Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 710702N **Date: 13/02/2012**

Subject Name: Advanced Power Electronics

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)** Arrange SCR, BJT, Power MOSFET, GTO, and IGBT in ascending order with respect to their maximum operating power capability and the operating speed. Also, draw (no need to explain) *i-v* characteristics for SCR, Power MOSFET and IGBT. **07**

(b) With relevant circuits and waveforms explain the operation of flyback converter. Derive the equation of output voltage in terms of duty ratio. **07**

Q.2 **(a)** With relevant waveforms explain the operation of boost converter in discontinuous mode of operation. Also, derive expression of output voltage in terms of duty ratio in the discontinuous mode. **07**

(b) (i) Compare SMPS with linear voltage regulator. **07**

(ii) Forward converter and DC-DC bridge converters (half-bridge or full bridge) are in-fact isolated buck converter. Which of these topologies is better? Justify your answer.

OR

(b) How is the space vector PWM (SVPWM) control better than 180 degree conduction control (six-stepped output) of a 3-phase bridge inverter? Also, prove that SVPWM is superior to sine-triangle PWM (SPWM) technique in terms of achieving higher amplitude of output voltage. How much higher amplitude will be obtained with SVPWM than that of SPWM? **07**

Q.3 **(a)** Write a brief note on selective harmonic elimination technique. **07**

(b) A single phase full wave ac voltage controller working on ON-OFF control technique has supply voltage of 230V, 50Hz. It supplies a resistive load of 50Ω. The controller is ON for 30 cycles and off for 40 cycles. Calculate (i) RMS output voltage (ii) Input P.F (iii) Derive the average thyristor current equation and hence calculate it. **07**

OR

Q.3 **(a)** With neat waveforms and circuit diagram, explain the operation of single-phase auto-sequential Current Source Inverter. **07**

(b) With neat waveforms explain the operation of 3-phase bridge inverter having 150° conduction mode control. Discuss how it incorporates the features of both 180° and 120° conduction modes. **07**

Q.4 **(a)** What is PWM Inverter principle? Compare Bipolar and Unipolar switching schemes of Sinusoidal PWM inverter with necessary waveforms and harmonic spectrums and justify which one is better. **07**

(b) Draw the circuit for 3-phase to 1-phase cyclo-converter and discuss its principle of operation in brief. **07**

OR

Q.4 **(a)** Explain the method of providing electrical isolation between control circuit and driver circuit using transformer when the switching frequency is very less. Draw relevant waveforms and circuit diagram **07**

(b) With relevant waveforms and circuit, explain the operation of 3-phase bi-directional (full wave) AC voltage controller operating with firing angle $\alpha = 60°$ and feeding star connected resistive load. **07**

Q.5 **(a)** Distinguish between CSI and VSI. **07**

(b) Design an inductor for step-down converter for following specifications: **07**

Output voltage : 5V — Output current I_o : 5A

Switching frequency: 40 kHz — Input voltage : 12V ± 10%

Current ripple = 10% of I_o — $B_m = 0.2T$; $J = 3$ A/mm^2

$K_c = 1$; $K_w = 0.6$;

Conductor SWG 16 with area of cross-section = 2.075 mm^2

Ferrite core with following specification is available

$A_c = 201$ mm^2; $A_w = 101$ mm^2; $A_p = 20100$ mm^4

Check if this core matches the requirement or not.

OR

Q.5 **(a)** Obtain the following 'Area Product' equation for the transformer used in forward converter **07**

$$A_p = \frac{\sqrt{D} \times P_{O2}\left(1+\frac{1}{\eta}\right)}{K_w J B_m f_s}$$

(b) State the important differences in the functioning and design of transformers and inductors used for DC-DC converters. Also list the steps involved in the design inductor of DC-DC converters. **07**

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