Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER 2012

Subject code: 712902N Date: 09/01/2013

Subject Name: Power Processing Circuits

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.**
4. **Notations and symbols used have usual technical meaning.**

Q.1 **(a)** Explain the "latching" phenomenon of SCR using two-transistor equivalent model. Also derive the equation for the anode current. **07**

(b) An SCR has Vg-Ig characteristics given as Vg = 2+7Ig. In a certain application, the gate voltage consists of rectangular pulses of 15V and of duration 60μs with 40% duty cycle. Determine the value of series resistor (Rg) in gate circuit to limit the peak power dissipation in the gate to 3.5W. Also calculate average power dissipation in the gate. **07**

Q.2 **(a)** Draw the schematic construction, circuit symbol and V-I characteristic of TRIAC. Enlist all the triggering modes of a TRIAC and explain only the most sensitive mode. **07**

(b) For an inverter controlled by single pulse width modulation technique; prove that selective harmonic (n) can be eliminated from the inverter output using this technique by adjusting firing angle (α) = 90°/n, using Fourier analysis. **07**

OR

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

Positive half-cycle of output voltage (Vo) waveform:

θ (degree)	0	0	60	60	120	120	180	180
Vo (volt)	0	10	10	20	20	10	10	0

Negative half-cycle of output voltage (Vo) waveform:

θ (degree)	180	180	240	240	300	300	360	360
Vo (volt)	0	-10	-10	-20	-20	-10	-10	0

Q.3 **(a)** Explain complementary voltage commutation of SCR with necessary waveforms. **07**

(b) A 1-phase half-wave controlled rectifier is having a purely resistive load of 10Ω. Transformer secondary voltage is 100V (peak), 50Hz. Output voltage is controlled with firing angle (α) = 30°. Do as directed: **07**

(i) Derive the equation of average output voltage and calculate the same.
(ii) Derive the equation of RMS output voltage and calculate the same.
(iii) Transformer utilization factor

OR

Q.3 **(a)** Explain the operation of fly-back converter with neat circuit diagram and **07**

waveforms.

(b) Discuss gate driver circuit for a Power MOSFET. **07**

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

(b) Explain the operation of 3-phase bridge inverter with Y-connected resistive load in 180° 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. **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 over modulated switching mode (Ar > Ac). What is the relationship between carrier signal and the most significant harmonic component? **07**

(b) What is Safe Operating Area (SOA)? Draw and explain SOA of a Power BJT. **07**

Q.5 **(a)** Explain Space Vector PWM (SVPWM) technique. **07**

(b) Explain the operation 1-phase AC voltage controller working on the principle of ON-OFF control. Draw neat waveforms of input voltage, various gate pulses and output voltage. Also derive the expression for RMS value of output voltage in terms of duty cycle. **07**

OR

Q.5 **(a)** Explain dual converter with circulating current control mode. **07**

(b) Explain center-tapped 1-phase to 1-phase cycloconverter with neat circuit diagram and waveforms for the conversion of 3 input cycles to 1 output cycle. **07**

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