

POWER ELECTRONICS

Full Marks – 70

Time : 3 Hours

*Answer question No. 1 which is compulsory and any five questions from the remaining questions.*

*The figures in the right hand margin indicate full marks for the questions.*

1. Answer **all** questions : 2×10
- (i) A UJT used for triggering an SCR has supply voltage  $V_{BB} = 25$  V. The intrinsic standoff ratio  $\eta = 0.75$ . At what bias voltage  $V_E$  the UJT will conduct ?

P.T.O.

(ii) Two identical SCRs are placed back-to-back in series with load. If each is fired at  $90^\circ$ , what will be the reading of a dc voltmeter connected across the load? Explain your answer.

(iii) A single-phase one pulse controlled rectifier has  $400 \sin 314t$  volts as the input voltage and resistor  $R$  as the load. For firing angle of  $60^\circ$  for the SCR, what is the average output voltage?

(iv) A dc source of 100 V supplies a purely inductive load 0.1 H. The controller is a thyristor in series with the source and load. The latching current specified is 100 mA. What is the minimum width of the gating pulse to ensure thyristor turn on?

(v) A thyristor is triggered by a pulse train of 5 KHz. The duty ratio is 0.4. If the allowable average power is 100 W. What is the maximum allowable gate drive power?

(vi) In a three phase semi converter, for firing angle less than or equal to  $60^\circ$ , what is the conduction angle of each diode and thyristor.

(vii) A voltage commutated chopper has the following parameters :

$V_s = 200$  V, load circuit parameters :  $1 \Omega$   
 $2$  mH,  $50$  V. Commutation circuit parameters :  
 $L = 25 \mu\text{H}$ ,  $C = 50 \mu\text{F}$ .

For constant load current at 100 A, what is the effective on period and peak current through the main thyristor?

(viii) Why cosine-law triggering scheme is commonly used?

(ix) If for a single-phase half bridge inverter, the amplitude of output voltage is  $V_s$  and the output power is  $P$ , then what is their corresponding values for a single-phase full-bridge inverter?



(x) In type A chopper source voltage is 100 V, dc on period = 100  $\mu$ s, off-period = 150  $\mu$ s and load RLE consists of  $R = 2 \Omega$ ,  $L = 5$  mH,  $E = 10$  V. For continuous conduction what are the average output voltage and average output current for this chopper ?

2. (a) Give the basic structural features and working of an IGBT. 3
- (b) Describe the static V-I characteristic of IGBT. 4
- (c) Why IGBTs becoming popular in their applications to controlled converters ? 3
3. (a) Can a forward voltage be applied to an SCR soon after its anode current has fallen to zero value ? Explain. 4
- (b) Justify the statement, "Higher the gate current, lower is the forward breakover voltage". 2

(c) Discuss the importance of  $di/dt$  rating during the turn-on process of a thyristor. 4

4. (a) Discuss how SCRs suffer from unequal voltage distribution across them during their turn-on and turn-off process. 4

(b) Three series connected thyristors, provided with static and dynamic equalizing circuits, have to withstand an off-state voltage of 8 kV. The static equalizing resistance is 8 k $\Omega$  and the dynamic equalizing circuit has  $R_c = 40 \Omega$  and  $C = 0.06 \mu$ F. These three thyristors have leakage currents of 25 mA, 23 mA and 22 mA respectively. Determine voltage across each SCR in the off-state and the discharge current of each capacitor at the time of turn on. 6

5. (a) Describe the working of a single-phase full converter in the rectifier mode with RLE load. Discuss how one pair of SCRs is

commutated by an incoming pair of SCRs. Illustrate your answer with waveforms for source voltage  $V_s$ , output voltage and current, source current, current through and voltage across one thyristor. Assume continuous conduction. Derive expressions for average and rms output voltage, 5

(b) A three phase half-wave converter is operated from a three phase Y-connected 220 V, 60 Hz supply and the load resistance is  $R = 10 \Omega$ . If the average output voltage is 25 % of the maximum possible average output voltage, calculate 5

- (i) the delay angle
- (ii) the rms and average output currents
- (iii) the average and rms thyristor currents
- (iv) the input power factor.

6. (a) With neat circuit diagrams and waveforms describe the operation of a current commutated chopper. 5

(b) A load-commutated chopper, fed from 230 V dc source, has a constant load current of 50 A. For a duty cycle of 0.4 and a chopping frequency of 2 kHz, compute, 5

- (i) the average output voltage
- (ii) the value of the commutating capacitance
- (iii) circuit turn-off time for one thyristor pair
- (iv) total commutation period.

7. (a) Discuss the principle of working of a three-phase bridge inverter with an appropriate circuit diagram. Draw phase and line voltage waveforms on the assumption that each

thyristor conducts for  $180^\circ$  and the resistive load is star-connected. The sequence of firing of various SCRs should also be indicated in the diagram. 5

(b) With circuit diagram and voltage waveforms, describe the operation of a single phase bridge cycloconverter. 5

8. Write short notes on : 5×2

(i) Parallel Inverter

(ii) UPS.

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