

Total No. of printed pages = 4

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02/01/2023

2022

BINA CHOWDHURY CENTRAL LIBRARY  
(E.I.T. & G-3)  
Azim, Hoshangabad.  
Guzarat-381017

B.Tech. 5<sup>th</sup> Semester End-Term Examination

Electrical Engineering

POWER ELECTRONICS

((For New Regulation w.e.f. 2017-18) &  
(New Syllabus 2018-19))

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Choose the correct answer : (10 × 1 = 10)
- (i) For reliable commutation in class-B commutation circuit, the peak value of the capacitor current would be
- (a) Equal to the main thyristor current
  - (b) Equal to the load current
  - (c) More than the load current
  - (d) Less than the load current
- (ii) The softness factor for soft-recovery and fast recovery power diodes are respectively
- (a) 1, >1
  - (b) <1, 1
  - (c) 1, 1
  - (d) 1, <1
- (iii) In a thyristor
- (a) Latching current is associated with turn-off process and holding current with turn-on process
  - (b) Both are associated with turn-off process
  - (c) Latching current is associated with turn-on process and holding current with turn-off process
  - (d) Both are associated with turn-on process

[Turn over

(iv) In a single phase semi-converter with resistive load and for a firing angle  $\alpha$ , each SCR and freewheeling diode conduct, respectively, for

- (a)  $\alpha, 0^\circ$  (b)  $\pi - \alpha, \alpha$   
(c)  $\pi + \alpha, \alpha$  (d)  $\pi - \alpha, 0^\circ$

(v) A dc chopper is fed from constant voltage mains. The duty ratio  $\alpha$  of the chopper is progressively increased while the chopper feeds RL load. The per unit current ripple would be

- (a) Increase progressively  
(b) Decrease progressively  
(c) Decrease to a minimum value at  $\alpha = 0.5$  and then increase  
(d) Increase to a minimum value at  $\alpha = 0.5$  and then decrease

(vi) In the single phase modulation of PWM inverters, fifth harmonic can be eliminated if pulse width is equal to

- (a)  $30^\circ$  (b)  $72^\circ$   
(c)  $36^\circ$  (d)  $108^\circ$

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(vii) In series resonant inverter

- (a) The load current has square waveform  
(b) Trigger frequency is higher than damped resonant frequency  
(c) Change of frequency does not alter transferred power  
(d) Output voltage depends upon damping factor of the load

(viii) The number of thyristors required for single phase to single phase cycloconverter of the mid-point type is

- (a) 4 (b) 8  
(c) 6 (d) 12

(ix) Consider the following statements :

SMPS are preferred over the continuous types, because these are :

1. Suitable for use in both ac and dc
2. More efficient
3. Suitable for low power circuits
4. Suitable for high power circuits.

Of these statements, the correct is

- (a) 1, 2 (b) 1, 3  
(c) 2, 3 (d) 2, 4



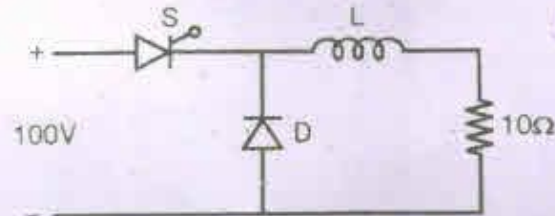
(x) An UJT exhibit negative resistance region

- (a) Before the peak point
- (b) Between peak and valley point
- (c) After the valley point
- (d) Both (a) and (b)

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2. (a) Explain with the help of waveform the two-quadrant type-B chopper with output voltage negative. (4)
- (b) In a type-A chopper, source voltage is 100 V dc, on-period = 100  $\mu$ s, off-period = 150  $\mu$ s and RLE consists of  $R = 2 \Omega$ ,  $L = 5$  mH,  $E = 10$  V for continuous conduction, find the average output voltage. (3)
- (c) Explain the switching characteristics of IGBT. How IGBT differs in structure from PMOSFET? (6 + 2)
3. (a) Describe the operation of a single-phase two-pulse mid-point converter with relevant voltage and current waveforms. Discuss how each SCR is subjected to a reverse voltage equal to double the supply voltage in case turns ratio from primary to each secondary is unity. (6 + 4)
- (b) Following are the specification of a thyristor operating from a peak supply of 500 V: repetitive peak current,  $I_p = 150$  A,  $(dv/dt)_{max} = 100$  v/ $\mu$ s and  $(di/dt)_{max} = 60$  A/ $\mu$ s.
- Take a safety factor of 2 for the three specifications mentioned above. Design a suitable snubber circuit if the minimum load resistance is 20  $\Omega$ . Take  $\xi = .65$ . (5)
4. (a) Describe the various techniques adopted for the protection of SCRs. (5)
- (b) A Thyristor string is made up of a number of SCRs connected in series and parallel. The string has voltage and current ratings of 11 kV and 4 kA respectively. The voltage and current ratings of available SCRs are 1800 V and 1000A respectively. For a string efficiency of 90%, calculate the number of series and parallel SCRs. For these SCRs maximum off-state blocking current is 12 mA. Determine the value of static equalizing resistance for the string. Derive the formula used for this resistance. (5)
- (c) What is an UPS? Describe the various types of UPS with its industrial application. (5)

5. (a) Discuss the principle of working of a three-phase bridge inverter with an appropriate circuit diagram. Draw phase and line voltage waveforms on the assumptions that each thyristor conducts for  $180^\circ$  and the resistive load is star-connected. (10)
- (b) Figure below shows a chopper operating from a 100 V dc input. The duty ratio of the main switch S is 0.8. The load is sufficiently inductive so that the load current is ripple free. Find the average current through the diode D under steady state condition. (5)



6. (a) Explain the need of commutation circuit for thyristor. Enumerate the various commutation schemes used for thyristors. (4)
- (b) For the class C commutation circuit,  $V_s = 200$  V,  $R_1 = 20 \Omega$ , and  $R_2 = 100 \Omega$ . Determine the minimum value of C so that thyristor do not get turned-on due to re-applied  $dv/dt$ . Each SCR has a minimum charging current of 4mA to turn it on and its junction capacitance is 20pF. (6)
- (c) A three-phase semi-converter, fed from 3-phase, 400 V, 50 Hz source, delivers power to load such that load current is continuous. The triggering angle for each SCR is such that FD conducts for  $60^\circ$ . Find the firing angle for each SCR. (5)
7. Write short notes on any *three* of the following : (3 × 5 = 15)
- Single-phase to single-phase step down cyclo-converter
  - SCR based battery charger circuit
  - Single-phase full wave AC voltage controller
  - Other members of the thyristor family: PUT, SUS, LASCR
  - Application of Power Electronics devices as a replacement of electromechanical devices.