Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – WINTER • 2013

Subject code: 1720709 Date: 02-01-2014

Subject Name: Advanced Power Converters

Time: 10.30 am – 01.00 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)** What does one mean by multi-pulse converter? What are its advantages? With appropriate block-diagram explain how a 24 pulse converter can be obtained. Clearly indicate the type of phase shifting transformer used with the corresponding phase shift. **07**

(b) With necessary waveforms and circuit diagram, explain the operation of series loaded resonant (SLR) half-bridge DC-DC converter operating in discontinuous mode. **07**

Q.2 **(a)** Discuss in brief the significance of Y/Z transformers in context to the multipulse converters and derive the necessary equations for a Y/Z-2 configuration that helps to determine the number of turns to achieve the desired phase shift. **07**

(b) With neat waveforms discuss the operation of ZVS-CV (Zero Voltage Switching-Clamped Voltage) dc-dc converter. **07**

OR

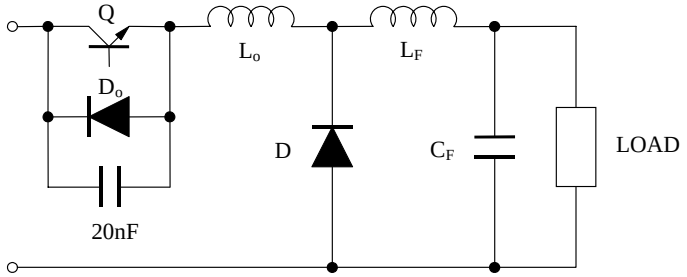
(b) The SLR dc-dc converter is operating in a discontinuous conduction mode. The initial conditions in terms of normalized quantities are always $V_{CO} = -2V_O$ and $I_{LO} = 0$. Show that in terms of normalized quantities, $V_{C\ peak} = 2$ and $I_{L\ peak} = 1 + V_O$. **07**

Q.3 **(a)** The Zero Voltage Switching (ZVS) forward converter shown below works with a range of load currents from 5A to 15A. The supply voltage is 40V and the load voltage is 20V. You may assume that the output filter inductor current is smooth. **07**

(i) Determine the value of L_O if it is chosen so that ZVS is just possible at the minimum load current.

(ii) Calculate the converter operating frequency when operating at 5A output.

(iii) Calculate the peak voltage across the transistor when operating at maximum load current.



(b) Why does one require bi-directional switches for a matrix converter? How can such bi-directional switches be obtained? Also, critically evaluate/compare these bi-directional switches. **07**

OR

Q.3	**(a)**	State the two basic rules to be observed for operating the switches of a Matrix converter and hence, group the possible switching state combinations of a 3-phase Matrix converter. Also, discuss the significance of LC filter in context to the converter.	**07**
	(b)	A 5-level CHB inverter is controlled by phase shifted carrier based PWM strategy. Comment on the number of carrier waveforms and draw the relevant waveforms with all details. Also, briefly comment on the harmonic spectrum for the phase and line voltage.	**07**
Q.4	**(a)**	Classify the space vectors into different groups for a 3-level NPC (diode clamped) inverter. With relevant analysis, obtain the magnitude and orientation for PPP, PPN, NOP, and NON vectors. Also, draw the entire space vector diagram for this inverter.	**07**
	(b)	Comment on harmonic contents in the input current and output voltage of converters used in HVDC transmission. Hence, discuss the various types of filters that need to be employed to eliminate these harmonics.	**07**
		OR	
Q.4	**(a)**	List the advantages of static active reactive power compensators over conventional passive reactive power compensators. Also, discuss the scheme for instantaneous reactive power compensation.	**07**
Q.4	**(b)**	Write a brief note on flying capacitor multi-level inverter.	**07**
Q.5	**(a)**	It is required to eliminate harmonics of below 10^{th} order in the input line current for a HVDC transmission. Suggest a suitable transformer configuration and derive an equation for primary current of transformer.	**07**
	(b)	Justify the role of power electronics converter in effective utilization of the PV array (in terms of extracting the maximum power from the array). Select the power electronics converter of your choice to discuss the concept.	**07**
		OR	
Q.5	**(a)**	How can one get more than 5 levels in phase voltage with only two cascaded H-bridge converters? List all the possible levels available in the phase voltage and line voltage. Also mention the demerits of the scheme if any.	**07**
	(b)	Discuss in brief the factors that lead to the deviation in neutral point voltage of an NPC converter. Also, discuss the control scheme for minimizing this deviation.	**07**

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