

B.Tech 5th Semester Exam., 2020
(New Course)

POWER ELECTRONICS

Time : 3 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.

1. Choose the correct answer of the following
(any seven) : 2×7=14

- (a) It is preferable to use a train of pulse of high frequency for gate triggering of SCR in order to reduce
- (i) dv/dt problem
 - (ii) di/dt problem
 - ~~(iii)~~ the size of the pulse transformer
 - (iv) the complexity of the firing circuit

(b) Reverse recovery current in a diode depends upon

- ~~(i)~~ forward field current
- (ii) storage charge
- (iii) temperature
- (iv) PIV

(c) 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

(d) A fully controlled natural commutated 3-phase bridge rectifier is operating with a firing angle $\alpha = 30^\circ$. The peak to peak voltage ripple expressed as a ratio of the peak output d.c. voltage to the output of the converter bridge is

- (i) 0.5
- (ii) $\sqrt{3}/2$
- (iii) $1 - (\sqrt{3}/2)$
- ~~(iv)~~ $\sqrt{3} - 1$

(e) Natural commutation of a thyristor takes place when

- ~~(i)~~ anode current becomes zero
- (ii) gate current becomes zero
- (iii) voltage across the device becomes zero
- (iv) voltage across the device becomes negative

(f) A four-quadrant chopper cannot be operated as

- (i) one-quadrant chopper
- ~~(ii)~~ cycloconverter
- (iii) inverter
- (iv) bi-directional rectifier

(g) A boost regulator has an input voltage of 5 V and the average output voltage of 15 V. The duty cycle is

- (i) $3/2$
- ~~(ii)~~ $2/3$
- (iii) $5/2$
- (iv) $15/2$

(h) PWM switching is preferred in voltage source inverter for the purpose of

- (i) controlling output voltage
- (ii) output harmonics
- (iii) reducing filter size
- (iv) controlling output voltage, output harmonics and reducing filter size

(i) Compared to a single-phase half-bridge inverter, the output power of a single-phase full-bridge inverter is higher by a factor of

- (i) 12
- (ii) 8
- (iii) 4
- (iv) 2

(j) How many switches are used to construct a 3-phase to 3-phase cycloconverter?

- (i) 3
- (ii) 6
- (iii) 12
- (iv) 18

2. (a) A single-phase bridge-type cyclo-converter feeds a load R . For an output frequency equal to one-third of the input frequency, sketch output voltage waveform for a firing angle of about 30° . Also derive an expression for the r.m.s. output voltage.
- (b) Explain the processes of dv/dt triggerring and temperature triggering.

10+4=14

3. (a) A 3-phase bridge inverter delivers power to a resistive load from a 450 V d.c. source. For a star-connected load 10Ω per phase, determine the following for 120° mode of operation :

(i) r.m.s. value of output phase and line voltages

(ii) r.m.s. value of transistor current

(iii) r.m.s. value of load current

(iv) Load power

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

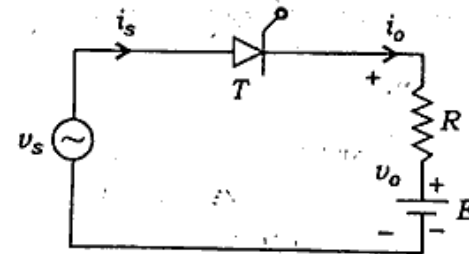
8+6=14

4. (a) A single-phase full-converter delivers a constant load current I_0 . Express its source current in Fourier series.
- (b) Derive the expressions for the following performance parameters with the help of waveforms and Fourier series expression in Question No. 4(a) :

Input displacement factor, Current distortion factor, Power factor, Total harmonic distortion, Voltage ripple factor, Active and Reactive power inputs

5+9=14

5. (a) A battery is charged through a resistor R as shown below :



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.

10+4=14

6. (a) Discuss with relevant waveforms, class-B (resonant-pulse commutation) type of commutation employed for thyristor circuits.
- (b) What are forward blocking losses and gate power loss in a thyristor? 10+4=14

7. (a) For step-down chopper circuit, source voltage $V_s = 220$ V, chopping period $T = 2000$ μ s, on period = 600 μ s, load circuit parameters—

$$R = 1 \Omega, L = 5 \text{ mH and } E = 24 \text{ V}$$

- (i) Find whether load current is continuous or not.
- (ii) Calculate the value of average output current.
- (iii) Compute the maximum and minimum values of steady state output currents.

- (b) Draw the circuit diagram of step-down chopper, also draw the waveforms of source voltage V_s and output voltage V_o for duty ratio $\alpha = 0.4$ and time period $T = 10$ μ s. 10+4=14

8. (a) Describe unipolar-voltage switching in a single-phase full-bridge inverter by suitable waveforms for carrier wave, reference wave and output voltage. Show the turn-on and turn-off of various switches in waveforms.
- (b) Justify why it is called unipolar-voltage switching inverter or three-level PWM inverter. 10+4=14
9. (a) Explain the operation of boost converter with voltage and current waveforms across the boost inductor. Assume continuous conduction.
- (b) Derive its output voltage equation in terms of duty cycle and input voltage. 7+7=14
