



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

ELECTRICAL AND ELECTRONICS ENGINEERING

TUTORIAL QUESTION BANK

Course Title	POWER ELECTRONICS				
Course Code	AEE010				
Programme	B.Tech				
Semester	V	EEE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lectures	Tutorials	Credits	Laboratory	Credits
	3	1	4	3	2
Chief Coordinator	Mr. S. Srikanth, Assistant Professor				
Course Faculty	Dr. T. Devaraju, Professor Mr. S. Srikanth, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to:

I	Integrate the revolutionary development in power transmission, distribution and utilization with the advent of semiconductor devices.
II	Demonstrate rectifiers, choppers and various schemes of pulse width modulated inverters.
III	Explain AC voltage converters and cycloconverters
IV	Outline complete range of power supplies, including switched mode and uninterruptible power supplies.

COURSE OUTCOMES (COs):

CO 1	Describe the characteristics of basic elements, turn on and turn off methods of SCR, protection, ratings of SCRs and series parallel operations of SCRs.
CO 2	Discuss the operation of single phase, three phase rectifiers and single phase, three phase dual converters.
CO 3	Analyze the principle of operation of AC voltage controllers and cycloconverters
CO 4	Discuss the principle of operation of chopper, classification of choppers, AC chopper and switched mode regulators
CO 5	Describe the operation of series, parallel inverters, single phase inverters, three phase inverters, voltage source inverters and current source inverters

COURSE LEARNING OUTCOMES (CLOs):

AEE010.01	Understand the characteristics of basic elements of power electronics
AEE010.02	Understand the turn on and turn off methods of Silicon controlled rectifier
AEE010.03	Describe the protection, series parallel and ratings of thyristors
AEE010.04	Understand the operation of single phase rectifiers with different loads
AEE010.05	Understand the operation of three phase rectifiers with different loads
AEE010.06	Describe the operation of single phase and three phase dual converter
AEE010.07	Understand the principle of operation of AC voltage controller and modes of operation
AEE010.08	Compute input power factor, total harmonic distortion of various input and output waveforms of AC voltage controllers
AEE010.09	Describe the principle of operation and classification of cycloconverters.
AEE010.10	Understand the principle of operation and control strategies of chopper
AEE010.11	Describe the classification of choppers
AEE010.12	Describe the importance of AC chopper and switched mode regulators
AEE010.13	Understand the concept of single phase voltage source inverters and waveforms
AEE010.14	Understand the principle of operation of three phase voltage source inverters and waveforms
AEE010.15	Understand the principle of operation of current source inverters and waveforms
AEE010.16	Apply the concept of power electronics and converters to solve real time world applications
AEE010.17	Explore the knowledge and skills of employability to succeed in national and international level competitive examinations

TUTORIAL QUESTION BANK

UNIT – I				
POWER SEMICONDUCTOR DEVICES AND COMMUTATION CIRCUITS				
Part - A(Short Answer Questions)				
S No	QUESTION	Blooms taxonomy level	Course Outcomes	Course Learning Outcomes
1	List out differences between power diode and signal diode.	Remember	CO1	AEE010.01
2	Define latching current & holding current of a Silicon Controlled Rectifier.	Remember	CO1	AEE010.01
3	Describe the function of Snubber circuit.	Remember	CO1	AEE010.03
4	List the turn on method of Silicon Controlled Rectifier.	Remember	CO1	AEE010.02
5	Draw the static V-I characteristics of Silicon Controlled Rectifier and mark Latching current and holding current	Understand	CO1	AEE010.01
6	Define string efficiency of Silicon Controlled Rectifiers connected in series	Remember	CO1	AEE010.04
7	List the advantages of pulse triggering over RC triggering	Remember	CO1	AEE010.02
8	Classify the firing circuits for line commutated converter	Understand	CO1	AEE010.02
9	Define commutation	Remember	CO1	AEE010.02
10	Define natural commutation	Understand	CO1	AEE010.02
11	Define forced commutation	Understand	CO1	AEE010.02
12	List the various forced commutation techniques used to turn off Silicon Controlled Rectifier.	Remember	CO1	AEE010.02
13	Draw the static V-I characteristics of MOSFET	Understand	CO1	AEE010.01
14	List out the losses occur in a thyristor during working conditions	Understand	CO1	AEE010.02
Part - B (Long Answer Questions)				
1	a) Discuss the different modes of operation of thyristor with the help of its static V-I characteristics. b) Draw the basic structure of an IGBT and explain its operation.	Understand	CO1	AEE010.01
2	a) Explain the structure and operation of turn on and turn off characteristics of SCR. b) Describe the any two methods of turn-on mechanism of SCR.	Understand	CO1	AEE010.02
3	a) Explain the switching performance of BJT with relevant waveforms indicating clearly the turn on, turn off times and their components. b) Compare the performance characteristics of MOSFET with BJT.	Understand	CO1	AEE010.01
4	Define commutation. Classify the different types of commutation techniques. Discuss and differentiate the natural commutation and forced commutation.	Understand	CO1	AEE010.02
5	Draw the two transistor model of SCR and derive an expression for anode current.	Analyze	CO1	AEE010.01
6	Describe triggering of SCR. classify the different types of triggering circuits. Briefly discuss the R-C triggering and UJT triggering of SCR.	Understand	CO1	AEE010.02
7	Explain the static and dynamic characteristics of SCR	Understand	CO1	AEE010.02
8	a) Explain the necessity of series and parallel connection of SCRs. b) What is String efficiency in series and parallel connections?	Understand	CO1	AEE010.04

10	Draw the circuit diagram of Class A commutation. State the function of each commutating components.	Understand	CO1	AEE010.02
11	Draw the circuit diagram of Class B commutation. State the function of each commutating components.	Understand	CO1	AEE010.02
12	Draw and explain the circuit diagram of Class C commutation.	Understand	CO1	AEE010.02
13	Draw class D commutation method. Name commutating components. State function of each commutating components	Understand	CO1	AEE010.02
14	Draw and explain the R and RC triggering of SCR.	Analyze	CO1	AEE010.02
15	Draw and explain UJT triggering of SCR.	Analyze	CO1	AEE010.02

Part - C (Problem Solving and Critical Thinking Questions)

1	For an SCR the gate-cathode characteristic has a straight line slope of 130. For trigger source voltage of 15V and allowable gate power dissipation of 0.5 watts, compute the gate source resistance.	Understand	CO1	AEE010.01
2	The trigger circuit of a thyristor has a source voltage of 15V and the load line has a slope of -120V per ampere. The minimum gate current to turn on the SCR is 25mA. Compute i. Source resistance required in the gate circuit ii. The trigger voltage and trigger current for an average gate power dissipation of 0.4 watts	Analyze	CO1	AEE010.02
3	An SCR has half cycle surge current rating of 3000A for 50Hz supply. Calculate its one cycle surge current rating and I^2t rating	Understand	CO1	AEE010.03
4	SCRs with a rating of 1000V and 200A are available to be used in a string to handle 6kV and 1kA. Calculate the number of series and parallel units required in case de-rating factor is 0.1 and 0.2	Understand	CO1	AEE010.04
5	It is required to operate 250A SCR in parallel with 350A SCR with their respective on state voltage drops of 1.6V and 1.2V. Calculate the value of resistance to be inserted in series with each SCR so that the share the total load of 600A in proportion to their current ratings.	Analyze	CO1	AEE010.04
6	SCRs with rating of 1100V and 210A are available to be used in a string to handle 6.6kV and 1kA. Calculate the number of series and parallel units required in case de-rating factor is (i) 0.1 and (ii) 0.2.	Understand	CO1	AEE010.04
7	Class B commutation has $C=20\mu\text{F}$ and $L=5\mu\text{H}$. initial voltage across capacitor is $V_s=230\text{V}$ for a constant load current of 300A, calculate i. Conduction time for the auxiliary thyristor ii. Voltage across the main thyristor when it gets commutated and iii. The circuit turn off time for the main thyristor	Understand	CO1	AEE010.02
8	Class C commutation has $V_s=200\text{V}$, $R_1=10\Omega$ and $R_2=100\Omega$, determine i. Peak value of current through thyristors T1 and T2 ii. Value of capacitor C if each thyristor has turn off time of $40\mu\text{s}$. take a factor of safety 2.	Analyze	CO1	AEE010.02
9	In the complementary commutation circuit the load resistances $R_1 = R_2 = 10\Omega$ and capacitor $C = 10\mu\text{F}$. The supply voltage is 100V. Determine the circuit turnoff time.	Understand	CO1	AEE010.02
10	SCRs with a rating of 2000V and 100A are available to be used in a string to handle 12kV and 2kA. Calculate the number of series and parallel units required in case de-rating factor is 0.2 and 0.3	Understand	CO1	AEE010.04

UNIT - II

SINGLE PHASE AND THREE PHASE CONTROLLED RECTIFIERS

Part – A (Short Answer Questions)

1	Describe Phase controlled technique.	Remember	CO2	AEE010.05
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2	List the applications of phase controlled rectifier.	Remember	CO2	AEE010.05
3	Describe the function of freewheeling diode in phase controlled rectifier	Understand	CO2	AEE010.05
4	List the advantages of freewheeling diode in a controlled rectifier?	Remember	CO2	AEE010.05
5	Define delay angle.	Remember	CO2	AEE010.05
6	List the advantages of single phase bridge converter over single phase mid-point converter	Remember	CO2	AEE010.05
7	Define commutation angle or overlap angle	Understand	CO2	AEE010.05
8	Give an expression for average and RMS output voltage of single phase semi converters.	Understand	CO2	AEE010.05
9	Describe the effect of the source inductance in full converter.	Remember	CO2	AEE010.05
10	Define input power factor in controlled rectifier.	Remember	CO2	AEE010.05
11	Give an expression for average and RMS output voltage of single phase Full Converter with R load	Understand	CO2	AEE010.05
12	Describe inversion mode in fully controlled rectifier	Remember	CO2	AEE010.05
13	Sketch the four quadrants in which the dual converter operates	Understand	CO2	AEE010.06
14	Give the range of firing angles of a dual converter for all 4 quadrants.	Understand	CO2	AEE010.06
15	List the differences between non-circulating current mode & circulating current mode of a dual converter.	Remember	CO2	AEE010.06
16	Give the relation between the firing angles of two converters in a dual converter.	Understand	CO2	AEE010.06
Part - B (Long Answer Questions)				
1	Explain the operation of a single phase full wave mid-point converter with R-load with the help of circuit and output waveforms	Understand	CO2	AEE010.05
2	Explain the operation of a single phase half wave converter for R-load with neat circuit diagram and necessary waveforms	Understand	CO2	AEE010.05
3	Explain the operation of three phase fully controlled bridge converter with RL loads.	Understand	CO2	AEE010.05
4	Describe the operation of a single phase two pulse midpoint converter with R load and relevant waveforms.	Understand	CO2	AEE010.05
5	Derive the expressions for the following performance factors of single phase fully controlled bridge converter (a) input power factor (b) voltage ripple factor (c) active power input (d) Reactive power input	Understand	CO2	AEE010.05
6	Describe the operation of a single phase two pulse midpoint converter with RL loads and also derive an expression for average output voltage.	Remember	CO2	AEE010.05
7	List the advantages of Half-controlled converters over full controlled converters?	Remember	CO2	AEE010.05
8	Explain the operation of single phase dual converter with neat sketch.	Understand	CO2	AEE010.06
9	Explain the working of a single phase half wave controlled rectifier with R-L load.	Understand	CO2	AEE010.05
10	Derive the output voltage single phase full wave mid-point converter with R-load for $\alpha = 45^\circ$.	Understand	CO2	AEE010.05
11	Derive an expression for average output voltage of a single phase two pulse midpoint converter	Understand	CO2	AEE010.05
12	Explain the working of a three phase half wave controlled rectifier with R-L load.	Understand	CO2	AEE010.05

13	Derive the output voltage three phase full wave mid-point converter with R-load for $\alpha = 45^\circ$.	Understand	CO2	AEE010.05
14	Explain the operation of three phase dual converter with neat sketch.	Understand	CO2	AEE010.06
15	Explain the working of a three phase full wave controlled rectifier with R-L load.	Understand	CO2	AEE010.05
Part - C (Problem Solving and Critical Thinking Questions)				
1	A single phase transformer, with secondary voltage of 230V, 50Hz, delivers power to load $R=10\Omega$ through a half-wave controlled rectifier circuit. For a firing angle delay of 60° , determine (i) the rectifier efficiency (ii) form factor (iii) voltage ripple factor (iv) transformer utilization factor and (v) PIV of thyristor.	Understand	CO2	AEE010.05
2	The full wave controlled bridge rectifier has an ac Input of 120V rms at 60Hz and a 20Ω load resistor. The delay angle is 40° . Determine 1) Average load voltage 2) Average load current and 3) RMS load voltage.	Analyze	CO2	AEE010.05
3	A resistive load of 10Ω is connected through a half-wave controlled rectifier circuit to 220V, 50 Hz, single phase source. Calculate the power delivered to the load for a firing angle of 60° . Find also the value of input power factor	Understand	CO2	AEE010.05
4	For the single phase fully controlled bridge converter having load of 'R', determine the average output voltage, rms output voltage and input power factor if the supply is 230V, 50 Hz, single phase AC and the firing angle is 60 degrees	Analyze	CO2	AEE010.05
5	For the single phase fully controlled bridge is connected to RLE load. The source voltage is 230 V, 50 Hz. The average load current of 10A continuous over the working range. For $R= 0.4 \Omega$ and $L = 2\text{mH}$, Compute (a) firing angle for $E = 120\text{V}$ (b) firing angle for $E = -120\text{V}$	Understand	CO2	AEE010.05
6	A single phase two pulse converter feeds power to RLE load with $R= 6\Omega$, $L= 6\text{mH}$, $E= 60\text{V}$, AC source voltage is 230V, 50Hz for continuous condition. Find the average value of load current for a firing angle of 50° . In case one of the 4 SCRs gets open circuited. Find the new value of average load current assuming the output current as continuous.	Analyze	CO2	AEE010.05
7	A three-phase half-wave controlled rectifier has a supply of 200V/phase. Determine the average load voltage for firing angle of 0° , 30° and 60° assuming a thyristor volt drop of 1.5V and continuous load current.	Understand	CO2	AEE010.05
8	A single phase semi converter delivers to RLE load with $R=5\Omega$, $L = 10\text{mH}$ and $E = 80\text{V}$. The source voltage is 230V, 50Hz. For continuous conduction, Find the average value of output current for firing angle = 50° .	Analyze	CO2	AEE010.05
9	A single phase fully controlled bridge converter is supplied with 230 V, 50 Hz source. The load consists of $= 20\Omega$ and a large inductance so as to 5reach the load current constant. For a delay angle of 60° , Determine i) average output voltage ii) average output current iii) average values of SCR current and iv) input power factor.	Understand	CO2	AEE010.05
10	A three phase half wave converter is supplying a load with a continuous constant current of 50A over a firing angle from 0° to 60° . What will be the power dissipated by the load at these limiting values of firing angle. The supply voltage is 415V (line).	Understand	CO2	AEE010.05

11	A single phase semi converter delivers to RLE load with $R=5\Omega$, $L = 10\text{mH}$ and $E = 80\text{V}$. The source voltage is 230V , 50Hz . For continuous conduction, Find the average value of output current for firing angle $= 60^\circ$ and draw a rough sketch of output voltage, current and source current.	Understand	CO2	AEE010.05
12	The full wave controlled bridge rectifier has an ac Input of 110V rms at 50Hz and a 30Ω load resistor. The delay angle is 40° . Determine 1) Average load voltage 2) Average load current and 3) RMS load voltage.	Analyze	CO2	AEE010.05
13	A three-phase half-wave controlled rectifier has a supply of $200\text{V}/\text{phase}$. Determine the average load voltage for firing angle of 0° , 45° and 75° assuming a thyristor volt drop of 1.5V and continuous load current.	Understand	CO2	AEE010.05
14	A single phase fully controlled bridge converter is supplied with 230V , 50Hz source. The load consists of $= 30\Omega$ and a large inductance so as to reach the load current constant. For a delay angle of 30° , Determine i) average output voltage ii) average output current iii) average values of SCR current and iv) input power factor.	Understand	CO2	AEE010.05

UNIT – III

AC VOLTAGE CONTROLLERS AND CYCLOCONVERTERS

Part – A (Short Answer Questions)

1	Define AC voltage controller	Understand	CO3	AEE010.07
2	List the disadvantages of continuous gating signal	Remember	CO3	AEE010.07
3	Describe high frequency carrier gating	Remember	CO3	AEE010.07
4	Describe sequence control in AC voltage regulators	Understand	CO3	AEE010.07
5	Describe bidirectional or half-wave ac voltage controller	Remember	CO3	AEE010.07
6	List the gating signals used in AC voltage controller	Remember	CO3	AEE010.07
7	List the applications of AC voltage controllers	Understand	CO3	AEE010.07
8	List the advantages of AC voltage controllers	Remember	CO3	AEE010.07
9	List the control methods in AC voltage controllers	Remember	CO3	AEE010.07
10	Describe the difference between ON-OFF control and phase control	Understand	CO3	AEE010.07
11	List the applications of TRIAC?	Remember	CO3	AEE010.08
12	Describe the limitations of TRIAC as a AC voltage controller	Understand	CO3	AEE010.08
13	Define Cyclo-converter	Remember	CO3	AEE010.09
14	Classify the Cyclo-converters	Understand	CO3	AEE010.09
15	Define step up Cyclo-converter	Remember	CO3	AEE010.09
16	Define step down Cyclo-converter	Remember	CO3	AEE010.09
17	Give the expression for step up cyclo converter	Understand	CO3	AEE010.09
18	Give the expression for step down cyclo converter	Understand	CO3	AEE010.09
19	Describe the commutation used in step down cyclo-converter	Remember	CO3	AEE010.09
20	Describe the commutation used in Step up cyclo-converter	Understand	CO3	AEE010.09
21	Mention the Applications of cyclo-converter	Remember	CO3	AEE010.09

22	List the advantages and disadvantages of cyclo-converter	Remember	CO3	AEE010.09
23	List the advantages of bridge type cyclo-converter	Understand	CO3	AEE010.09
24	List the disadvantages of midpoint cyclo-converter	Remember	CO3	AEE010.09
Part – B (Long Answer Questions)				
1	Explain the operation of single phase AC voltage controller with RL load.	Understand	CO3	AEE010.07
2	Describe the effects of load inductances on the performance of AC voltage controllers	Remember	CO3	AEE010.07
3	For a voltage controller, feeding a resistive load, draw the waveforms of Source voltage, gating signals, output voltage and voltage across the SCR. Describe the working with reference to waveforms drawn.	Remember	CO3	AEE010.08
4	Explicate the principle of ON-OFF control used in AC voltage controller.	Understand	CO3	AEE010.08
5	Derive the expressions for the Power dissipated in the load, for a single phase AC voltage controller feeding Resistive-inductive load for continuous operation of current.	Understand	CO3	AEE010.08
6	Explain the different modes of operation of a TRIAC.	Understand	CO3	AEE010.07
7	Derive the expression for the input power factor in an AC voltage controller using ON-OFF control.	Understand	CO3	AEE010.07
8	Explain the operation of AC voltage controller with TRIAC and draw the input and output waveforms	Understand	CO3	AEE010.07
9	Describe the limitations of cyclo converter	Remember	CO3	AEE010.09
10	Explain the operation of single phase midpoint cyclo-converter with R and RL loads with neat waveforms.	Understand	CO3	AEE010.09
11	Explain the working of single phase bridge type cyclo-converter with RL load for a) Continuous conduction and for b) Discontinuous conduction with the help of neat circuit diagram and relevant output waveforms.	Understand	CO3	AEE010.09
12	List the salient features of cyclo-converters, with the help of a neat circuit diagram explicate the performance of step up cyclo-converter.	Remember	CO3	AEE010.09
13	Describe the operation of single phase Cyclo-converter with R load and also draw the neat waveforms.	Understand	CO3	AEE010.09
14	List the merits and demerits of a cyclo-converter	Remember	CO3	AEE010.09
15	Compare the operational features of single phase midpoint and bridge type cyclo-converter for R-L loads, with neat circuit diagrams and waveforms.	Understand	CO3	AEE010.09
Part - C (Problem Solving and Critical Thinking Questions)				
1	An ac voltage controller uses a TRIAC for phase angle control of a resistive load of 100Ω . Calculate the value of delay angle for having an rms load voltage of 220 volts. Also calculate the rms value of TRIAC current. Assume the rms supply voltage to be 230V.	Analyze	CO3	AEE010.08
2	The ac voltage controller uses on-off control for heating a resistive load of $R = 4\ \text{ohms}$ and the input voltage is $V_s = 208\text{V}$, 60Hz. If the desired output power is $P_o = 3\text{KW}$, determine the (a) duty cycle δ (b) input power factor (c) sketch waveforms for the duty cycle obtained in (a)	Understand	CO3	AEE010.08

3	A single phase load of resistance 12Ω in series with an Inductance of 24 mH is fed from a 230V (rms), 50Hz supply by a pair of inverse parallel thyristors. Find mean power in the load at firing angles of i) 0° ii) 60° and iii) 135° . Ignore source inductance and device voltage drops.	Understand	CO3	AEE010.08
4	A single phase full-wave AC voltage controller feeds a load of $R=20\Omega$ with an input voltage of 230V, 50Hz. Firing angle for both the thyristors is 45° . Calculate (i) rms value of output voltage (ii) Load power and input pf (iii) Average and rms current of thyristors.	Analyze	CO3	AEE010.08
5	A single phase voltage controller is employed for controlling the power flow from 230V, 50Hz source into a load circuit consisting of $R=3\Omega$ and $\omega L=4\Omega$. Calculate (i) the range of firing angle (ii) the maximum value of rms load current (iii) the maximum power and power factor (iv) The maximum values of average and rms thyristor currents.	Understand	CO3	AEE010.08
6	A single phase voltage controller has input voltage of 230V, 50 Hz and a load of $R=15\Omega$. For 6 cycles on and 4 cycles off, determine (i) rms output voltage (ii) input pf (iii) average and rms thyristor currents	Analyze	CO3	AEE010.08
7	A single phase full wave AC voltage converter has an input voltage of 230 V, 50Hz and its feeding a resistance load of 10 ohms. If firing angle of thyristors is 110 degree, find the output RMS voltage input power factor and average current of thyristor.	Understand	CO3	AEE010.08
8	The ac voltage controller uses on-off control for heating a resistive load of $R = 4$ ohms and the input voltage is $V_s = 210V$, 60Hz. If the desired output power is $P_o = 3KW$, determine the (a) duty cycle δ (b) input power factor a) sketch waveforms for the duty cycle obtained in (a)	Understand	CO3	AEE010.08
9	A single phase voltage controller is employed for controlling the power flow from 220V, 50Hz source into a load circuit consisting of $R=4\Omega$ and $\omega L=4\Omega$. Calculate (i) the range of firing angle (ii) the maximum value of rms load current (iii) the maximum power and power factor (iv) The maximum values of average and rms thyristor currents.	Analyze	CO3	AEE010.08
10	A single phase full wave AC voltage converter has an input voltage of 220 V, 50Hz and its feeding a resistance load of 5 ohms. If firing angle of thyristors is 120 degree, find the output RMS voltage input power factor and average current of thyristor.	Understand	CO3	AEE010.08
11	In a standard A single-phase bridge-type cyclo-converter has input voltage of 230V, 50Hz and load of $R=10\Omega$. Output frequency is one-third of input frequency. For a firing angle delay of 30° , Calculate (i) rms value of output voltage (ii) rms current of each converter (iii) rms current of each thyristor (iv) input power factor.	Understand	CO3	AEE010.09

12	A 3-phase to single-phase cyclo-converter employs a 6-pulse bridge circuit. This device is fed from 400 V, 50 Hz supply through a delta/star transformer whose per-phase turns ratio is 3 : 1. For an output frequency of 2 Hz, the load reactance is $\omega_o L = 3\text{ohms}$ If the load resistance is 4 ohms. The commutation overlap and thyristor turn-off time limit the firing angle in the inversion mode to 165° . Compute (a) peak value of rms output voltage (b) rms output current and (c) output power.	Understand	CO3	AEE010.09
13	A single-phase to single-phase mid-point cyclo-converter is delivering power to a resistive load. The supply transformer has turns ratio of 1: 1: 1. The frequency ratio is $f_o/f_s = 1/5$. The firing angle delay α for all the four SCRs are the same. Sketch the time variations of the following waveforms for $\alpha = 0^\circ$ and $\alpha = 30^\circ$ (a) Supply voltage (b) Output current and (c) Supply current. Indicate the conduction of various thyristors also.	Analyze	CO3	AEE010.09
14	A 3-phase to single-phase cyclo-converter employs a 6-pulse bridge circuit. This device is fed from 400 V, 50 Hz supply through a delta/star transformer whose per-phase turns ratio is 3 : 1. For an output frequency of 2 Hz, the load reactance is $\omega_o L = 3\text{ohms}$ If the load resistance is 4 ohms. The commutation overlap and thyristor turn-off time limit the firing angle in the inversion mode to 135° . Compute (a) peak value of rms output voltage (b) rms output current and (c) output power.	Understand	CO3	AEE010.09
15	A single-phase to single-phase mid-point cyclo-converter is delivering power to a resistive load. The supply transformer has turns ratio of 1: 1: 1. The frequency ratio is $f_o/f_s = 1/5$. The firing angle delay α for all the four SCRs are the same. Sketch the time variations of the following waveforms for $\alpha = 45^\circ$ and $\alpha = 60^\circ$ (a) Supply voltage (b) Output current and (c) Supply current. Indicate the conduction of various thyristors also.	Analyze	CO3	AEE010.09

UNIT-IV

DC – DC CONVERTERS

Part – A (Short Answer Questions)

1	Define duty ratio	Understand	CO4	AEE010.10
3	Define time ratio control and classify the time ratio control	Remember	CO4	AEE010.10
4	Classify the control strategies in choppers	Understand	CO4	AEE010.10
5	Describe step-up and step-down chopper	Remember	CO4	AEE010.10
6	Write the expression for average output voltage for step down chopper	Understand	CO4	AEE010.10
7	Write the expression for average output voltage for step up chopper	Remember	CO4	AEE010.10
8	Write the expression for average output voltage for step up/down chopper	Remember	CO4	AEE010.10
9	Discuss the control strategy with constant frequency control	Understand	CO4	AEE010.10
10	Discuss the control strategy with variable frequency control	Understand	CO4	AEE010.10
11	List the applications of dc chopper?	Remember	CO4	AEE010.11
12	List the different types of chopper with respect to commutation process?	Remember	CO4	AEE010.11
13	Draw the circuit diagram of type A chopper.	Remember	CO4	AEE010.12
14	Write the expressions for minimum and maximum currents in type A chopper	Remember	CO4	AEE010.11

15	Classify the choppers based on quadrant operations.	Understand	CO4	AEE010.11
16	Draw the circuit diagram of four quadrant chopper.	Remember	CO4	AEE010.11
Part – B (Long Answer Questions)				
1	Describe the principle of step-up chopper. Derive an expression for the average output voltage in terms of input dc voltage & duty cycle.	Remember	CO4	AEE010.11
2	Describe the principle of step-down chopper. Derive an expression for the average output voltage in terms of input dc voltage & duty cycle.	Remember	CO4	AEE010.10
3	Describe the working of four quadrant chopper with neat sketch.	Remember	CO4	AEE010.11
4	Describe the step up and step down chopper with neat diagram.	Remember	CO4	AEE010.10
5	Explain the operation of class-B Chopper for resistive load with neat circuit diagram and output voltage and current waveforms.	Understand	CO4	AEE010.11
6	Compare the control techniques used in choppers.	Understand	CO4	AEE010.10
7	Explain the operation of an AC chopper with neat sketch and waveforms	Analyze	CO4	AEE010.12
8	With the help of circuit diagrams, discuss the operation of class-C and class –D chopper.	Understand	CO4	AEE010.12
9	Explain with waveforms the constant & variable frequency system for chopper control.	Understand	CO4	AEE010.10
10	Explain the effects of source and load inductance on the operation of a chopper.	Analyze	CO4	AEE010.11
11	Derive expressions for minimum and maximum output currents for class –A chopper	Understand	CO4	AEE010.11
12	Explain the control techniques used in choppers	Understand	CO4	AEE010.10
13	Explain the operation of cuk regulator.	Understand	CO4	AEE010.12
14	Explain the operation of buck boost regulator.	Understand	CO4	AEE010.12
Part - C (Problem Solving and Critical Thinking Questions)				
1	A step-up chopper supplies a load of 480 V from 230 V dc supply. Assuming the non conduction period of the thyristor to be 50 microsecond, find the on time of the thyristor	Understand	CO4	AEE010.10
2	In a type A chopper, the input supply voltage is 230 V the load resistance is 10 Ω and there is a voltage drop of 2 V across the chopper thyristor when it is on. For a duty ratio of 0.4, calculate the average and rms values of the output voltage. Also find the chopper efficiency	Analyze	CO4	AEE010.11
3	Design the filter components for a buck converter which has an input voltage of 12 V and output voltage of 5 V. the peak to peak output ripple voltage is 20 mV and peak to peak ripple current of inductor is limited to 0.8 A. the switching frequency is 25 KHz	Understand	CO4	AEE010.12
4	A step down DC chopper has input voltage of 230 V with 10 Ω load resistor connected, voltage drop across chopper is 2 V when it is ON. For a duty cycle of 0.5, calculate: 1) Average and rms values of output voltage 2) Power delivered to the load	Understand	CO4	AEE010.10
5	A step up chopper has input voltage of 220 V and output voltage of 660 V. If the non-conducting time of thyristor chopper is 100 micro sec compute the pulse width of output voltage. In case the pulse width is halved for constant frequency operation , find the new output voltage	Analyze	CO4	AEE010.10

6	A dc chopper has an input voltage of 200 V and a load of 20 Ω resistances. When chopper is on, its voltage drop is 1.5 V and the chopping frequency is 10 KHz. If the duty cycle is 80%, find. 1) Average output voltage 2) RMS output voltage 3) Chopper on time	Understand	CO4	AEE010.11
7	A chopper operating from 220V dc supply with for a duty cycle of 0.5 and chopping frequency of 1KHz drives an R L load with R = 1 Ω , L=1mH and E = 105V. Find whether the current is continuous and also find the values of I_{max} and I_{min} .	Understand	CO4	AEE010.10
8	Input to step-up chopper is 100V. The output required is 300V. If the conducting time is 200 μ s. Calculate. a) chopping frequency b) If the pulse width is halved for constant frequency of operation find the output voltage.	Analyze	CO4	AEE010.10
9	A battery is charged from a constant dc source of 220V through a chopper. The dc battery is to be charged from its internal emf of 90V to 122 V. The battery has internal resistance 1.For a constant charging current of 10A. Compute the range of duty cycle.	Analyze	CO4	AEE010.11
10	An ideal chopper operating at a chopping period of 2ms supplies a load of 4 ohms having an induction of 8 mH from 80V battery. Assuming the load is shunted by a perfect commutating diode, and battery to be loss less, compute load current waveforms for T_{on} / T_{off} values of 1/1, 4/1.	Understand	CO4	AEE010.11
11	For the ideal type A-chopper circuit, following conditions are given, $E_{dc} = 220V$, chopping frequency=500 Hz, duty cycle $\delta=0.3$ and R = 1 ohm, L = 3mH and $E_b= 23V$. Compute the following quantities. a) Check whether the load current is continuous or not. b) Average output current c) Maximum and minimum values of steady state output current	Understand	CO4	AEE010.11
12	An ideal chopper operating at a chopping period of 2ms supplies a load of 5 ohms having an induction of 8 mH from 100V battery. Assuming the load is shunted by a perfect commutating diode, and battery to be loss less, compute load current waveforms for T_{on} / T_{off} values of 1/1, 4/1.	Analyze	CO4	AEE010.11

UNIT-V

INVERTERS

Part - A (Short Answer Questions)

1	Describe inverter.	Remember	CO5	AEE010.13
2	Discuss the classification of inverters.	Understand	CO5	AEE010.13
3	Describe why thyristors are not preferred for inverters.	Remember	CO5	AEE010.13
4	List the applications of an inverter?	Remember	CO5	AEE010.14
5	Compare Current Source Inverter and Voltage Source Inverter	Understand	CO5	AEE010.15
6	Give two advantages of Current Source Inverter.	Understand	CO5	AEE010.15
7	Give the main drawback of a single phase half bridge inverter?	Understand	CO5	AEE010.13
8	Describe the need to be connected in anti parallel with the thyristors in inverter circuits	Remember	CO5	AEE010.13
9	Define series inverter	Remember	CO5	AEE010.13
10	Describe the condition to be satisfied in the selection of L and C in a series inverter	Understand	CO5	AEE010.13
11	List the applications of a series inverter	Remember	CO5	AEE010.13

12	Describe parallel inverter	Remember	CO5	AEE010.13
13	Classify the inverters based on commutation circuit used	Understand	CO5	AEE010.13
14	Discuss PWM control	Understand	CO5	AEE010.13
15	List the advantages of PWM control?	Remember	CO5	AEE010.13
Part - B (Long Answer Questions)				
1	Describe the operation of series inverter with aid of diagrams. Describe an expression for output frequency, current and voltages. What are the disadvantages of basic series inverter?	Remember	CO5	AEE010.13
2	Draw and explain the circuit diagram of single phase half and full bridge inverter.	Understand	CO5	AEE010.13
3	Explain the operation of 3 phase bridge inverter for 180 degree mode of operation with aid of relevant phase and line voltage waveforms.	Understand	CO5	AEE010.14
4	Explain the operation of 3 phase bridge inverter for 120 degree mode of operation with aid of relevant phase and line voltage waveforms.	Understand	CO5	AEE010.14
5	State different methods of voltage control inverters. Describe about PWM control in inverter.	Remember	CO5	AEE010.14
6	Describe the pulse width modulated and sinusoidal pulse width modulated inverter.	Remember	CO5	AEE010.13
7	a) Describe the operation of basic series inverter. State its limitation. b) How the limitation is overcome in modified series inverter.	Understand	CO5	AEE010.13
8	Describe the operation of basic parallel inverter with neat diagram.	Remember	CO5	AEE010.13
9	Explain the different pulse width modulation techniques used for inverters?	Understand	CO5	AEE010.13
10	Discuss load commutation in an Inverter. Under what condition commutation can be achieved by load.	Understand	CO5	AEE010.13
11	Compare Single pulse width modulation over multiple pulse width modulation technique.	Understand	CO5	AEE010.13
12	Compare the advantages and disadvantages of half bridge and full bridge inverter.	Remember	CO5	AEE010.13
13	Compare series and parallel inverter on the basis of circuit components, current rating, type of communication and type of O/P waveforms.	Understand	CO5	AEE010.13
14	List the advantages and disadvantages of sinusoidal pulse width modulation technique?	Remember	CO5	AEE010.13
Part - C (Problem Solving and Critical Thinking Questions)				
1	A 1 phase half bridge inverter has a resistive load of 2Ω . The dc supply voltage is 24V. Calculate a) rms output voltage at fundamental frequency b) output power c) Average and peak current.	Understand	CO5	AEE010.13
2	The single phase half bridge inverter has a resistive load of 2.4Ω and the dc input voltage is 48 V. Determine the rms output voltage at the fundamental frequency, output power and the total harmonic distortion	Understand	CO5	AEE010.13
3	A single phase full bridge inverter has a resistive load of $R = 10\Omega$ and the input voltage V_{dc} of 100 V. Find the average output voltage and rms output voltage at fundamental frequency.	Analyze	CO5	AEE010.13
4	A single PWM full bridge inverter feeds an RL load with $R=10\Omega$ and $L= 10\text{ mH}$. If the source voltage is 120V, find out the total harmonic distortion in the output voltage and in the load current. The width of each pulse is 120° and the output frequency is 50Hz.	Understand	CO5	AEE010.14

5	A single phase full bridge inverter has rms value of fundamental component of output voltage with single pulse width modulation equal to 110V. Compute the pulse width required and the rms value of output voltage in case dc source voltage is 220V.	Understand	CO5	AEE010.15
6	A single-phase bridge Inverter feeds an R-L-C series load with $R=3$, $L=6\text{mH}$ & $C=15\mu\text{F}$. The output frequency is 120Hz, supply voltage being 180V. Express the output voltage in terms of Fourier series & determine, i. RMS values of thyristor current load current. ii. Current at the instant of commutation considering up to 7th harmonics only.	Understand	CO5	AEE010.13
7	Single phase half bridge inverter has a resistive load of $R = 3$ ohms and dc input voltage $E_{dc} = 50\text{V}$. Calculate a) rms output voltage at fundamental frequency E_1 b) the output power c) average and peak current of each thyristor	Analyze	CO5	AEE010.13
8	A single phase full-bridge inverter has RLC load of $R = 4\Omega$, $L = 35\text{mH}$ and $C = 155\mu\text{F}$. The dc input voltage of 230V and the output frequency is 50 Hz. Find the expression for load current upto fifth harmonic. Also calculate rms value of all the (fundamental, harmonic) current components.	Understand	CO5	AEE010.15
9	In a single-phase series inverter, the operating frequency is 50kHz and the thyristor turn-off time $t_q=10\mu\text{s}$. Circuit parameters are: $R=3\Omega$, $L=60\mu\text{H}$, $C=7.5\mu\text{F}$ and $V_s=220\text{V DC}$. Determine (i) the circuit turn-off time and (ii) maximum possible operating frequency, assuming a factor of safety = 1.5.	Understand	CO5	AEE010.13
10	A single PWM full bridge inverter feeds an RL load with $R=10\Omega$ and $L= 10 \text{ mH}$. If the source voltage is 110V, find out the total harmonic distortion in the output voltage and in the load current. The width of each pulse is 120° and the output frequency is 60Hz.	Analyze	CO5	AEE010.13
11	Single phase half bridge inverter has a resistive load of $R = 4\text{ohms}$ and dc input voltage $E_{dc} = 60\text{V}$. Calculate a) rms output voltage at fundamental frequency E_1 b) the output power c) average and peak current of each thyristor	Understand	CO5	AEE010.14
12	A single phase full-bridge inverter has RLC load of $R = 5\Omega$, $L = 35\text{mH}$ and $C = 160\mu\text{F}$. The dc input voltage of 220V and the output frequency is 50 Hz. Find the expression for load current up to fifth harmonic. Also calculate rms value of all the (fundamental, harmonic) current components.	Understand	CO5	AEE010.15

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