Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– I (New course)• REMEDIAL EXAMINATION – SUMMER 2015

Subject Code: 2714501 **Date:13/05/2015**

Subject Name: Power Electronics – I

Time: 10:30 am to 1:00 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 basic structure of a Power BJT and briefly explain its various operating regions. **07**

(b) An SCR has Vg-Ig characteristics given as Vg = 2.3+3.4Ig. In a certain application, the gate voltage consists of rectangular pulses of 15V and of duration 40εs with 75% duty cycle. Determine the value of the series resistor (Rg) in gate circuit to limit the peak power dissipation in the gate to 3W. Calculate the average power dissipation in the gate and the triggering frequency. **07**

Q.2 **(a)** 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 (α) = $\pi/2n$. **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**

(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 resistance with 150A SCR is double than that with 100A SCR. Also calculate power dissipation in the external resistances.

OR

(b) Neatly draw the output voltage (Vo) waveform from the description given below. Carry out Fourier analysis up to 21 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	5	5	10	10	5	5	0

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

θ (degree)	180	180	240	240	300	300	360	360
Vo (volt)	0	-5	-5	-10	-10	-5	-5	0

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 basic structure of an IGBT and its principle of operation with neat diagrams. **07**

OR

Q.3	**(a)**	Explain the operation of 3-phase bridge inverter with Y-connected resistive load in 180° conduction mode with neat diagram and waveforms.	**07**
	(b)	A buck-boost regulator has following parameters: input voltage = 12V, duty cycle = 0.6, switching frequency = 25kHz, L = 250µH, C = 220µF 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**
Q.4	**(a)**	Explain the operation of fly-back converter with neat diagram and waveforms.	**07**
	(b)	Explain Class-D commutation of SCR with necessary waveforms.	**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 (Ar < Ac).	**07**
	(b)	A thyristor string is formed by series & parallel connection of thyristors. The voltage and current ratings of the string are 5kV and 2kA respectively. Available thyristors have voltage and current ratings of 1kV and 500A respectively. The de-rating factor of 14% is to be kept for both series & parallel connections. Calculate the number of thyristors to be connected in series & parallel. If the maximum blocking current is 15mA and the maximum difference in their reverse recovery charge is 25εC; then calculate the value of resistance in static equalizing circuit and the value of capacitance in dynamic equalizing circuit.	**07**
Q.5	**(a)**	Explain the need of Heat-sink. Explain its selection process.	**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**
		OR	
Q.5	**(a)**	Explain the principle of operation of ON-OFF 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 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 = 200Ý. 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**

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