INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

ASSIGNMENT

Course Name	**:**	**POWER ELECTRONICS**
Course Code	**:**	**A50220**
Class	**:**	**III B. Tech I Semester**
Branch	**:**	**Electrical and Electronics Engineering**
Year	**:**	**2017 – 2018**
Course Faculty	**:**	Mr. 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 - I **POWER SEMI CONDUCTOR DEVICES & COMMUTATION CIRCUITS**		
	Part - A (Short Answer Questions)		
1	What is a thyristor? How this term has been coined? Name the most popular thyristors?	Remember	1
2	Why IGBT is very popular nowadays?	Remember	1
3	What are the different methods to turn on the thyristor?	Understand	1
4	What is the difference between power diode and signal diode?	Analyze	1
5	How can a thyristor turned off?	Analyze	1
6	Define latching current?	Remember	1
7	Define holding current?	Understand	1
8	What is a Snubber circuit?	Remember	1
9	What losses occur in a thyristor during working conditions?	Analyze	1
10	What is meant by current communication of SCR?	Remember	1
11	Define circuit turn off time?	Remember	1
12	Why circuit turn off time should be greater than the thyristor turn-off time?	Analyze	1
13	What is the turn-off time for converter grade SCRs and inverter grade SCRs?	Analyze	1
14	What is meant by commutation?	Remember	1
15	What are the types of commutation?	Remember	1
16	What is meant by natural commutation?	Understand	1
17	What is meant by forced commutation?	Understand	1
18	Define string efficiency of SCRs connected in series.	Remember	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	Apply	1

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	SCR. 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 BJT has current gain β =40. The load resistance R_C=10 Ω, dc supply voltageVcc=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
10	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
	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
18	Differences between non-circulating current mode & circulating current node of a dual converter.	Understand	2
19	Give the relation between the firing angles of two converters in a dual converter.	Remember	2

S. No	Question	Blooms Taxonomy Level	Course Outcome
20	Give an expression for three phase full converter for a delay angle of 60^0	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 $\alpha = 30^0$.	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 $\omega Ls/\pi$ 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 45^0 for purely resistive load.	Analyze	2
9	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
10	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
11	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^o. 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
12	A three-phase half-wave controlled rectifier has a supply of 200V/phase. Determine the average load voltage for firing angle of 0^o, $30^o$and 60^o assuming a thyristor volt drop of 1.5V and continuous load current.	Apply	2
13	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^o.	Apply	2
14	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 5reach the load current constant. For a delay angle of 60^0, Determine i) average output voltage ii) average output current iii) average values of SCR current and iv) input power factor.	Apply	2
15	A three phase half wave converter is supplying a load with a continuous constant current of 50A over a firing angle from 0^o to 60^0. What will be the power dissipated by the load at these limiting values of firing angle. The supply voltage is 415V (line).	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 cyclo-converter?	Understand	3
8	Write down the expression for average output voltage for step down chopper	Remember	3
9	What is meant by FM control in a dc chopper?	Understand	3
10	What is meant by PWM control in dc chopper?	Understand	3
11	What are the applications of dc chopper?	Remember	3
12	What is meant by current commutation?	Remember	3
13	What is AC chopper?	Remember	3
14	What are the different types of chopper with respect to commutation process	Understand	3
15	What is Jones chopper?	Remember	3
17	Write down the expression for average output voltage for step up chopper.	Remember	3
17	What are the advantages and disadvantages of load commutated 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
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	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
12	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	Evaluate	3
13	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
14	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	Apply	3

S. No	Question	Blooms Taxonomy Level	Course Outcome
	duty cycle is 80%, find 1) Average output voltage 2) RMS output voltage 3) Chopper on time		
15	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 = 1Ω , L=1mH and E = 105V. Find whether the current is continuous and also find the values of I_{max} and $I_{min.}$	Evaluate	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 are the effects of load inductances on the performance of AC voltage controllers?	Apply	4
2	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
3	Explicate the principle of ON-OFF control used in a.c. voltage controller.	Understand	4
4	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
5	What is cyclo-converter? What are its limitations?	Understand	4
6	Explain the operation of single phase midpoint cyclo-converter with R and RL loads with neat waveforms.	Understand	4
7	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
8	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
9	Explain the different modes of operation of a TRIAC.	Remember	4

S. No	Question	Blooms Taxonomy Level	Course Outcome
10	In a standard A single-phase bridge-type cyclo-converter has input voltage of 230V, 50Hz and load of R=10Ω. Output frequency is one-third of input frequency. For a firing angle delay of 30^o, 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
11	A single phase voltage controller is employed for controlling the power flow from 230V, 50Hz source into a load circuit consisting of R=3 Ω and ωL=4 Ω. 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
12	A single phase voltage controller has input voltage of 230V, 50 Hz and a load of R=15Ω. For 6 cycles on and 4 cycles off, determine (i) rms output voltage (ii) input pf (iii) average and rms thyristor currents	Apply	4
13	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
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 ω_oL= 3ohms 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
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 fo/fs = 1/5. The firing angle delay α for all the four SCRs are the same. Sketch the time variations of the following waveforms for α = 0° and α = 30° (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)			
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

S. No	Question	Blooms Taxonomy Level	Course Outcome
	Part - B (Long Answer Questions)		
1	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
2	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
3	State different methods of voltage control inverters. Describe about PWM control in inverter.	Remember	5
4	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
5	a) Describe the operation of basic series inverter. State its limitation. b) How the limitation is overcome in modified series inverter.	Understand	5
6	Describe the operation of basic parallel inverter with neat diagram.	Understand	5
7	What are the different pulse width modulation techniques used for inverters?	Remember	5
8	What is meant by load commutation in an Inverter? Under what condition commutation can be achieved by load.	Understand	5
9	How it is possible to achieve voltage control within the Inverter. Briefly explain them	apply	5
10	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
11	The single phase half bridge inverter has a resistive load of 2.4 Ω 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
12	A single phase full bridge inverter has a resistive load of R = 10 Ω and the input voltage V_{dc} of 100 V. Find the average output voltage and rms output voltage at fundamental frequency.	Apply	5
13	A single PWM full bridge inverter feeds an RL load with R=10Ω 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
14	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
15	A single-phase bridge Inverter feeds an R-L-C series load with R=3, L=6mH & C=15μF. 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

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