Code : 031709

B.Tech 7th Semester Exam., 2017

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 option (any *seven*) : 2×7=14

(a) In the SCR structure, the gate terminal is located

(i) near the anode terminal

(ii) near the cathode terminal

(iii) in between the anode and cathode terminal

(iv) None of the above

(b) The latching current is ____ the holding current.

(i) lower than

(ii) higher than

(iii) same as

(iv) negative of

(c) When a diode is connected in series with an AC source and *R* load, the conduction time per cycle is

(i) 0

(ii) 2π

(iii) π

(iv) $\pi/2$

(d) In a single-phase half-wave circuit with RL load and a freewheeling diode, the freewheeling period is

(i) 0 to π

(ii) α to $\pi+\alpha$

(iii) π to $2\pi+\alpha$

(iv) $\pi/2$ to $2\pi-\alpha$

(e) A three-phase three-pulse M-3 type controlled converter has firing angle for one of the SCRs set as 15°. This SCR would start conducting at

(i) 0°

(ii) 15°

(iii) 30°

(iv) 45°

(f) Find the output voltage for a step-up chopper when it is operated at a duty cycle of 50% and $V_s = 240V$.

(i) 240 V

(ii) 480 V

(iii) 560 V

(iv) 120 V

(g) In the 180° mode VSI, ____ devices conduct at a time.

(i) 5 (ii) 2

(iii) 3 (iv) 4

(h) In AC voltage controllers, the

(i) variable AC with fixed frequency is obtained

(ii) variable AC with variable frequency is obtained

(iii) variable DC with fixed frequency is obtained

(iv) None of the above

(i) The single-phase bridge-type cyclo-converter uses ____ number of SCRs.

(i) 4 (ii) 8

(iii) 6 (iv) None of the above

(j) A single full converter alone can give a

(i) four-quadrant operation

(ii) three-quadrant operation

(iii) two-quadrant operation

(iv) None of the above

2. (a) Describe the different modes of operation of a thyristor with the help of its static *V-I* characteristic. 8

(b) With the help of a neat diagram, explain the two-transistor analogy of an SCR. 6

3. (a) Explain the working of an oscillator employing an UJT. Derive expression for the frequency of triggering. 7

(b) A relaxation oscillator using a UJT is to be designed for triggering an SCR. The UJT has the following data :

$\eta = 0 \cdot 72$, $I_P = 0 \cdot 6$ mA, $V_P = 18V$,
$V_V = 1V$, $I_V = 2 \cdot 5$ mA, $R_{BB} = 5$ kΩ

Normal leakage current with emitter open = 4·2 mA. The firing frequency is 2 kHz. For $C = 0 \cdot 04 \mu F$, compute the values of R, R_1 and R_2. 7

4. *(a)* A single-phase half-wave controlled converter is operated from a 120 V, 50 Hz supply. Load resistance $R = 10\Omega$. If the average output voltage is 25% of the maximum possible average output voltage, determine—

(i) firing angle;

(ii) r.m.s. and average output currents;

(iii) average and r.m.s. SCR currents. 6

(b) Explain the operation of single-phase half-controlled bridge converter (symmetrical configuration) with resistive load along with suitable waveforms. Also derive the expressions for average load voltage, average load current and RMS load voltage. 8

5. A three-phase fully controlled converter is connected to a resistive load. Show that the average output voltage is given by

$$E_{dc} = \frac{3\sqrt{3}}{2\pi} E_m \cos\alpha, \quad \text{for } 0 < \alpha < \frac{\pi}{6} \text{ and}$$

$$E_{dc} = \frac{3}{2\pi} E_m [1 + \cos(\alpha + \frac{\pi}{6})], \quad \text{for } \frac{\pi}{6} < \alpha < \frac{5\pi}{6} \quad 14$$

6. *(a)* With the help of neat circuit diagram and associated waveforms, explain the operation of single-phase half-bridge voltage-source inverter with resistive load. 6

(b) The single-phase half-bridge inverter has a resistive load of 10 Ω and the center-tap DC input voltage is 96 V. Compute—

(i) RMS value of the output voltage;

(ii) fundamental component of the output voltage waveform;

(iii) first five harmonics of the output voltage waveform;

(iv) RMS power consumed by the load. 8

7. *(a)* Draw the schematic of step-down and step-up choppers and derive an expression for output voltage in terms of duty cycle for a step-up and step-down choppers. 8

(b) Draw the schematic of class E chopper and explain the working of the same. 6

8. Describe the basic principle of working of a single-phase to single-phase cycloconverter for both continuous and discontinuous conductions for a bridge-type cycloconverter. Mark the condition of various thyristors also. 14

9. *(a)* For a single-phase full-wave a.c. voltage controller feeding a resistive load, draw the waveforms of source voltage, gating signals, output voltage, source and output currents and voltage across SCRs. Describe its working with reference to the waveforms drawn. 10

(b) A single-phase full-wave a.c. voltage controller feeds power to a resistive load of 4 Ω from 230 V, 50 Hz source. Determine the peak values of average and RMS thyristor currents for any firing angle α. 4

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