Calculation of error analysis for a periodic steady state waveform	T1T2
22	Error analysis by time domain methods	Calculation of error analysis by time domain methods	T1T2
23	Frequency domain methods	Analysis of Frequency domain methods	T1T2
24,25	Laplace‟s, Fourier transform, Hartley transform	Understand the application of Laplace‟s, Fourier transform, Hartley transform	T1T2
26	Walsh transform, wavelet transform	Understand the application of Walsh transform, wavelet transform	T1T2
27	Analysis of power outages, Analysis of unbalance	Problems of power outages, Analysis of unbalance	T1T2
28	symmetrical components of phasor quantities	Analyse the symmetrical components of phasor quantities	T1T2
29	instantaneous symmetrical components	Analyse the instantaneous symmetrical components	T1T2
30	instantaneous real and reactive powers	Analyse the instantaneous real and reactive powers	T1T2
31,32	Analysis of distortion: Online extraction of fundamental sequence components from measured samples	Online extraction of fundamental sequence components from measured samples	T1T2
33	harmonic indices; Analysis of voltage sag	Understand harmonic indices; Analysis of voltage sag	T1T2
34	Detorit Edison sag score, voltage sag energy, voltage sag lost energy index (VSLEI)	Understand the Detorit Edison sag score, voltage sag energy, voltage sag lost energy index (VSLEI)	T1T2
35	analysis of voltage flicker, reduced duration and customer impact of outages	Understand voltage flicker	T1T2
36	Classical load balancing problem: Open loop balancing, closed loop balancing	Analysis of Classical load balancing problem	T1T2
37	current balancing, harmonic reduction, voltage sag reduction	Understand current balancing, harmonic reducction techniques	T1T2
38	Power quality improvement: Utility, customer interface	Understand the utility and customer interface	T1T2
39	harmonic filters, passive, active and hybrid filters	Understand techniques of harmonic filters, passive, active and hybrid filters	T1T2
40	Custom power devices: Network reconfiguring devices	Analysis of Network reconfiguring devices	T1T2
41	load compensation using DSTATCOM, voltage regulation using DSTATCOM	Understand the load compensation using DSTATCOM, voltage regulation using DSTATCOM	T1T2
42	protecting sensitive loads using DVR, UPQC;Control strategies: P-Q	Analysis of protecting sensitive loads using DVR, UPQC;Control strategies:	T1T2

	theory	P-Q theory	
43	synchronous detection method custom power park, status of application of custom power devices	Understand the synchronous detection method	T1T2
44	Problems	Problem solving of power quality	T1T2
45	Revision	revision	T1T2

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
I			H	S			S								S
II				H	H				S					S	S
III			H								S	S			S

S=Supportive H=Highly related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	S			S			S								S
2		H			H				S					S	S
3			H								S	S			S

S=Supportive H=Highly related

Prepared by: Dr. P.M. Sarma Professor