

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**M. E. - SEMESTER – I • EXAMINATION – WINTER • 2014**

**Subject code: 2714501****Date: 07-01-2015****Subject Name: Power Electronics - I****Time: 02:30 pm - 05:00 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)** Once the SCR turns ON; gate loses its control over SCR. Explain this phenomenon using two-transistor equivalent model of SCR. Also derive the equation for the anode current. **07**
- (b)** For an inverter controlled by single pulse width modulation technique; using Fourier analysis, prove that a selective harmonic (n) can be eliminated from the inverter output voltage using this technique by adjusting firing angle ( $\alpha$ ) =  $90^\circ/n$ . **07**

- Q.2 (a)** Draw only the circuit diagram of self-commutation of SCR by resonating the load. Derive the expression for the anode current and also draw its waveform. **07**
- (b)** Draw only the basic structure of a TRIAC. Draw only the two-transistor equivalent models for all the 4 triggering modes of TRIAC. Also mention the sensitivity level of each triggering mode. **07**

**OR**

- (b)** Neatly draw the output voltage ( $V_o$ ) waveform from the description given below. Carry out Fourier analysis up to 17 harmonic components for the output voltage ( $V_o$ ) waveform. Also calculate %THD. **07**

Positive half-cycle of output voltage ( $V_o$ ) waveform:

$\theta$ (degree)	0	0	60	60	120	120	180	180
$V_o$ (volt)	0	10	10	20	20	10	10	0

Negative half-cycle of output voltage ( $V_o$ ) waveform:

$\theta$ (degree)	180	180	240	240	300	300	360	360
$V_o$ (volt)	0	-10	-10	-20	-20	-10	-10	0

- Q.3 (a)** Explain the basic structure of a Power MOSFET and briefly explain its principle of operation with neat diagram. **07**
- (b)** A buck-boost regulator has following parameters: input voltage = 12V, duty cycle = 0.6, switching frequency = 25kHz,  $L = 250\mu\text{H}$ ,  $C = 220\mu\text{F}$  and average load current = 1.5A. Calculate: (1) Average output voltage, (2) Peak-to-peak output voltage ripple, (3) Peak-to-peak ripple current of inductor, (4) Peak current of the transistor and (5) Critical values of L & C. **07**

**OR**

- Q.3 (a)** Derive the equation for duty cycle in terms of supply voltage & load voltage for cuk converter with necessary diagram & waveforms. **07**
- (b)** Explain the operation of 3-phase bridge inverter with Y-connected **07**

resistive load in  $120^\circ$  conduction mode. Draw the waveforms of all the 6 gate pulses, any 1 pole voltage, common mode voltage, any 1 phase voltage and any 1 line voltage.

- Q.4 (a)** Explain the operation of push-pull converter with neat diagram and waveforms. **07**
- (b)** An SCR has  $V_g$ - $I_g$  characteristics given as  $V_g = 1.6 + 5I_g$ . In a certain application, the gate voltage consists of rectangular pulses of 15V and of duration 50  $\mu$ s with 40% duty cycle. Determine the value of series resistor ( $R_g$ ) in gate circuit to limit the peak power dissipation in the gate to 3W. Also calculate average power dissipation in the gate. **07**

**OR**

- Q.4 (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 ( $A_r < A_c$ ). What is the relationship between carrier signal and the most significant harmonic component? **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 ratings of 1kV and 800A respectively. The string efficiency is 90% for both series and parallel connections. Calculate the number of thyristors to be connected in series and parallel. If the maximum blocking current is 12mA and the maximum difference in their reverse recovery charge is 20 C; then calculate the value of resistance in static equalizing circuit and the value of capacitance in dynamic equalizing circuit. **07**

- Q.5 (a)** Explain center-tapped 1-phase to 1-phase cycloconverter with neat circuit diagram and waveforms for the conversion of 2 input cycles to 1 output cycle. **07**
- (b)** A buck regulator has an input voltage = 15V, required average output voltage = 5V, peak-to-peak output ripple voltage = 10mV, switching frequency = 20kHz and load resistance =  $200\Omega$ . The peak-to-peak ripple current of inductor is limited to 0.5A. Calculate: (1) Duty cycle, (2) Filter inductor, (3) Filter capacitor and (4) Critical values of L & C. **07**

**OR**

- Q.5 (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 100A SCR is to be connected in parallel with a 150A SCR. The on state voltage drop of the SCRs are 2.1V and 1.75V respectively. **07**
- Calculate the series resistance to be connected with each SCR in order to share a total current of 180A in proportion to their ratings. Also calculate the total power dissipation in the external resistances.
  - Calculate the series resistance to be connected with each SCR in order to share a total current of 180A equally. Assume that the resistance with 150A SCR is double than that with 100A SCR. Also calculate power dissipation in the external resistances.

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