Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME - SEMESTER–I(New course)• EXAMINATION – WINTER- 2015**

**Subject Code: 2714501** **Date: 01/01/2016**

**Subject Name: Power Electronics – I**

**Time:2:30 pm to 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 only the basic structure, symbol and V-I characteristic of a GTO. Explain Turn ON and Turn OFF mechanism of GTO with neat diagrams. **07**

**(b)** In a 1-phase AC voltage controller; output voltage is half the input voltage. What will be the firing angle ($\alpha$)? **07**

**Q.2** **(a)** Draw only the basic structure of a TRIAC. Is it possible to operate TRIAC in Mode III– having –ve gate pulse, –ve $MT_2$ and +ve $MT_1$? If yes, then explain this operation using its two transistor equivalent model. **07**

**(b)** Explain center-tapped 1-phase to 1-phase cycloconverter with neat circuit diagram and waveforms for the conversion of 5 input cycles to 1 output cycle. **07**

**OR**

**(b)** Neatly draw the output current (Io) waveform from the description tabulated below. Carry out Fourier analysis up to 17 harmonic components for the output current (Io) waveform to calculate Distortion Factor. **07**

Positive half-cycle of output current ($I_O$) waveform:

| θ (degree) | 0 | 0 | 45 | 45 | 135 | 135 | 180 | 180 |
|---|---|---|---|---|---|---|---|---|
| $I_O$ (A) | 0 | 5 | 5 | 10 | 10 | 5 | 5 | 0 |

Negative half-cycle of output current ($I_O$) waveform:

| θ (degree) | 180 | 180 | 225 | 225 | 315 | 315 | 360 | 360 |
|---|---|---|---|---|---|---|---|---|
| $I_O$ (A) | 0 | -5 | -5 | -10 | -10 | -5 | -5 | 0 |

**Q.3** **(a)** Explain the basic structure of an IGBT and briefly explain its principle of operation with neat diagram. **07**

**(b)** Explain Cuk converter with neat circuit diagram and necessary waveforms. **07**

**OR**

**Q.3** **(a)** Explain buck-boost converter with neat circuit diagram and necessary waveforms. **07**

**(b)** Explain the operation of 3-phase bridge inverter with Y-connected resistive load in 180° conduction mode. Draw only the following waveforms: **07**

(i) All the 6 Gate Pulses

(ii) Any 1 Pole Voltage

(iii) Common Mode Voltage (CMV)

(iv) Any 1 Phase Voltage
(v) Any 1 Line Voltage

**Q.4 (a)** Explain the operation of fly-back converter with neat circuit diagram and necessary waveforms. **07**

**(b)** An SCR has Vg-Ig characteristics given as Vg = 2+1.75Ig. In a certain application, the gate voltage consists of rectangular pulses of 15V and of duration 30μs with 60% duty cycle. Calculate: **07**

(i) Value of series resistor in gate circuit to limit the power dissipation to 3.5W
(ii) Average power dissipation in the gate circuit
(iii) Switching frequency of SCR

**OR**

**Q.4 (a)** Explain the principle of operation of integral cycle control type 1-phase AC voltage controller with neat circuit diagram and waveforms. Also derive the expression for RMS value of output voltage in terms of duty cycle. **07**

**(b)** A thyristor string is formed by series and parallel connection of thyristors. The voltage and current ratings of the string are 5kV and 3kA respectively. Available thyristors have voltage and current rarings of 1kV and 800A respectively. The de-rating factor of 15% is kept for both series and parallel connections. How many thyristors are required to form this string? **07**

If the maximum blocking current is 10mA and the maximum difference in their reverse recovery charge is 15μC; then calculate the value of resistance in static equalizing circuit and the value of capacitance in dynamic equalizing circuit.

**Q.5 (a)** Explain Class-D commutation of SCR. **07**

**(b)** A buck converter has an input voltage = 15V, required average output voltage = 5V, peak-to-peak output ripple voltage = 10mV, switching frequency = 25kHz and load resistance = 150Ω. The peak-to-peak ripple current of inductor is limited to 0.4A. Calculate: **07**

(i) Duty cycle
(ii) Filter inductor
(iii) Filter capacitor
(iv) Critical values of L & C

**OR**

**Q.5 (a)** Explain bipolar switching scheme of a 1-phase sinusoidal PWM inverter with neat circuit diagram. Also draw the neat waveforms for under modulated switching mode (Ar < Ac). **07**

**(b)** A 100A SCR is to be connected in parallel with a 150A SCR. The on state voltage drop of the SCRs are 2V and 1.5V respectively. **07**

(i) Calculate the series resistance to be connected with each SCR in order to share a total current of 200A in proportion to their ratings. Also calculate the total power dissipation in the external resistances.
(ii) Calculate the series resistance to be connected with each SCR in order to share a total current of 200A equally. Assume that the one resistance is double than another resistance. Also calculate the total power dissipation in the external resistances.

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