

**Bihar Engineering University, Patna**  
**End Semester Examination - 2022**

Course: B.Tech.  
Code: 100506

Semester: V  
Subject: Power Electronics

Time: 03 Hours  
Full Marks: 70

**Instructions:-**

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.

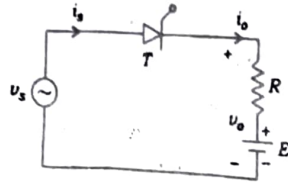
**Q.1 Choose the correct option of the following (Any seven question only):**

[2 x 7 = 14]

- (a) In a 3-phase full-wave a.c. to d.c. converter, the ratio of output-ripple frequency to the supply-voltage frequency is
    - (i) 2
    - (ii) 3
    - (iii) 6
    - (iv) 12
  - (b) Reverse recovery current in a diode depends upon
    - (i) forward field current
    - (ii) storage charge
    - (iii) temperature
    - (iv) PIV
  - (c) The most suitable device for high frequency inversion in SMPS is
    - (i) BJT
    - (ii) IGBT
    - (iii) MOSFET
    - (iv) GTO
  - (d) As compared to power MOSFET, a BJT has
    - (i) lower switching losses but higher conduction loss
    - (ii) higher switching losses and higher conduction loss
    - (iii) higher switching losses but lower conduction loss
    - (iv) lower switching losses and lower conduction loss
  - (e) In a thyristor-controlled rectifier, the firing angle of thyristor is to be controlled in the range of
    - (i)  $0^\circ$  to  $90^\circ$
    - (ii)  $0^\circ$  to  $180^\circ$
    - (iii)  $90^\circ$  to  $180^\circ$
    - (iv)  $90^\circ$  to  $270^\circ$
  - (f) A single-phase voltage source square-wave inverter feeds pure inductive load. The waveform of the load current will be
    - (i) triangular
    - (ii) rectangular
    - (iii) trapezoidal
    - (iv) sinusoidal
  - (g) An SCR is a
    - (i) four layer, four junction device
    - (ii) four layer, three junction device
    - (iii) four layer, two junction device
    - (iv) three layer, single junction device
  - (h) In a step down chopper, if  $V_s = 100$  V and the chopper is operated at a duty cycle of 75%. Find the output voltage.
    - (i) 100 V
    - (ii) 25 V
    - (iii) 75 V
    - (iv) None of the above
  - (i) The single phase mid-point type cycloconverter uses \_\_\_\_\_ number of SCRs
    - (i) 2
    - (ii) 4
    - (iii) 5
    - (iv) 8
  - (j) The principle of three phase cycloconverter is to
    - (i) add and remove number of SCRs
    - (ii) vary progressively the firing angle of the devices
    - (iii) keep the firing angle as  $0^\circ$  for all the devices
    - (iv) none of the mentioned
- Q.2 (a)** A 3-phase bridge inverter delivers power to a resistive load from a 450 V d.c. source. For a star connected load  $10 \Omega$  per phase, determine the following for  $120^\circ$  mode of operation: [7]
- (i) r.m.s value of output phase and line voltages
  - (ii) r.m.s value of load current
  - (iii) Load power

- (b) Describe the structural features of power diodes. How do these differ from signal diodes? [7]

- Q.3 (a) A battery is charged through a resistor R as shown below: [10]



If  $v_s = 220\sqrt{2} \sin\omega t$ ,  $E=100$  V (d.c) and  $R = 20 \Omega$ , calculate the battery charging current and power supplied to the battery.

- (b) Write down any four applications of cycloconverters. [4]

- Q.4 (a) Explain the I-V characteristics of a thyristor. Label the various voltages, currents and the operation modes. [6]

- (b) A 3-phase full converter delivers a ripple free load current of 10 A with a firing delay of  $45^\circ$ . The input voltage is 3-phase, 400 V, 50 Hz- [8]

(i) draw the waveform of source current and write the expression of Fourier series;

(ii) calculate input power factor and THD.

- Q.5 (a) Explain the time ratio control and current limit control of DC choppers. [8]

- (b) For an SCR, gate-cathode characteristic is given by  $V_g = 1 + 10I_g$ . Gate source voltage is a rectangular pulse of 15 V with  $20\mu$  sec duration. For an average gate power dissipation of 0.3 W and a peak gate-drive power of 5 W, compute: [6]

(i) the resistance to be connected in series with the SCR gate

(ii) the triggering frequency

(iii) the duty cycle of the triggering pulse.

- Q.6 With the help of equivalent circuit, obtain the nature of waveform of phase voltage of a star connected resistive load fed from a three phase DC to AC bridge inverter operating in  $120^\circ$  conduction time. [14]

- Q.7 (a) For type A chopper connected to RLE load, write the basic voltage equation and derive the expression for the maximum and minimum value of load current in terms of source voltage  $V_s$ , R, E, T,  $\alpha$ ,  $T_a$  [7]

- (b) A type-A chopper feeds RLE load. For low values of  $T_{ON}$ , limit of continuous conduction is reached when load current during  $T_{ON} < t < T$  fall to zero. Derive an expression for this load current from basic voltage equations and hence obtain waveform that the duty cycle  $\alpha'$  at the limit of continuous conduction is given by [7]

$$\alpha' = \frac{T_a}{T} \ln \left[ 1 + \frac{E}{V_s} (e^{T/T_a} - 1) \right]$$

Where  $V_s$  = source voltage,  $T_a = L/R$  and  $T$  = chopping period

- Q.8 (a) A single phase ac voltage controller is employed for controlling the power flow from 230 V, 50 Hz source in to a load circuit consisting of  $R = 4\Omega$  and  $\omega L = 3 \Omega$ . Calculate (i) the control range of Firing angle; (ii) the maximum power delivered to load and power factor; (iii) the maximum values of average and rms SCR currents. [7]

- (b) Describe the operation of single phase full wave ac regulator feeding resistive load. Derive the expression for output voltage. [7]

- Q.9 Write short notes on any two of the following: [7x2=14]

- (i) Boost convertor (ii) Cycloconverters (iii) Firing circuits for thyristors  
(iv) Thyristor commutation techniques