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
(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 MOSFET is a
(a) voltage controlled device (b) current controlled device
(c) frequency controlled device (d) none of (a), (b) and (c).

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

(v) The average output voltage is maximum when SCR is triggered at ωt =
(a) π (b) 0
(c) π/2 (d) π/4.

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

(vii) For a full wave bridge inverter, the output voltage (Vo)
(a) Vo = Vs/2 for 0 < t < T/2 (b) Vo = Vs for 0 < t <T/2
(c) Vo = Vs for T/2< t < T (d) Vo = -Vs for T/2< t < 3T/2.

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

(ix) 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.

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

Group – B

2. Draw the V-I characteristics of TRIAC. State the different advantages and disadvantages of TRIAC. State and explain some of the application of TRIAC. **(4 + 4 + 4) = 12**

3. (a) What is an IGBT? Sketch the equivalent circuit and transfer characteristics of an IGBT.

(b) Compare the power MOSFETs with Power BJTs. **(4 + 4) + 4 = 12**

Group – C

4. (a) Draw and explain the different modes of operation using static V-I characteristic of thyristor. What is the effect of gate current on these characteristics?

(b) Define latching current and holding current. **(4 + 4) + 4 = 12**

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

(b) How do you protect the thyristor from over voltages and currents? Explain the various protection schemes available now-a-days. **(4 + 2) + (2 + 4) = 12**

Group – D

6. (a) Explain the operation of a single- thyristor half- wave controlled rectifier and draw the input and output waveforms.

(b) Single phase half controlled rectifier is with resistive load where the delay angle is 45^0. 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 compared to voltage source inverter.

   (b) A single-phase bridge inverter supplies bridge inverter supplies to series connected RLC load having R=3 Ω and inductive reactance equal to 12Ω at frequency of 5 kHz. The turn-off time of the thyristor is 14μs. Assume 50% tolerance in circuit. Find the value of Capacitor for proper load commutation.

(4 + 6) + 2 = 12

Group – E

8. (a) With neat circuit diagram explain a step up chopper with resistive load. What is current limit control?

   (b) A step-up chopper operating at 20 kHz has non-conductive time of 20μs. Calculate output voltage if the input voltage is 100 Volt DC.

(4 + 4) + 4 = 12

9. (a) Explain briefly the function of a Cycloconverter with proper circuit diagram.

   (b) 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°, calculate (i) rms value of output voltage (ii) rms current of each converter (iii) rms current of each thyristor and (iv) input power factor.

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