POWER ELECTRONICS AND DRIVES
(AEIE 4102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) For regulation of ac voltages, the following device is used:
(a) triac (b) diac
(c) circuit breaker (d) diode.

(ii) Power MOSFETs find applications in
(a) low power low frequency applications
(b) low power high frequency applications
(c) high power low frequency applications
(d) high power high frequency applications.

(iii) A Schottky diode will have
(a) a low on state voltage and a small recovery time
(b) a low on state voltage and a high recovery time
(c) a high on state voltage and a low recovery time
(d) a high on state voltage and a high recovery time.

(iv) The snubber circuit is used in thyristor circuits for
(a) dv/dt protection (b) di/dt protection
(c) triggering (d) overcurrent protection.

(v) In a controlled rectifier a freewheeling diode is necessary if the load is
(a) inductive (b) resistive
(c) capacitive (d) all of these.

(vi) For an SCR in the reverse blocking mode, (practically)
(a) leakage current does not flow
(b) leakage current flows from anode to cathode
(c) leakage current flows from cathode to anode
(d) leakage current flows from gate to anode.

(vii) For a half wave bridge inverter, the output voltage
(a) $V_o = -V_s/2$ for $0 < t < T/2$ (b) $V_o = -V_s/2$ for $T/2 < t < T$
(c) $V_o = -V_s$ for $0 < t < T/2$ (d) $V_o = V_s/2$ for $T/2 < t < T$.

(viii) A step-up chopper has V_s as the source voltage and k as the duty cycle. The output voltage for this chopper is given by
(a) $V_s (1 + k)$ (b) $V_s / (1 - k)$
(c) $V_s (1 - k)$ (d) $V_s / (1 + k)$.

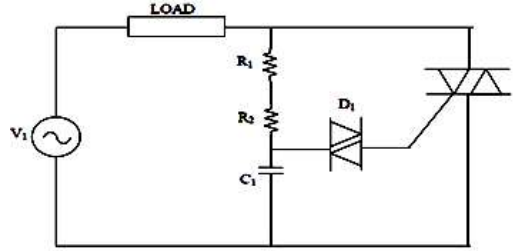
(ix) A cycloconverter can be considered to be composed of two converters
(a) connected back to back (b) series connected
(c) parallel connected (d) series- parallel connected.

(x) Power factor of synchronous motor can be made leading by adjusting its
(a) speed (b) supply voltage
(c) excitation (d) supply frequency.

Group – B

2. (a) Draw and explain the v-i characteristic of triac. Name the modes of operation of a triac. What is a difference between a Diac and a Triac?

(b) In the triac triggering circuit, the parameters are : input voltage V_1 = 230 V, 50 Hz, diac breakdown voltage = 30 V, load = 100 Ω, C_1 = 0.8 μF, R_1 = 900 Ω, R_2 can be varied from 1 kΩ to 19 kΩ. Find the minimum and maximum triggering angles of triac.



(4 + 2 + 2) + 4 = 12

3. (a) Describe the turn on and turn off switching characteristics of IGBT. Compare among power BJT, power MOSFET and IGBT.

(b) A power BJT is used to switch an inductive load carrying 20 A. The supply voltage is 200 V, switching frequency and duty cycle are 1 kHz and 0.5 respectively. Switching times are as follows, t_d = 1 μs, $t_{ri} = t_{fv1}$ = 8 μs, t_{fv2} = 0, t_s = 12 μs, $t_{fi} = t_{rv2}$ = 8 μs, t_{rv1} = 0. $V_{CE}|_{sat}$ = 1.0 V at i_c = 20 A. Calculate switching and conduction losses in the transistor.

(4 + 4) + 4 = 12

Group – C

4. (a) What is thyristor? Give the constructional details of a thyristor with a schematic diagram.

   (b) How positive feedback takes place during turn on of SCR?

(2 + 6) + 4 = 12

5. (a) What are the different turning on methods of a thyristor? Explain each method.

   (b) Discuss the different protection schemes of a thyristor.

7 + 5 = 12

Group – D

6. (a) Explain the operation of a parallel inverter and mention the merits.

   (b) A single phase half bridge inverter has a resistive load of 10 Ω and centre-tap dc input voltage of 96 volts. Compute (i) RMS value of output voltage, (ii) fundamental component of output voltage wave form and (iii) fundamental power consumed.

6 + (2 + 2 + 2) = 12

7. (a) Explain single phase half wave rectifier for RL load with suitable voltage and current wave forms. Derive the expression for average output voltage and current. Explain the effect of freewheeling diode with associated waveforms.

   (b) A single phase half-wave controlled rectifier with resistive load of 10Ω and it is fed from a 220 Volt, 50 Hz ac supply. When firing angle is 45^0 determine (i) average dc output voltage (ii) rms output voltage and (iii) form factor.

(2 + 2 + 2) + (2 + 2 + 2) = 12

Group – E

8. (a) Why does a chopper need forced commutation? What is duty cycle of a chopper? With neat diagram briefly explain the operation of a step up dc chopper.

   (b) A step up dc chopper has an input of 200 V and an output of 250 V. The blocking period in each cycle of operation is 0.6 ms. Find the period of conduction in each cycle. If the input voltage is decreased to 150 V, find the new period of conduction to maintain the same output voltage.

(2 + 1 + 5) + (2 + 2) = 12

9. (a) What is regenerative breaking? Briefly explain the regenerative breaking mode operation of chopper drives with suitable diagram.

   (b) A 230 V, 1500 rpm separately excited dc motor has an armature resistance of 1 Ω and rated armature current of 10 A. It is fed from 230 V, single phase 50 Hz supply through a fully controlled bridge converter. Compute
   (i) speed if torque is 6 N-m and triggering angle is 45^0.
   (ii) torque if speed is 1000 rpm and triggering angle is 30^0.

(2 + 4) + (3 + 3) = 12