This question paper contains 6 printed pages.

3294

Your Roll No.....

B.Tech.(E) / III **J**

Paper II - POWER ELECTRONICS
(EEE - 302)

Time : 3 hours *Maximum Marks :70*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Assume suitable missing data if any
Attempt any five questions
Attempt all parts of a question at one place.

1. a) What is the difference between a power diode and an electronic diode. What makes power diode withstand high reverse blocking voltage. Explain with VI characteristics and real structure diagrams. *03*

   b) Draw a neat diagram depicting VI characteristics of Thyristor duly labelled at appropriate places. *02*

   c) Why Triacs are not suitable for highly inductive loads. Explain different modes of operation of TRIACS with neat structure diagrams. *05*

   d) Find limiting values of 'R' for the RC circuit used for UJT relaxation oscillator. The parameter of UJT are V_s = 30V, η = 0.51, I_p = 10μA, V_v = 3.5V and I_v = 10mA. The frequency of osciallation is 60Hz. Show that the value of 'R' for 'C' to be 0.5μF falls within the limiting values. Draw a neat diagram (VI characteristics) of UJT. *04*

P.T.O

2 a) Draw a neat diagram of complementary commutation circuit for turning off the main thyristor feeding load. Explain its operation with the help of waveforms. Briefly explain why maximum amplitude of current through the capacitor is $2V_s/R$. *05*

b) Design a RCD snubber circuit such that $V_s = 100V$, $I_c = 5A$, switching frequency is 100kHz with duty ratio of 50%. Use the criterion that the MOSFET voltage reaches its final value at the same time that MOSFET current reaches zero. *05*

c) Ten thyristors are used in string to withstand a dc voltage of $V_s = 15kV$. The maximum leakage current and recovery charge differences of thyristors are 10mA and 15μC, respectively. Each thyristor has a voltage sharing resistance of $R = 50k\Omega$ and capacitance of $C = 0.5\mu F$. Determine the maximum steady state and transient voltage sharing. *04*

3 a) In the single phase, full wave convertor the load consists of $R = 10\Omega$ and L = 50mH. The convertor is fed from sinusoidal supply voltage of $l_s = 240\sqrt{2}$ sinwt at 50Hz. Calculate the values for the average and rms load currents, the power dissipation and the power factor at the supply terminals if thyristor firing angle $\alpha = 45°$. *05*

b) For the full converter circuit having highly inductive load, calculate fourier components 'a_1' and 'b_1' at

fundamental frequency of its current. Further derive expression for displacement factor and power factor. *05*

c) Draw a neat diagram of output voltage waveform of
(i) Full converter feeding RL load having large inductor with $\alpha = 90^{\circ}$.
(ii) Full converter feeding RL load having small inductor with $\alpha = 90^{\circ}$ and $\beta = 210^{\circ}$.
(iii) Semi converter feeding RL load having large inductor with $\alpha = 30^{\circ}$.
(iv) Semi converter feeding RL load having large inductor with $\alpha = 180^{\circ}$. *04*

4 a) Derive the equation for output voltage, minimum value of inductor so as to have continuous conduction in the Buck - Boost convertor. Also derive the expression of ripple at the output. Draw neat diagram of the circuit and relevant waveforms. *05*

b) The buck dc-dc converter has the following parameters : $V_s = 50V$, $d = 0.4$, $L = 400\mu H$, $C = 100\mu F$, $f = 20kHz$, $R = 20\Omega$. Assuming ideal components calculate output voltage, maximum and minimum inductor current and output ripple voltage. *05*

c) Draw a neat diagram of two quadrant class 'D' chopper circuit, and explain briefly its operation through current and voltage waveforms. *04*

5 a) Explain briefly the Static Vor compensator circuit. How it can meet variable reactive power demand. Derive

an expression for net acceptance offered by TCR and SVC for compensation reactive power in terms of conduction angle 'σ'. *05*

b) A single phase ac voltage controller is connected to 120V (rms) 60Hz supply feeding resistive load of 15Ω. If the firing angle is kept at 88.1°, calculate the power delivered to the load and the input side power factor. *05*

c) With the help of neat diagram explain the operation of three phase - single phase cyclo converter. Draw its voltage waveform and indicate the positive and negative group of bridges / devices. *04*

6 a) Derive the expression of phase voltage (V_{ar}) across load for a three phase Y connected load for isolated neutral connection, and 120° conduction. Derive the inference that voltage waveforms does not contain triplens. Draw neat waveforms also. *07*

b) A single phase half bridge inverter supplies a resistive load of 10Ω. If supply voltage is 200V, determine the rms output voltage at fundamental frequency, output power, input power factor and distortion factor. *04*

c) Derive the value of angle 'α' by which the square waveform should be chopped off so as to eliminate 3rd harmonic in the output of inverter. *03*

7 a) With the help of voltage and current waveforms explain the operation of separately excited DC motor in motoring and regenerative modes. The machine is fed from full converter thyristorised bridge both for continuous operation and discontinuous operation modes. *04*

b) A 220V, 1500rpm, 11.6A separately excited DC motor is controlled by a single phase semi controlled rectifies with an ac source voltage of 230V, 50Hz. Enough filter inductor is added to ensure continuous conduction for any torque greater than 30% of the rated torque. The armature resistance $R_a = 2\Omega$. Calculate the firing angle when head demands 30Nm at 424rpm. *05*

c) A 230V, 500rpm, 90A separately excited DC motor has the armature resistance and inductance of 0.115Ω and 11mH respectively. The motor is controlled by class C chopper at 400Hz. Calculate
   (i) motor speed for motoring at d = 0.5 and half the rated torque.
   (ii) motor speed for regeneration at d = 0.5 and at rated torque. *05*

8 a) Discuss in brief the speed control & regnerative braking mode of operations of Squirral cage induction motor with constant V/f ratio. Draw relevant diagram to show speed control & regeneration mode of operations. *05*

b) A 460V, 60Hz, 6pole, 1180rpm, Y connected squirrel cage induction motor has the following parameters per phase referred to stator side :

$r_s = 0.19\Omega$; $r'_r = 0.07\Omega$; $x_s = 0.75\Omega$; $x'_r = 0.67\Omega$; $x\phi = 20\Omega$.

If the motor is fed by VSI at constant V/f ratio, calculate the inverter frequency at half rated torque and 500 rpm. Neglect derating due to harmonics. *05*

c) A 440V, 50Hz, 6Pole, Y connected wound rotor motor has the following parameters :

$r_s = 0.5\Omega$; $r'_r = 0.4\Omega$; $x_s = x'_r = 1.2\Omega$; $x\phi = 50\Omega$, stator to rotor turns ratio = 3.5.

Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty ratio of zero. Calculate the value of external resistance. *04*