POWER ELECTRONICS & DRIVES
(AEIE 3102)

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

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

(iii) Power MOSFET is a
(a) voltage controlled device (b) current controlled device
(c) frequency controlled device (d) none of these.

(iv) 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.

(v) 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.

(vi) 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 $T/2 < t < T$.

(vii) 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.

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

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

(x) Cycloconverter converts
(a) ac voltage to dc voltage
(b) dc voltage to ac voltage
(c) ac voltage to dc voltage at same frequency
(d) ac voltage at supply frequency to ac voltage at load frequency.

Group- B

2. (a) Draw the two transistor model of SCR and derive an expression for anode current. [(CO1)(Apply/IOCQ)]
(b) Describe the various methods of thyristor turn-on. [(CO1)(Remember/LOCQ)]
8 + 4 = 12

3. (a) Explain the switching performance of BJT with relevant waveforms indicating clearly the turn on, turn off times and their components. [(CO1)(Apply/IOCQ)]
(b) Compare the performance characteristics of MOSFET with BJT. [(CO1)(Apply/IOCQ)]
8 + 4 = 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)(Understand/IOCQ)]
(b) What are the advantages of single phase bridge converter over single phase mid-point converter? [(CO2,CO6)(Analyze/IOCQ)]
(3 + 3 + 3) + 3 = 12

5. (a) Discuss the purpose of using three phase ac to dc converter? Explain different types of three phase controlled converter. [(CO2,CO6)(Evaluate/HOCQ)/(Remember/LOCQ)]
(b) A single-phase half-wave controlled rectifier supplied from 230V a.c. supply is operating at $\alpha = 60^0$. If the load resistor is 10 Ω, determine:
(i) The power absorbed by the load (Pdc).
(ii) The power drawn from the supply (Pac).
(iii) The power factor at the a.c. source. [(CO2, CO6)(Analyze, Apply/IOCQ)]
(3 + 3) + (2 + 2 + 2) = 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, CO6)(Evaluate/HOCQ)]

(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, CO6)(Evaluate/HOCQ)].

(4 + 4) + 4 = 12

7. (a) What is meant a series inverter? What is the condition to be satisfied in the selection of L and C in a series inverter? What are the applications of a series inverter?

[(CO4, CO6)(Understand/LOCQ)]

(b) A single phase full bridge inverter has rms value of fundamental component of output voltage with single pulse width modulation equal to 110V. Compute the pulse width required and the rms value of output voltage in case dc source voltage is 220V.

[(CO4, CO6)(Evaluate /HOCQ)]

(3 + 3 + 2) + 4 = 12

Group - E

8. (a) Define electric drives? What are the various parts of electrical drives?

[(CO5, CO6 (Analyse/IOCQ)

(b) Define armature reaction. What are the main effects of armature reaction?

[(CO5, CO6)(Analyse/IOCQ)]]

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

9. (a) What is regenerative breaking? Briefly explain the regenerative breaking mode operation of chopper drives with suitable diagram.[(CO5, CO6 (Analyse /IOCQ)]]

(b) What are the advantages of microprocessor based control of traction motors?

[(CO5, CO6)(Analyse/IOCQ)]]

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

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	15.62	64.58	19.79

Course Outcome (CO):

After the completion of the course students will be able to

2. Describe single phase power converter circuits and understand their applications.
3. Analyze three phase power converter circuits and understand their applications.
4. Explain inverter, chopper circuits and list their industrial uses.
5. Understand the applications of AC and DC drives in industry.
6. Learn about power converters for sustainable energy technologies.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question