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

   (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) The average output voltage is maximum when SCR is triggered at $\omega t =$
   (a) π (b) 0 (c) $\pi/2$ (d) $\pi/4$

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

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

   (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 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)   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)(Understand/LOCQ)]

   (b) 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?
                                                    [(CO1) (Remember/LOCQ)]
                                                    (4 + 4) + (2 + 2) = 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 UJT.
                                                    [(CO1) (Apply/IOCQ)]
                                                    (4 + 4) + 4 = 12

Group - C

4. (a) Explain single phase half wave rectifier for RL load with suitable voltage and current wave forms. Explain the effect of freewheeling diode with associated waveforms.   [(CO2) (Understand/LOCQ)]

   (b) The single-phase half-wave controlled rectifier supplies a resistive load draws an average current of 1.62 A. If the converter is operated from a 240 V, 50 Hz supply and if the average value of the output voltage is 81V, calculate the following:
        i. The firing angle α.
        ii. Load resistance.
        iii. The rms load voltage.
        iv. The rms load current.
        v. DC power.
        vi. The ripple factor.   [(CO6) (Evaluate/HOCQ)]
                                                    (3 + 3) + (1 + 1 + 1 + 1 + 1 + 1) = 12

5. (a) Explain the operation of three phases fully controlled bridge converter with RL loads. Illustrate in detail with discontinuous conduction mode with associated waveforms.   [(CO6)(Analyze, Apply/IOCQ)]

    (b) A single-phase half-wave controlled rectifier supplied from 230V a.c. supply is operating at α = 60°. If the load resistor is 10, 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)(Evaluate /HOCQ)]

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

Group - D

6. (a) What is duty cycle of a chopper? With neat diagram briefly explain the operation of a stepdown dc chopper.   [(CO3)(Remember/LOCQ)]]

    (b) 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) (Evaluate/HOCQ)]

    (2 + 3) + (4 + 3) = 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) (Understand/LOCQ)]

    (b) Evaluate different methods for voltage control inverters. How can you apply PWM control in inverter action?   [(CO4) (Evaluate /HOCQ)]

    (3 + 3 + 2) + 4 = 12

Group - E

8. (a) What is meant by V/F control? What are the advantages of V/F control?
                                    [(CO5) (Analyse/IOCQ)]

    (b) Explain armature reaction.Identify the main effects of armature reaction?
                                    [(CO5) (Analyse/IOCQ)]]
    (4 + 2) + (3 + 3) = 12

9. (a) State two basic speed control schemes of DC shunt motor? Why is the starting current high in a DC motor? Why series motor cannot be started on no-load?
                                    [(CO5) (Analyse /IOCQ)]]

    (b) What is meant by rotor resistance control? What are the advantages of microprocessor-based control of traction motors? [(CO5) (Understand/LOCQ)]]
    (2 + 2 + 2) + (3 + 3) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	38.5%	37.5%	24%

Course Outcome (CO):

After the completion of the course students will be able to
1. Gain knowledge on basic power electronics devices.
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

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/NDA1NTYyMzUxMDE0/a/NDY0NTMzNDk3NDE5/details