Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEM-V Examination-Nov/Dec.-2011

Subject code: 150903 **Date: 26/11/2011**

Subject Name: Power Electronics-I **Time: 2.30 pm -5.00 pm**

Total marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Draw the internal diagram of an SCR (specifying the different layers and their doping levels) and hence, explain the various operating modes of the device. Also draw the static V- I characteristic of the SCR **07**

(b) Describe the working of single phase fully controlled bridge converter connected to R – L load. Sketch the waveforms of (i) load voltage (ii) load current (iii) thyristor current and voltage for $\alpha = 45°$
Hence derive the expression for rms load voltage. **07**

Q.2 **(a)** For an SCR, the G –K characteristic is a straight line with a slope of 16 V/A passing through the origin. The maximum turn on time is 4 μsec and the minimum gate current required for this quick turn on is 500 mA. If the gate source voltage is 15 V, calculate **07**

i. The resistance to be inserted in the series with the SCR gate
ii. The gate power dissipation given that the pulse width is equal to the turn on time and average gate power dissipation is 0.3 W
iii. The maximum triggering frequency that will be possible when pulse triggering is used

(b) What do you understand by 'commutation of SCR'. What are the conditions required for successful commutation. Hence explain Class C – Complementary Commutation method. **07**

OR

(b) Explain how UJT works as a relaxation oscillator. Hence, with neat diagram and waveforms, describe the line synchronized UJT triggering circuit. **07**

Q.3 **(a)** Explain the following current and voltage ratings of a thyristor **07**

i. Peak working forward blocking voltage
ii. Peak repetitive reverse voltage
iii. Average on state current
iv. I^2t rating

(b) What is the need of a snubber circuit. Discuss the function of each component and hence mention the steps involved in the design details (selecting the values) of each component when used in a d.c. circuit. **07**

OR

Q.3 **(a)** Compare MOSFET with SCR in terms of basic structure, V-I characteristics, ratings, control principle, applications etc. **07**

(b) With the help of appropriate waveforms and equations, show how the source inductance reduces the average output voltage of a single phase full converter. **07**

Q.4 **(a)** Write a note on single phase dual converter showing the circuit configuration and details of operation. What are the applications of such a dual converter ? **07**

(b) Explain in brief various control strategies of a chopper **07**

OR

Q.4 **(a)** Explain the operation of a three phase, half controlled bridge converter with associated waveforms for $\alpha < 60°$ Derive the expression for average output voltage. Will the average output voltage change for $\alpha > 60°$? **07**

Q.4 **(b)** Draw the circuit configuration of step up chopper and explain its working. Derive its output voltage equation in terms of duty cycle and input voltage. **07**

Q.5 **(a)** Explain the operation of 1-phase fully controlled converter to operate a separately excited DC motor in 1^{st} and 4^{th} quadrant. Derive the expression for speed-torque characteristic of the DC motor and clearly mention how the characteristics will change with the change in firing angle. **07**

(b) Classify various chopper circuits based on principle of operation, circuit configuration etc. **07**

OR

Q.5 **(a)** Explain how a chopper circuit can be employed in the regenerative braking operation of a d.c. motor. Derive the expression for the range of speed control. **07**

(b) A d.c. chopper is used for regenerative braking of a separately excited dc motor. The dc supply voltage is 400 V. The motor has $R_A = 0.2\ \Omega$ and $K_m = 1.2$ V-s/ rad. The average current during regenerative braking is constant at 300 A. For a duty cycle of 60% , determine **07**

i. Power returned to the dc supply

ii. Minimum and maximum permissible braking speeds

iii. Speed during regenerative braking

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