



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

QUESTION BANK

Course Name	:	POWER ELECTRONICS
Course Code	:	A50220
Class	:	III B. Tech I Semester
Branch	:	Electrical and Electronics Engineering
Year	:	2017 - 2018
Course Faculty	:	S. Srikanth, Assistant Professor

OBJECTIVES

Power Electronics course introduces the basic concepts of power semiconductor devices and power converters which is the foundation for power transmission, distribution and utilization of the Electrical Engineering discipline. The course deals with the basic analysis of AC - DC, DC - AC, DC - DC, AC - AC converters.

S. No	Question	Blooms Taxonomy Level	Course Outcome
UNIT - 1			
POWER SEMI CONDUCTOR DEVICES & COMMUTATION CIRCUITS			
Part - A (Short Answer Questions)			
1	What are the differences between power diode and signal diode?	Understand	1
2	Define latching current & holding current of a SCR?	Remember	1
3	What is Snubber circuit? What is the function of Snubber circuit?	Analyze	1
4	What are the different methods to turn on the thyristor?	Remember	1
5	Define Thyristor turn off time and circuit turn off time?	Understand	1
6	Why circuit turn off time should be greater than the thyristor turn-off time?	Remember	1
7	Draw the turn-on characteristics of SCR and mark the timings t_d , t_r , t_{on} .	Analyze	1
8	What are the factors that influence the turn-off time of a thyristor?	Remember	1
9	Draw the V-I characteristics of SCR and mark the holding current and latching current in the characteristics.	Analyze	1
10	Define string efficiency of SCRs connected in series?	Remember	1
11	Why is pulse triggering preferred over RC triggering?	Remember	1
12	What are the different methods of firing circuits for line commutated converter?	Understand	1
13	What is meant by commutation?	Understand	1
14	What is meant by forced commutation?	Understand	1
15	List the various forced commutation techniques used to turn off SCR.	Remember	1
16	What losses occur in a thyristor during working conditions?	Understand	1
17	What is meant by natural commutation?	Remember	1
18	What are the types of commutation?	Understand	1
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	1
2	a) Explain the structure and operation of turn on and turn off characteristics of SCR.	Apply	1

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	b) Describe the any two methods of turn-on mechanism of SCR. c) Explain the turn off characteristics of SCR.		
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.	Apply	1
4	What is commutation? What are the different types of commutation techniques? Discuss and differentiate the natural commutation and forced commutation.	Understand	1
5	a) Draw the two transistor model of SCR and derive an expression for anode current. b) Describe the various methods of thyristor turn-on.	Apply	1
6	What is meant by triggering of SCR? What are the different types of triggering circuits? Briefly discuss the R-C triggering and UJT triggering of SCR.	Understand	1
7	a) Explain the static and dynamic characteristics of SCR. b) What are different types of ratings of SCR. Explain them.	Apply	1
8	a) Explain the necessity of series and parallel connection of SCRs. b) What is String efficiency in series and parallel connections? c) What are the problems arising in series and parallel connections.	Apply	1
9	a) What is the importance of Surge current rating of a thyristor, explain in detail? b) A thyristor has half-cycle surge current rating of 1000mA for a 50Hz supply. Calculate its one-cycle surge current rating and i^2t rating	Understand	1
10	a) Enlighten the simple SCR series inverter circuit employing class A-type commutation. With the help of important waveforms. b) State the limitations of employing class A type commutation	Remember	1
11	a) Draw & explain the characteristics of SCR. What is the effect of gate current on operation of SCR? b) State the difference between GTO and conventional thyristor in terms of commutation and also state any two advantages over conventional Thyristor.	Understand	1
12	a) Draw the circuit diagram of Class B commutation. State the function of each commutating components. b) Draw and explain the circuit diagram of Class C commutation.	Apply	1
13	a) Define commutation. State the types of commutation. b) Draw class D commutation method. Name commutating components. State function of each commutating components	Understand	1
14	a) What are the requirements of pulse to trigger SCR successfully? b) State the advantages of gate triggering methods of SCR.	Apply	1
15	a) Draw and explain the gate triggering characteristics of SCR. b) Explain dv/dt triggering and light triggering of SCR.	Apply	1
Part – C (Analytical Questions)			
1	A BJT has current gain $\beta = 40$. The load resistance $R_C = 10\Omega$, dc supply voltage $V_{CC} = 130V$ and input voltage to base circuit $V_B = 10V$. for $V_{CES} = 1V$ and $V_{BES} = 1.5V$, calculate: i. the value of R_B for operation in the saturation state ii. the value of R_B for an overdrive factor 5 iii. forced current gain	Apply	1
2	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.	Apply	1
3	Latching current for an SCR, inserted in between a dc voltage source of 200V and the load is 100mA. Compute the minimum width of gate pulse current required to turn on this SCR in case the load consists of i. $L = 0.2H$, ii. $R = 20\Omega$ in series with $L = 0.2H$ and iii. $R = 20\Omega$ in series with $L = 2H$	Apply	1
4	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	Apply	1

S. No	Question	Blooms Taxonomy Level	Course Outcome
	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		
5	An SCR has half cycle surge current rating of 3000A for 50Hz supply. Calculate its one cycle surge current rating and I^2t rating	Apply	1
6	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	Apply	1
7	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.	Apply	1
8	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	Apply	1
9	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.	Apply	1
10	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.	Apply	1
11	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.	Apply	1

UNIT – II
AC-DC CONVERTERS (1-PHASE & 3-PHASE CONTROLLED RECTIFIERS)

Part - A (Short Answer Questions)

1	What is meant by phase controlled rectifier?	Remember	2
2	Mention some of the applications of controlled rectifier.	Remember	2
3	What is the function of freewheeling diode in controlled rectifier?	Analyze	2
4	What are the advantages of freewheeling diode in a controlled in a controlled rectifier?	Remember	2
5	What is meant by delay angle?	Understand	2
6	What are the advantages of single phase bridge converter over single phase mid-point converter?	Remember	2
7	What is commutation angle or overlap angle?	Remember	2
8	What are the different methods of firing circuits for line commutated converter?	Understand	2
9	Give an expression for average voltage of single phase semi converters.	Remember	2
10	Show the effect of the source inductance in full converter.	Understand	2
11	What is meant by input power factor in controlled rectifier?	Remember	2
12	Give an expression for average voltage of single phase Full Converter with R load	Remember	2
13	How full converter operates in an inversion mode?	Understand	2
14	What is phase control technique?	Understand	2
15	What is six pulse converter? Write its advantages.	Remember	2
16	Sketch the four quadrants in which the dual converter operates?	Remember	2
17	Give the range of firing angles of a dual converter for all 4 quadrants.	Remember	2

S. No	Question	Blooms Taxonomy Level	Course Outcome
18	Differences between non-circulating current mode & circulating current mode of a dual converter.	Understand	2
19	Give the relation between the firing angles of two converters in a dual converter.	Remember	2
20	Give an expression for three phase full converter for a delay angle of 60°	Remember	2
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 with respect to supply voltages.	Apply	2
2	a) Explain the operation of a single phase half wave converter for R-load with neat circuit diagram and necessary waveforms. b) Obtain the output average voltage and current of a single phase half wave converter for R-load for $\alpha = 30^\circ$.	Understand	2
3	a) Explain the operation of three phase fully controlled bridge converter with RL loads. b) Illustrate in detail with discontinuous conduction mode with associated waveforms.	Understand	2
4	Describe the operation of a single phase two pulse midpoint converter with relevant waveforms.	Apply	2
5	Derive the expressions for the following performance factors of single phase fully controlled bridge converter (a) input displacement factor (b) input power factor (c) voltage ripple factor (d) active power input (e) Reactive power input	Apply	2
6	Describe the operation of a single phase two pulse midpoint converter with relevant waveforms. Derive an expression for average output voltage.	Apply	2
7	What are the features of Half-controlled converters over full controlled converters?	Understand	2
8	a) Show that the effect of source inductance on the performance of single phase fully controlled converter is to present an equivalent resistance of $\omega L_s/\pi$ ohms in series with the internal rectifier voltage. b) A single phase fully controlled converter is supplied at 220V, 50Hz. Determine the average load voltage for the following cases when the firing angle is 45° for purely resistive load.	Analyze	2
9	What do you mean by the requirement of reactive power for a converter? Why at all it is required, even for purely resistive load?	Understand	2
10	Explain the operation of dual converter with neat sketch.	Apply	2
11	Explain the working of a single phase half wave controlled rectifier with R-L load.	Apply	2
12	Derive the output voltage single phase full wave mid-point converter with R-load for $\alpha = 45^\circ$.	Apply	2
13	Derive an expression for average output voltage of a single phase two pulse midpoint converter	Apply	2
14	Bring out the features of Free-wheeling diode used in converters.	Understand	2
15	A single phase fully controlled bridge converter is supplied at 230V, 50Hz, with source inductance of 2mH. Neglecting resistance voltage drop, when the converter is operating at a firing angle of 45° and the load current is constant at 10A. Determine also the load voltage	Apply	2
Part - C (Analytical 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.	Apply	2
2	The full wave controlled bridge rectifier has an ac Input of 120V rms at 60Hz	Evaluate	2

S. No	Question	Blooms Taxonomy Level	Course Outcome
	and a 20Ω load resistor. The delay angle is 40°. Determine 1) Average load voltage 2) Average load current and 3) RMS load voltage.		
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	Apply	2
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	Evaluate	2
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 Ω and L = 2mH, Compute (a) firing angle for E = 120V (b) firing angle for E = -120V	Apply	2
6	A single phase two pulse converter feeds power to RLE load with R= 6Ω, L= 6mH, E= 60V, 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.	Apply	2
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.	Apply	2
8	A single phase semi converter delivers to RLE load with R=5Ω, L = 10mH and E = 80V. The source voltage is 230V, 50Hz. For continuous conduction, Find the average value of output current for firing angle = 50°.	Apply	2
9	A single phase fully controlled bridge converter is supplied with 230 V, 50 Hz source. The load consists of = 20Ω and a large inductance so as to reach 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.	Apply	2
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).	Apply	2
11	A single phase semi converter delivers to RLE load with R=5Ω, L = 10mH and E = 80V. The source voltage is 230V, 50Hz. For continuous conduction, Find the average value of output current for firing angle = 60° and draw a rough sketch of output voltage, current and source current.	Apply	2
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.	Evaluate	2
13	A three-phase half-wave controlled rectifier has a supply of 200V/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.	Apply	2
14	A single phase fully controlled bridge converter is supplied with 230 V, 50 Hz source. The load consists of = 30Ω 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.	Evaluate	2
15	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= 0.5 Ω and L = 6mH, Compute (a) firing angle for E = 110V (b) firing angle for E = -110V	Apply	2

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UNIT - III			
DC-DC CONVERTERS (CHOPPERS)			
Part - A (Short Answer Questions)			
1	What is meant by dc chopper?	Remember	3
2	What is meant by duty-cycle?	Remember	3
3	What is meant by Time Ratio Control? What are the two types of TRC?	Understand	3
4	What are the two types of control strategies?	Remember	3
5	How the output voltage of chopper depends on the duty cycle?	Remember	3
6	What is meant by step-up and step-down chopper	Understand	3
7	What are the differences between Step-up and step down choppers?	Understand	3
8	Write down the expression for average output voltage for step down chopper?	Remember	3
9	Write down the expression for average output voltage for step up chopper?	Remember	3
10	Write down the expression for average output voltage for step up/down chopper?	Remember	3
11	What is meant by FM control in a dc chopper?	Understand	3
12	What is meant by PWM control in dc chopper?	Understand	3
13	Discuss the control strategy with constant frequency control	Understand	3
14	Discuss the control strategy with variable frequency control	Understand	3
15	What are the applications of dc chopper?	Remember	3
17	What is meant by current commutation?	Remember	3
18	What is AC chopper?	Remember	3
19	What are the different types of chopper with respect to commutation process?	Understand	3
20	What is Jones chopper?	Remember	3
21	Write down the expression for average output voltage for step up chopper?	Remember	3
22	Draw the circuit diagram of type A chopper.	Understand	3
23	Write the expressions for minimum and maximum currents in type A chopper	Understand	3
24	Draw the input and output waveforms of type A chopper	Understand	3
25	Classify the choppers based on quadrant operations.	Remember	3
26	Draw the circuit diagram of four quadrant chopper.	Remember	3
27	What are the modes of operations in type-D chopper?	Remember	3
28	What are the quadrant operations in type- C chopper?	Understand	3
29	Draw the circuit diagram of type-B chopper.	Remember	3
30	List the advantages of Jones chopper	Understand	3
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.	Apply	3
2	Describe the principle of step-down chopper. Derive an expression for the average output voltage in terms of input dc voltage & duty cycle.	Apply	3
3	Explain the working of current commutated chopper with aid of circuit diagram and necessary waveforms. Derive an expression for its output voltage.	Apply	3
4	Explain the working of voltage commutated chopper with aid of circuit diagram and necessary waveforms. Derive an expression for its output voltage.	Apply	3
5	Describe the working of four quadrant chopper with neat sketch.	Understand	3
6	Describe the step up and step down chopper with neat diagram.	Understand	3
7	Explain the operation of class-B Chopper for resistive load with neat circuit diagram and output voltage and current waveforms.	Apply	3
8	Compare the control techniques used in choppers.	Understand	3

S. No	Question	Blooms Taxonomy Level	Course Outcome
9	Explain the operation of an AC chopper with neat sketch and waveforms	Understand	3
10	With the help of circuit diagrams, discuss the operation of class-C and class –D chopper.	Apply	3
11	Explain with waveforms the constant & variable frequency system for chopper control.	Understand	3
12	Explain the effects of source and load inductance on the operation of a chopper.	Understand	3
13	Enumerate the demerits of Morgan chopper compared to Jones chopper.	Understand	3
14	Derive expressions for minimum and maximum output currents for class –A chopper	Apply	3
15	Explain the control techniques used in choppers	Understand	3
Part – C (Analytical 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	Apply	3
2	In a type A chopper, the input supply voltage is 230 V the load resistance is 10Ω 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	Evaluate	3
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	Apply	3
4	A step down DC chopper has input voltage of 230 V with 10Ω 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	Evaluate	3
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	Apply	3
6	A dc chopper has an input voltage of 200 V and a load of 20Ω 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	Apply	3
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 $R = 1\Omega$, $L=1\text{mH}$ and $E = 105\text{V}$. Find whether the current is continuous and also find the values of I_{max} and I_{min} .	Evaluate	3
8	Input to step-up chopper is 100V. The output required is 300V. If the conducting time is $200\mu\text{s}$. Calculate. a) chopping frequency b) If the pulse width is halved for constant frequency of operation find the output voltage.	Apply	3
9	A load commutated chopper, fed from a 230V dc source has a constant load current of 50A. For a duty cycle of 0.4 and a chopping frequency of 2 KHz, Calculate. a) the value of commutating capacitance b) average output voltage	Apply	3
10	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.	Evaluate	3
11	An ideal chopper operating at a chopping period of 2ms supplies a load of 4	Apply	3

S. No	Question	Blooms Taxonomy Level	Course Outcome
	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.		
12	For the ideal type A-chopper circuit, following conditions are given, $E_{dc} = 220V$, chopping frequency=500 Hz, duty cycle $\delta=0.3$ and $R = 1 \text{ ohm}$, $L = 3mH$ 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	Apply	3
13	A load commutated chopper, fed from a 230V dc source has a constant load current of 50A. For a duty cycle of 0.4 and a chopping frequency of 2 KHz, Calculate a) Circuit turn-off time for one SCR pair b) Total commutation interval	Apply	3
14	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.	Apply	3
15	Input to step-up chopper is 120V. The output required is 300V. If the conducting time is 150 μ s. Calculate chopping frequency If the pulse width is halved for constant frequency of operation find the output voltage.	Apply	3
UNIT - IV			
AC-AC CONVERTERS (AC VOLTAGE CONTROLLERS) & FREQUENCY CHANGERS (CYCLO-CONVERTERS)			
Part - A (Short Answer Questions)			
1	What does ac voltage controller mean?	Understand	4
2	What are the disadvantages of continuous gating signal?	Remember	4
3	What is meant by high frequency carrier gating?	Understand	4
4	What is meant by sequence control of ac voltage regulators?	Understand	4
5	What is meant by bidirectional or half-wave ac voltage controller?	Understand	4
6	What type of gating signal is used in single phase ac voltage controller with RL load?	Remember	4
7	What are the applications of ac voltage controllers?	Remember	4
8	What are the advantages of ac voltage controllers?	Remember	4
9	What are the two methods of control in ac voltage controllers?	Remember	4
10	What is the difference between ON-OFF control and phase control?	Understand	4
11	What are the applications of TRIAC?	Remember	4
12	What is meant by Cyclo-converter?	Remember	4
13	What are the two types of Cyclo-converters?	Remember	4
14	What is meant by step-up and step-down Cyclo-converters?	Understand	4
15	Give the expression for step up and step down cyclo converter?	Remember	4
16	What type of commutation will be used for the Step up and step down cyclo-converter?	Remember	4
17	Mention the Applications of cyclo-converter.	Remember	4
Part - B (Long Answer Questions)			
1	What is an AC voltage controller? Explain the operation of single phase AC voltage controller with RL load.	Understand	4
2	What are the effects of load inductances on the performance of AC voltage controllers?	Apply	4
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.	Understand	4

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4	Explicate the principle of ON-OFF control used in a.c. voltage controller.	Understand	4
5	a) Derive the expressions for the Power dissipated in the load, for a single phase AC voltage controller feeding Resistive-inductive load for discontinuous operation of current. b) Enlighten the operation of the above circuit for continuous current conditions.	Apply	4
6	What is cyclo-converter? What are its limitations?	Understand	4
7	Explain the operation of single phase midpoint cyclo-converter with R and RL loads with neat waveforms.	Understand	4
8	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.	Apply	4
9	a) What are the salient features of cyclo-converters, with the help of a neat circuit diagram explicate the performance of step up cyclo-converter. b) What are the major limitations of cyclo-converters?	Remember	4
10	Explain the different modes of operation of a TRIAC.	Remember	4
11	Describe the operation of three phase Cyclo-converter with neat circuit diagram. Also draw the neat waveforms.	Understand	4
12	What are the merits and demerits of a cyclo-converter? Why is it not popular?	Apply	4
13	Compare the operational features of single phase midpoint and bridge type cyclo-converter for R-L loads, with neat circuit diagrams and waveforms.	Understand	4
14	Derive the expression for the input power factor in an a.c. voltage controller using ON-OFF control.	Understand	4
15	Explain the triggering of TRIAC using DIAC.	Understand	4
Part – C (Analytical 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.	Apply	4
2	The ac voltage controller uses on-off control for heating a resistive load of $R = 4$ ohms and the input voltage is $V_s = 208V, 60Hz$. If the desired output power is $P_o = 3KW$, determine the (a) duty cycle δ (b) input power factor (c) sketch waveforms for the duty cycle obtained in (a)	Evaluate	4
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.	Apply	4
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.	Apply	4
5	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.	Apply	4
6	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	Apply	4

S. No	Question	Blooms Taxonomy Level	Course Outcome
	(iii) the maximum power and power factor (iv) The maximum values of average and rms thyristor currents.		
7	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	Apply	4
8	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.	Apply	4
9	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 $\omega_o L= 3\text{ohms}$ Ii 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.	Apply	4
10	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.	Apply	4
11	The ac voltage controller uses on-off control for heating a resistive load of $R = 4$ ohms and the input voltage is $V_s = 210\text{V}$, 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)	Apply	4
12	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.	Apply	4
13	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.	Apply	4
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 $\omega_o L= 3\text{ohms}$ Ii 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.	Apply	4
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.	Apply	4
UNIT - V DC-AC CONVERTERS (INVERTERS)			

S. No	Question	Blooms Taxonomy Level	Course Outcome
Part - A (Short Answer Questions)			
1	What is meant by inverter?	Remember	5
2	What are the main classifications of inverter?	Remember	5
3	Why thyristors are not preferred for inverters?	Understand	5
4	How output frequency is varied in case of a thyristor?	Remember	5
5	What are the applications of an inverter?	Remember	5
6	Compare CSI and VSI.	Understand	5
7	Give two advantages of CSI.	Remember	5
8	What is the main drawback of a single phase half bridge inverter?	Remember	5
9	Why diodes should be connected in anti parallel with the thyristors in inverter circuits?	Understand	5
10	What is meant a series inverter?	Remember	5
11	What is the condition to be satisfied in the selection of L and C in a series inverter?	Understand	5
12	What are the applications of a series inverter?	Remember	5
13	What is meant a parallel inverter?	Remember	5
14	How is the inverter circuit classified based on commutation circuitry?	Remember	5
15	What is meant by McMurray inverter?	Understand	5
16	What is meant by PWM control?	Understand	5
17	What are the advantages of PWM control?	Remember	5
18	What are the disadvantages of the harmonics present in the inverter system?	Understand	5
19	What are the methods of reduction of harmonic content?	Apply	5
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?	Apply	5
2	a) Draw and explain the circuit diagram of single phase half and full bridge inverter. b) Compare series and parallel inverter on the basis of circuit components, current rating, type of communication and type of O/P waveforms.	Apply	5
3	Explain the operation of 3 phase bridge inverter for 180 degree mode of operation with aid of relevant phase and line voltage waveforms.	Apply	5
4	Explain the operation of 3 phase bridge inverter for 120 degree mode of operation with aid of relevant phase and line voltage waveforms.	Apply	5
5	State different methods of voltage control inverters. Describe about PWM control in inverter.	Remember	5
6	a) Describe the pulse width modulated and sinusoidal pulse width modulated inverter. b) What are the advantages and disadvantages of sinusoidal pulse width modulation technique?	Remember	5
7	a) Describe the operation of basic series inverter. State its limitation. b) How the limitation is overcome in modified series inverter.	Understand	5
8	Describe the operation of basic parallel inverter with neat diagram.	Understand	5
9	What are the different pulse width modulation techniques used for inverters?	Remember	5
10	What is meant by load commutation in an Inverter? Under what condition commutation can be achieved by load.	Understand	5
11	How it is possible to achieve voltage control within the Inverter. Briefly explain them	Apply	5
12	Compare Single pulse width modulation over multiple pulse width modulation technique.	Apply	5
13	Compare the advantages and disadvantages of half bridge and full bridge	Understand	5

S. No	Question	Blooms Taxonomy Level	Course Outcome
	inverter.		
14	Which of the schemes gives better quality of voltage and current?	Remember	5
15	Draw the circuit diagram of 3 phase series inverter and explain its working.	Understand	5
Part – C (Analytical 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.	Apply	5
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	Evaluate	5
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.	Apply	5
4	A single PWM full bridge inverter feeds an RL load with $R=10\Omega$ and $L= 10$ 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.	Apply	5
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.	Evaluate	5
6	A single-phase bridge Inverter feeds an R-L-C series load with $R=3$, $L=6$ mH & $C=15\mu$ 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.	Apply	5
7	The single phase modified Me Murray full-bridge inverter is fed by dc source of 300V. The D.C. source voltage may fluctuate by $\pm 15\%$. The current during com-mutation may vary from 20 to 100A. Obtain the value of commutating components, if the thyristor turn-off time is 20μ s. Also compute the value of R.	Evaluate	5
8	Single phase half bridge inverter has a resistive load of $R = 3$ ohms and dc input voltage $E_{dc} = 50$ V. Calculate a) rms output voltage at fundamental frequency E_1 b) the output power c) average and peak current of each thyristor	Apply	5
9	A single phase full-bridge inverter has RLC load of $R = 4\Omega$, $L = 35$ mH and $C = 155\mu$ 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.	Apply	5
10	In a single-phase series inverter, the operating frequency is 50kHz and the thyristor turn-off time $t_q=10\mu$ s. Circuit parameters are: $R=3\Omega$, $L=60\mu$ H, $C=7.5\mu$ F and $V_s=220$ V DC. Determine (i) the circuit turn-off time and (ii) maximum possible operating frequency, assuming a factor of safety = 1.5.	Apply	5
11	A single PWM full bridge inverter feeds an RL load with $R=10\Omega$ and $L= 10$ 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.	Apply	5
12	The single phase modified Me Murray full-bridge inverter is fed by dc source of 300V. The d.c. source voltage may fluctuate by $\pm 12\%$. The current during com-mutation may vary from 20 to 90A. Obtain the value of commutating components, if the thyristor turn-off time is 25μ s. Also compute the value of R.	Evaluate	5
13	Single phase half bridge inverter has a resistive load of $R = 4$ ohms and dc input voltage $E_{dc} = 60$ V. Calculate a) rms output voltage at fundamental frequency E_1 b) the output power c) average and peak current of each thyristor	Apply	5

S. No	Question	Blooms Taxonomy Level	Course Outcome
14	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.	Apply	5
15	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: $R=4\Omega$, $L=60\mu\text{H}$, $C=7.5\mu\text{F}$ and $V_s=210\text{V DC}$. Determine (i) the circuit turn-off time and (ii) maximum possible operating frequency, assuming a factor of safety = 1.3.	Apply	5

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