POWER ELECTRONICS & DRIVES
(AEI2204)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The minimum value of anode current below which it must fall to completely turn-off the device is called as the
(a) holding current value (b) latching current value
(c) switching current value (d) peak anode current value

(ii) 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

(iii) A single-phase half-wave thyristor circuit with R load is triggered at an angle of $\alpha = 0^0$. As such, the maximum value of the average output voltage would be given by (considering $V_s = V_m \sin\omega t$)
(a) V_m (b) $2V_m/\pi$
(c) V_m/π (d) V_m/α

(iv) In voltage source inverters (VSIs), the output currents_____
(a) amplitude depends upon the load impedance
(b) waveform depends upon the load impedance
(c) amplitude as well as the nature of the waveform depends on the load
(d) both amplitude and waveform are independent of the load impedance

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

(vi) The duty cycle of a chopper ?
(a) T_{on}/T_{off} (b) T_{on}/T
(c) T/T_{on} (d) $T_{off} * T_{on}$

(vii) If T is the time period for a chopper circuit and α is its duty cycle, then the chopping frequency is
(a) T_{on}/α (b) T_{off}/α
(c) α/T_{off} (d) α/T_{on}

(viii) If a three-phase induction motor is operated in motoring mode, the torque is
(a) directly proportional to slip
(b) inversely proportional to slip
(c) independent of the slip
(d) proportional to the square of the slip

(ix) Which of the following motors are preferred for traction work?
(a) Universal motor (b) D.C. series motor
(c) Synchronous motor (d) Three-phase induction motor

(x) 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

Fill in the blanks with the correct word

(xi) A triac can pass a portion of _____ half-cycle through the load.

(xii) A _____ converts the input dc current to an ac current at output.

(xiii) In a controlled rectifier a freewheeling diode is necessary if the load is _____.

(xiv) For a step-up chopper, when the duty cycle is increased the average value of the output voltage _____.

(xv) When the speed of D.C motor is increased, Back E.M.F _____ and current drawn _____.

Group - B

2. (a) Draw the basic structure of an IGBT and explain its operation. *[(CO1)(Understand/LOCQ)]*

(b) The V_g-I_g characteristics of an SCR is given by $V_g = 1 + 9I_g$. The gate pulses are rectangular with amplitude of 12 V, duty cycle is 0.3 and duration of 60 μs. Determine the series resistance in the gate circuit to limit the peak power loss to 6W. Also calculate the average gate power loss. *[(CO1)(Analyse/IOCQ)]*

(c) Compare the performance characteristics of MOSFET with BJT. *[(CO1)(Analyse/IOCQ)]*

5 + 4 + 3 = 12

3. (a) How do you protect the thyristor from over voltages and currents? Explain the various protection schemes available now-a-days. *[(CO1)(Analyse/IOCQ)]*

(b) Give the constructional details of a thyristor and schematic diagram. *[(CO1)(Understand /LOCQ)]*

(2 + 4) + 6 = 12

Group - C

4. (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. *[(CO2)(Analyse/IOCQ)]*

   (b) Why are the single phase bridge converters advantageous over single phase centre-tap converters? *[(CO2)(Analyse/IOCQ)]*

(3 + 3 + 3) + 3 = 12

5. (a) What is current source inverter? Mention its merits and demerits as compared to voltage source inverter. *[(CO3)(Analyse/IOCQ)]*

   (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. Calculate the value of C for proper load commutation. *[(CO3)(Analyse/IOCQ)]*

(2 + 4) + 6 = 12

Group - D

6. (a) A step down DC chopper has input voltage of 230 V with 10 Ω load resistor connected, voltage drop across chopper is 2 V when it is ON. For a duty cycle of 0.4, calculate: (i) Average and rms values of output voltage (ii) Power delivered to the load. *[(CO3)(Analyse/IOCQ)]*

   (b) A chopper operating from 220V dc supply with for a duty cycle of 0.4 and chopping frequency of 1KHz drives an R L load with R = 1Ω , L=1mH and E = 105V. Find whether the current is continuous and also find the values of I_{max} and I_{min}. *[(CO3)(Analyse/IOCQ)]*

(4 + 4) + 4 = 12

7. (a) Why is forced commutation necessary for choppers? Why is natural commutation not possible? *[(CO3)(Understand/LOCQ)]*

   (b) Draw the circuit of load commutated chopper and explain its operation. *[(CO3)(Understand/LOCQ)]*

   (c) Can chopper be both step up and step down? *[(CO3)(Understand/LOCQ)]*

(2 + 1) + 7 + 2 = 12

Group - E

8. (a) What is regenerative breaking? Briefly explain the regenerative breaking mode operation of chopper drives with suitable diagram. *[(CO5)(Understand/LOCQ)]*

   (b) What are the advantages of microprocessor based control of traction motors? *[(CO5, CO6)(Remember/LOCQ)]*

(2 + 6) + 4 = 12

9. (a) Explain why stator voltage control is suitable for speed control of induction motors in fan and pump drives. *[(CO6)(Evaluate/HOCQ)]*

   (b) Explain how braking of synchronous motor is done using VSI. *[(CO6)(Analyse/IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	62.5	6.25