

Fifth Semester Examination – 2008

POWER ELECTRONICS

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory
and any **five** from the rest.

The figures in the right-hand margin
indicate marks.

1. Answer the following 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.

- (ii) Two identical SCRs are placed back-to-back in series with load. If each is fired at 90° , 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° 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° , 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 : 1Ω , 2 mH, 5 V. Commutation circuit parameters : $L = 25 \mu$ H, $C = \mu$ F.

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

(viii) Compare between SCR and BJT.

(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) 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?
2. (a) Why is the cosine firing scheme so popular? Describe a cosine-firing scheme for the triggering of thyristors. 5
- (b) Explain the method of protection of thyristor against dv/dt . 5
3. (a) Discuss the effect of source inductance on the performance of a single-phase full converter indicating clearly the conduction of various thyristors during one cycle.
- Derive expressions for its output voltage in terms of (i) maximum voltage V_m , firing angle α and overlap angle μ and (ii) V_m , α , L_s and load current I_o . Here L_s is the source inductance. 5

IWL

- (b) A single phase fully controlled converter is operated at $\alpha = 45^\circ$. Input voltage is single phase 230 V at 50 Hz, overlap angle is 3° . A continuous and ripple free load current is 10 A. Find the source inductance. 5
4. A three phase semi converter (full wave half-controlled) 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
- (a) the delay angle,
- (b) the rms and average output currents,
- (c) the average and rms thyristor currents,
- (d) the rectification efficiency,
- (e) the transformer utilization factor, and
- (f) the input power factor. 10

5. (a) Describe the operating principles of a three-phase dual converter with waveforms for delay angles of $\alpha_1 = 60^\circ$ and $\alpha_2 = 120^\circ$. 5

(b) A three phase dual converter is operated from a three-phase Y-connected 220-V, 60 Hz supply and the load resistance $R = 10\ \Omega$. The circulating inductance $L_r = 5\ \text{mH}$, and the delay angles are $\alpha_1 = 60^\circ$ and $\alpha_2 = 120^\circ$. Calculate the peak circulating current and peak current of the converter. 5

6. (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 120° and the resistive load is star

connected. The sequence of firing of various SCRs should also be indicated in the diagram. 5

(b) What are the advantages of pulse width modulation ? Describe the method of symmetrical two pulse modulation. Derive the expression for the nth harmonic voltage and find the peak value of the 3rd harmonic voltage. 5

7. (a) Explain the need of commutation in thyristor circuits. Discuss, with relevant waveforms, class-A and class-D (Impulse commutation) types of commutations employed for thyristors. 5

(b) A battery with its terminal voltage of 200 V is supplied with power from type-A chopper circuit. The output voltage of the chopper consists of rectangular pulses of 2 ms

duration in an overall cycle time of 5 ms.
Internal resistance of the battery is negligible. Calculate: 5

- (i) ripple factor
- (ii) average and rms values of output voltage
- (iii) rms value of fundamental component of output voltage ac ripple voltage.

8. Write notes on :

5×2 IWL

- (i) Jones Chopper
- (ii) Series Inverter.