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) In power electronics, the solid state devices function as
(a) amplifiers (b) controlled resistors
(c) switches (d) none of these.

(ii) Which of the following is not a current triggered device?
(a) thyristor (b) BJT (c) triac (d) MOSFET.

(iii) 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.

(iv) 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.

(v) In forward blocking mode of SCR, the number of forward biased junctions is
(a) 1 (b) 2 (c) 3 (d) 4.

(vi) By using a freewheeling diode (FD) in a rectifier with RL load, the power consumed by the load
(a) increases (b) decreases
(c) is not affected (d) decreases to zero.

(vii) A triac is a
(a) three terminal bi-directional switch
(b) two terminal unilateral switch
(c) three terminal unilateral switch
(d) two terminal bilateral switch.

(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 dc-dc converter is also known as:
(a) rectifier (b) inverter
(c) cyclo-converter (d) chopper.

(x) A cyclo-converter can be considered to be composed of two converters
(a) connected back to back (b) connected in series
(c) connected in series-parallel (d) connected in parallel.

Group - B

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

(b) Write short note on GTO.

(4 + 2 + 2) + 4 = 12

3. (a) Draw & explain the V-I characteristic of a triac. Name the modes of operation of a triac.

(b) What is UJT firing circuit and explain with suitable waveforms?

(4 + 4) + 4 = 12

Group - C

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

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

(2 + 6) + 4 = 12

5. (a) Explain the two-transistor analogy of thyristor. Derive an equation for anode current. State the condition for turn-on.

(b) Write short note on LASCR.

(3 + 3 + 3) + 3 = 12

Group - D

6. (a) What is the purpose of using three-phase ac to dc converter? Explain different types of three-phase controlled converter.

(b) A single-phase half controlled rectifier is with resistive load where the delay angle is 45◦. Find the (i) rectifier efficiency, (ii) form factor and (iii) ripple factor.

6 +(2 + 2 + 2) = 12

7. (a) What is current source inverter? Mention its merits and demerits as compared to voltage source inverter.

(b) A single-phase bridge inverter supplies to a series-connected RLC load having R=2 Ω and inductive reactance equal to 10Ω at frequency of 4 kHz. The turn-off time of the thyristor is 12μs. Assume 50% tolerance in circuit. Find the value of C for proper load commutation.

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

Group - E

8. (a) What is duty cycle of a chopper? With neat diagram briefly explain the operation of a step down 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 + 4) + (3 + 3) = 12

9. (a) Differentiate between non-circulating and circulating mode of cyclo-converters. A single–phase bridge-type cyclo-converter has input voltage of 230 V, 50 Hz and load of R = 10 Ω. Output frequency is one-third of input frequency. For a triggering angle of 30^0, calculate (i) rms value of output voltage, (ii) rms current of each converter, (iii) rms current of each thyristor and (iv) input power factor.

(b) A separately excited dc motor is fed from 300 V dc source through a one-quadrant chopper. The armature resistance is 0.5 Ω and armature current is 100 A. The voltage and torque constants are 1.4 V-sec/A-rad and 1.4 N-m/A^2. The field current is 2 A. The duty cycle of chopper is 0.5. Find (i) input power, (ii) speed and (iii) torque.

(4 + 4) + 4 = 12