53 (IE 602) PWEL

2014

POWER ELECTRONICS

Paper : IE 602

Full Marks : 100

Time : Three hours

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

Answer ***any five*** *questions.*

1. *(a)* Explain the constructional details and working of a Power MOSFET. 7

   (b) What is IGBT ? Give its basic structural features and discuss its working. 6

   (c) Describe the occurrence of Quasi-saturation and Hard saturation region in Power BJT. 5

(d) Discuss the significance of drift region in Power Devices. 2

2. (a) Discuss briefly the various mechanisms by which thyristors can be triggered into conduction. 5

(b) With respect to the two-transistor model of a thyristor, describe the mechanism of thyristor conduction due to gate triggering. 4

(c) Why in Snubber circuits a resistor is used in series with the capacitor ? A thyristor is placed between a constant *dc* voltage source of $240V$ and resistive load R. The specified limits of di/dt and dv/dt for the SCR are $60A/\mu sec$ and $300V/\mu sec$ respectively. Determine the values of the di/dt inductor and the Snubber circuit parameter. Take damping ratio as 0·5. 6

(d) Draw the thermal equivalent circuit of an SCR and deduce the relation between average power P_{av} and difference in temperature between junction and ambient. 5

3. (a) From the static equilizing circuit of series connected thyristors, determine the expressions for shunt resistance R. 4

(b) Distinguish between a G.T.O and an SCR. 3

(c) Describe the resistance-capacitance firing circuit with relevant waveforms. 5

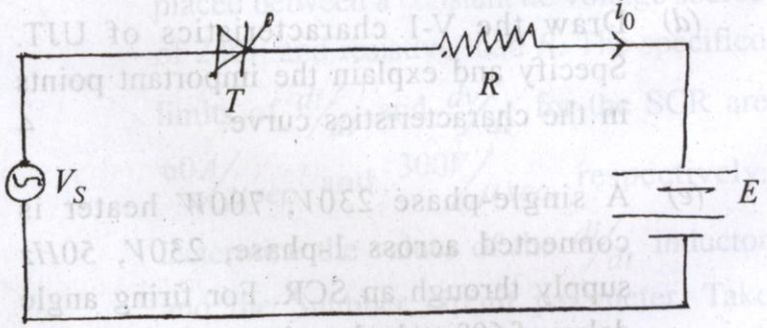
(d) Draw the V-I characteristics of UJT. Specify and explain the important points in the characteristics curve. 4

(e) A single-phase $230V$, $700W$ heater is connected across 1-phase, $230V$, $50Hz$ supply through an SCR. For firing angle delay of 60°, calculate the power absorbed in the heater element. 4

4. *(a)* For a single-phase full wave converter with *RL* load, determine the expression for average voltage and RMS voltage across the load. Also draw the relevant waveforms in each case. 8

(b) A *dc* battery is charged through a resistor *R* as shown in the figure. Derive an expression for the average value of charging current in terms of V_m, E, R etc. on the assumption that SCR is fired continuously.

For an *a.c* voltage of $230V$, $50Hz$, find the value of average charging current for $R = 10\Omega$ and $E = 140V$ 5



(c) For a 3-phase thyristor controlled half-wave rectifier with load R, show that average output voltages are given by

$$V_0 = \frac{3\sqrt{3}}{2\pi} V_{mp} \cos\alpha \quad \text{for } 0 < \alpha < \pi/6$$

and $$V_0 = \frac{3}{2\pi} V_{mp} [1 + \cos(\alpha + \pi/6)]$$

$$\text{for } \pi/6 < \alpha < \frac{5\pi}{6}$$

where V_{mp} is the maximum value of phase voltage and α is the firing angle delay. 7

5. (a) Describe the basic principle of Chopper operation. 4

(b) A step-up Chopper has input voltage of $200V$ and output voltage of $700V$. If the non-conducting time of thyristor-chopper is $100\mu sec$, compute the pulse width of output voltage.

In case pulse width is halved for constant frequency operation, find the new output voltage. 4

(c) What do you understand by two quadrant Chopper ? 2

(d) For a single-phase full wave *a.c* voltage controller feeding a resistive load, draw the waveforms of source voltage, output voltage and voltage across one SCR. Describe its working with reference to the waveform drawn. Also determine the expression for average value of O/P voltage. 6

(e) A single-phase half-wave *ac* voltage controller using one SCR in antiparallel with a diode, feeds $1kW$, $230V$ heater. Find the load power for a firing angle delay of *(I)* 70° *(II)* 180° *(III)* 0°. 4

6. (a) What is the function of a cycloconverter ? Describe the operation of a single-phase to single-phase step down cycloconverter with necessary diagrams and waveforms. 6

(b) Draw the circuit diagram of single-phase bridge inverter and explain its working. 4

(c) Determine the relations for the following in case of single phase bridge inverter 6

(I) RMS Output voltage V_0

(II) RMS Output voltage at the fundamental frequency V_{01}

(III) The total harmonic distortion (THD).

(d) What are the advantages of SMPS over regulated power supply ? Explain in brief the working of SMPS. 4

7. (a) Write short notes on ***any two :*** 7×2=14

(I) Three-phase bridge inverter

(II) Boost Converter

(III) Microprocessor control of power devices.

(b) Draw the gate drive circuit for Power BJT and power MOSFET. Describe in brief, the working of the circuits. 6