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Question Paper Code : 83296

M.E. DEGREE EXAMINATION, JANUARY 2014.

First Semester

Power Electronics and Drives

PX 7102 — ANALYSIS OF POWER CONVERTERS

(Common to M.E. Control and Instrumentation Engineering)

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Evaluate the output voltage ripple factor of a single–phase half–controlled converter, for a firing angle of 90°.

2. Why is the power factor of half controlled converters better than that of fully controlled Converters?

3. A three phase bridge converter is supplied from a star connected 208 V, 60 Hz supply. The average load current is 60 A and has negligible ripple. Calculate the percentage reduction of output voltage due to commutation if the line inductance per phase is 0.5 mH.

4. What is the effect of source impedance on the performance of converters?

5. What are the assumptions to be made during analysis of DC–DC converter circuits?

6. Write the effect of parasitic elements in a step-up converter.

7. What is extinction angle?

8. What is a 'TRIAC'? sketch its static characteristics.

9. Define discontinuous load current, with reference to cyclo–converters.

10. List the applications of cycloconverters.

PART B — (5 × 16 = 80 marks)

11. (a) For a single–phase fully controlled converter system, sketch waveforms for load voltage and load current for

(i) RL load

(ii) RL load with freewheeling diode across RL.

From a comparison of these waveforms, discuss the advantages of using a freewheeling diode. (16)

Or

(b) (i) Discuss the inverter mode of operation of thyristor converters. (8)

(ii) The single phase half controlled converter has an RL load of L = 6.5 mH, R = 2.5Ω, and E = 10 V. The input voltage is $V_s = 120V$ (rms) at 60Hz. Determine (1) load current I_{L0} at $\omega t = 0$, and the load current I_{L1} at $\omega t = \alpha = 60^\circ$, (2) Average thyristor current I_A, (3) the rms thyristor current I_R, (4) the rms output current I_{rms}, and average output current I_{dc}. (8)

12. (a) Explain the working of a 3 phase semi converter for R load and draw the output waveforms for firing angles 0°, 30°, 60°, 90°. (16)

Or

(b) (i) A three phase full converter bridge is connected to 'R' load. The three phase line voltage is of 400V. The average load current is of 25A. For R = 20 Ω find the firing angle. (8)

(ii) Explain the working of 12 pulse converter with necessary waveforms. (8)

13. (a) Explain the working principle of Cuk DC–DC converter with necessary waveforms. (16)

Or

(b) (i) Describe the working of Quasi resonant converter with necessary diagrams. (8)

(ii) A boost regulator has an input voltage of $V_s = 5V$. The average output voltage $V_\alpha = 15V$ and the average load current $I_\alpha = 0.5A$. The switching frequency is 25 KHz. If L=150 μH, and C = 200 μH, determine (1) the duty cycle k, (2) the ripple current of inductor ΔI, (3) the peak current of inductor and (4) the ripple voltage of filter capacitor ΔV_c. (8)

14. (a) Derive the expressions for RMS output voltage, RMS load current, and RMS thyristor current of a single phase full wave AC voltage controller for RL load. (16)

Or

(b) (i) Explain the working principle of three phase half wave AC voltage controller. Draw the relevant waveforms for $\alpha = 150^\circ$. (8)

(ii) The three phase half wave controller supplies a wye connected resistive load of $R = 10\Omega$ and the line to line input voltage is 280 V (rms), 60 Hz. The delay is $\alpha = \frac{\pi}{3}$. (8)

Determine:

(1) the rms output phase voltage V_0

(2) the input power factor PF, and

(3) expression for the instantaneous output voltage of phase α.

15. (a) (i) Derive the expression for output voltage equation for a cycloconverter. (8)

(ii) A 3-phase to single-phase cycloconverter employs 3-pulse positive and negative group converters. Each converter is supplied from delta/star transformer with per phase turns ratio of 2:1. The supply voltage is 400V, 50 Hz. The RL load has 2 Ω and at low output frequency $\omega_0 L = 1.5\Omega$. In order to account for commutation overlap and thyristor turn-off time, the firing angle in the inversion mode should not exceed 160°. Compute

(1) the value of the fundamental RMS output voltage

(2) RMS output current and

(3) output power. (8)

Or

(b) (i) Analyse the midpoint and bridge configurations for a three phase to three phase cycloconverter. (8)

(ii) Explain the working of a single phase to single phase bridge type step-up cycloconverter with neat sketch. (8)

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