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# P.E.S. College of Engineering, Mandya - 571 401

***(An Autonomous Institution affiliated to VTU, Belagavi)***

## Fifth Semester, B.E. - Electrical and Electronics Engineering

## Semester End Examination; Dec - 2017/Jan - 2018

## Power Electronics

*Time: 3 hrs* *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

### UNIT - I

1 a. Explain the control characteristics of; (i) SCR (ii) GTO (iii) MCT (iv) IGBT. 8

b. Sketch and explain the switching characteristics of power MOSFET. 8

c. List any four applications of Power electronics. 4

2 a. Explain any four power electronic converter circuits with their circuit, input and output waveforms. 8

b. For the transistor switch of fig 2(b);

(i) Calculate forced Beta ($\beta_f$) of transistor

(ii) If the manufacturer's specified $\beta$ is in the range of 8 to 40, calculate the minimum Over Drive Factor (ODF)

(iii) Obtain the power loss $\rho_T$ of the transistor 8

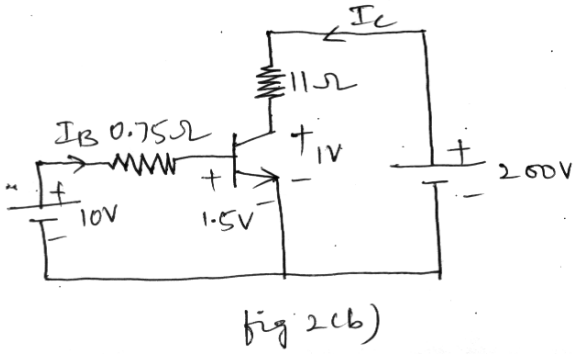


fig 2(b)

c. Suggest suitable remedial measures to reduce peripheral effects caused by power devices. 4

### UNIT - II

3 a. Explain the various methods that are used to turn on thyristors. 8

b. Calculate the required parameters for the snubber circuit to provide, $\frac{dv}{dt}$ protection to a SCR used in single phase bridge converter. The SCR has a minimum $\frac{dv}{dt}$ capability of 60 V/µs. The input line to line voltage has a peak value of 425 V and the source inductance is 0.2 mH. 6

c. Explain anti saturation control of power BJT. 6

4 a. Explain the two transistor analogy of an SCR. Derive an expression for anode current of SCR. 6

b. With a neat circuit diagram and waveform, explain RC firing circuit of SCR. 6

c. Ten thyristors are used in a string to withstand a dc voltage of $V_S$ = 15 kV. The maximum leakage current and recovery charge differences of thyristors are 10 mA and 150 µC. Each SCR has a voltage sharing resistance of R = 56 kΩ and capacitance of $C_1$ = 0.5 µF. 8

Contd…2

Determine;
(i) Maximum steady state voltage sharing $V_{DS(MAX)}$
(ii) The steady state voltage sharing derating factor
(iii) Maximum transient voltage sharing $V_{DT(MAX)}$
(iv) Transient voltage sharing derating factor.

**UNIT - III**

5 a. Explain resonant pulse commutation with a neat circuit and waveforms. 8

b. With relevant circuit and waveforms, explain phase control and derive the expression for output voltage. 8

c. Differentiate between Natural and Forced commutation. 4

6 a. Define commutation. What are the conditions for successful commutation? 6

b. With relevant circuit and waveforms, explain the operation of single phase full wave controller with R-load. 8

c. The complementary commutation circuit has load resistances of $R_1 = R_2 = R = 5\ \Omega$, capacitance, $C = 10\ \mu F$ and supply voltage, $V_S = 100$ V. Determine the circuit $t_{off}$ time. 6

**UNIT - IV**

7 a. Explain the principle of operation of step down chopper with R load. Also derive the expression for Average output voltage, $V_{0(av)}$ and $V_{0(rms)}$, rms output voltage. 8

b. Explain the performance parameters of Invertors. 6

c. A step down chopper with RL load has a load resistance of $R = 0.25\ \Omega$, input voltage $V_S = 550$ V and a battery voltage, $E = 0$ V. The average load current $I_a = 200$ A, and chopping frequency, $f = 250$ Hz. Using the average output voltage, calculate the load inductance L, which would limit the maximum load ripple current to 10% of $I_a$. 6

8 a. Briefly explain the classification of choppers. 8

b. With relevant circuit and waveforms, explain the operation of three phase bridge Inverter for $120^o$ mode of operation. 6

c. List the different voltage control techniques of Inverters. Also explain Sinusoidal Pulse Width Modulation (SPWM) technique. 6

**UNIT - V**

9 a. With a neat circuit and waveforms, explain the operation of single phase semiconverter with inductive load. 8

b. With a relevant circuit and waveforms, explain the operation of three phase Halfwave converter. 6

c. The single phase full converter with RL load having $L = 6.5$ mH, $R = 0.5\ \Omega$ and $E = 10$ V. The input voltage is $V_S = 120$ V at (rms) 60 Hz. Determine;
(i) The load current $I_{LO}$ at $\omega t = \alpha = 60^o$
(ii) The average thyristor current $I_A$
(iii) The rms thyristor current $I_R$
(iv) The rms output current $I_{rms}$. 6

10 a. With relevant circuit and waveforms, explain the operation of $1\phi$ dual converter. 8

b. With relevant circuit and waveforms, explain the operation of single phase 'Half wave converter'. Also derive the expression for $V_{a(rms)}$. 8

c. List the advantages of freewheeling diode. 4

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