INSTITUTE OF AERONAUTICAL ENGINEERING

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**DC to AC Converters**			
Course Code	**BPE005**			
Regulation	**2017 - 2018**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	-	-	3
Course Coordinator	**Mr. P Shiva Kumar, Assistant Professor**			
Team of Instructors	**Mr. P Shiva Kumar, Assistant Professor**			

I. COURSE OVERVIEW:

The course provides basic understanding of main principles of three phase PWM inverters, resonant pulse inverters, multilevel inverters and their applications

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
PG	3	3	Knowledge of three phase inverters, resonance pulse inverters and multilevel inverters

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. Analyze the operation of three phase PWM inverters
2. Analyze the operation of resonant pulse inverters and applications
3. Understand Design and classifications of Multilevel inverters

VI. COURSE OUTCOMES:

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

1. Students will able to understand operation of three phase PWM inverters
2. Student can Analyze the operation of resonant pulse inverters and applications
3. Student can understand design Analysis of Multilevel inverters

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
PWM INVERTERS (SINGLE PHASE AND THREE PHASE)

PWM Inverters: Principle of operation, performance parameters, single phase bridge inverter, evaluation of output voltage and current with resistive, inductive and capacitive loads, voltage control of single phase inverters, single PWM, multiple PWM, sinusoidal PWM, modified PWM, phase displacement control, advanced modulation techniques for improved performance, trapezoidal, staircase, stepped, harmonic injection and delta modulations, advantages, applications and numerical problems. Three phase inverters, analysis of 180 degree condition for output voltage and current with resistive, inductive loads, analysis of 120 degree conduction, voltage control of three phase inverters, sinusoidal PWM, third harmonic PWM, 60 degree PWM, space vector modulation, comparison of PWM techniques, harmonic reductions, current source inverter, variable DC link inverter, buck and boost inverter, inverter circuit design, advantages, applications and numerical problems.

UNIT II
RESONANT PULSE INVERTERS

Resonant pulse inverters: Series resonant inverters, series resonant inverters with unidirectional switches, series resonant inverters with bidirectional switches, analysis of half bridge resonant inverter, evaluation of currents and voltages of a simple resonant inverter, analysis of half bridge and full bridge resonant inverter with bidirectional switches, frequency response of series resonant inverters, for series loaded inverter, for parallel loaded inverter, for series and parallel loaded inverters parallel resonant inverters, voltage control of resonant inverters, class E inverter and class E rectifier, numerical problems. resonant converters: Resonant converters, zero current switching resonant converters, L type ZCS resonant converter, M type ZCS resonant converter, zero voltage switching resonant converters, comparison between ZCS and ZVS resonant converters, two quadrant ZVS resonant converters, resonant DC link inverters, evaluation of L and C for a zero current switching inverter and numerical problems.

UNITIII
MULTILEVEL INVERTERS

Multilevel concept: Classification of multilevel inverters, diode clamped multilevel inverter, principle of operation, main features, improved diode clamped inverter, principle of operation, flying capacitors multilevel inverter, principle of operation and main features.
Cascaded multilevel inverter: Principle of operation, main features, multilevel inverter applications, reactive power compensation, back to back inertia system, adjustable drives, switching device currents, DC link capacitor voltage balancing, features of multilevel inverters, comparisons of multilevel converters.

UNIT IV
DC POWER SUPPLIES

DC power supplies: Classification, switched mode DC power supplies, fly back converter, forward converter, push pull converter, half bridge converter, full bridge converter, resonant DC power supply, bidirectional power supplies and applications.

UNIT V AC POWER SUPPLIES

AC power supplies: Classification, switched mode ac power supplies, resonant AC power supplies bidirectional ac power supplies, multistage conversions, control circuits, applications, power line disturbances, power conditioners, uninterruptible power supplies and applications.

Text books:

1. Mohammed H. Rashid, "Power Electronics", Pearson Education, 3rd Edition, 1985.

2. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics", John Wiley and Sons Publications, 3rd Edition, 2006.

References:

1. R. Krishnan, "Electric Motor Drives Modeling, Analysis and Control", Pearson Publications, 1st Edition, 2002.
2. B K Bose, Modern Power Electronics and AC Drives", Pearson Publications, 1st Edition, 2002.

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 PWM Inverters	Introduction of PWM Inverters	T1T2
2	performance parameters	understand performance parameters	T1T2
3	single phase bridge inverter	Principle of single phase bridge inverter	T1T2
4	evaluation of output voltage and current with resistive, inductive and capacitive loads	Calculation of evaluation of output voltage and current with resistive, inductive and capacitive loads	T1T2
5	voltage control of single phase inverters	Working of voltage control of single phase inverters	T1T2
6	single PWM, multiple PWM, sinusoidal PWM	Understanding of single PWM, multiple PWM, sinusoidal PWM	T1T2
7	phase displacement control	Working of phase displacement control	T1T2
8	Advanced modulation techniques for improved performance	Learning of Advanced modulation techniques for improved performance	T1T2
9	Trapezoidal, staircase, stepped, harmonic injection and delta modulations	Understanding of modulation techniques	T1T2
10	Advantages and applications	Advantages and applications	T1T2
11	Numerical problems.	Numerical problems.	T1T2
12	Three phase inverters	Introduction of Three phase inverters	T1T2
13	Analysis of 180 degree condition for output voltage and current with resistive, inductive loads	Operation with resistive, inductive loads	T1T2

14	Analysis of 120 degree conduction	Understanding of 120 degree conduction wave forms	T1T2
15	voltage control of three phase inverters	Analyze working of three phase inverters	T1T2
16	60 degree PWM	Understanding of 60 degree PWM operation	T1T2
17	space vector modulation, comparison of PWM techniques	Understanding of PWM techniques	T1T2
18	harmonic reductions, current source inverter, variable DC link inverter	Learning of harmonic reduction techniques	T1T2
19	buck and boost inverter, inverter circuit design	Understanding the operation of buck and boost inverter	T1T2
20	Advantages, applications and numerical problems.	Understanding of applications	T1T2
21	Resonant pulse inverters	Analyze working of Resonant pulse inverters	T1T2
22	Series resonant inverters, series resonant inverters with unidirectional switches	Analyze working of series resonant inverters	T1T2
23	series resonant inverters with bidirectional switches, analysis of half bridge resonant inverter	Analyze working of half bridge resonant inverter	T1T2
24	Analysis of half bridge and full bridge resonant inverter with bidirectional switches	Analyze working of full bridge resonant inverter	T1T2
25	frequency response of series resonant inverters, for series loaded inverter	Understand frequency response of series resonant inverters	T1T2
26	class E inverter and class E rectifier, resonant converters	Analyze working of class E inverter and rectifier	T1T2
27	Numerical problems.	Numerical problems	T1T2
28, 29	ZCS resonant converter, M type ZCS resonant converter, two quadrant ZVS resonant converters, resonant DC link inverters	Analyze working ZCS and ZVS resonant converter	T1T2
30	zero voltage switching resonant converters, comparison between ZCS and ZVS resonant converters,	Understanding of comparison between ZCS and ZVS resonant converters,	T1T2
31	DC power supplies Classification	Understanding of DC power supplies Classification	T1T2
32	switched mode DC power supplies	Analyze working switched mode DC power supplies	T1T2
33	fly back converter, forward converter,	Introduction of fly back converter	T1T2

34	push pull converter, half bridge converter,	Introduction of push pull converter	T1T2
35	full bridge converter	Introduction of full bridge converter	T1T2
35	resonant DC power supply,	Introduction of resonant DC power supply	T1T2
36	bidirectional power supplies and application	Working of bidirectional power supplies	T1T2
37	AC power supplies: Classification	Introduction of AC power supplies Classification	T1T2
38	switched mode ac power supplies	Introduction of switched mode ac power supplies	T1T2
39	resonant AC power supplies	Introduction of resonant AC power supplies	T1T2
40	bidirectional ac power supplies	Understanding of bidirectional ac power supplies	T1T2
41	multistage conversions	Introduction of multistage conversions	T1T2
42	control circuits applications	Introduction of control circuits applications	T1T2
43	power line disturbances	Introduction of power line disturbances	T1T2
44	power conditioners	Introduction of power conditioners	T1T2
45	uninterruptible power supplies and applications	Introduction of uninterruptible power supplies	T1T2
46	Numerical problems	Numerical problems	T1T2
47	quarries	quarries	T1T2
48	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

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Prepared by: P Shiva Kumar, Assistant Professor

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