G 6415

M.E. DEGREE EXAMINATION, MAY/JUNE 2007.

First Semester

Power Electronics and Drives

PE 1603 — ANALYSIS OF POWER CONVERTERS

(Regulation 2005)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why is the instantaneous output voltage negative, in case of an RL load for a AC-DC converter?

2. Why is the power factor better in case of a semiconverter than a full converter?

3. How are harmonics generated in three phase system?

4. Why three phase twelve pulse converters are preferred over six pulse converters?

5. A power MOSFET based chopper operates at 10 kHz in TRC mode. The turn off time (t_q) of the power MOSFET is 12 μ sec. Find the maximum possible duty ratio of the chopper.

6. Why is a CuK converter better than buck boost converter?

7. Mention two merit and demerit of integral cycle switching.

8. What are the applications of three phase AC voltage controllers?

9. What are the steps involved in the changeover of conduction from one rectifier to another in a simultaneously controlled cyclo converter?

10. How are frequency and voltage controls achieved for cyclo converters?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Depending on what factors, does the load current become discontinuous? Explain the operation of single phase two pulse converter with discontinuous load current. (8)

(ii) A single phase fully controlled bridge rectifier supplies R-L load. By assuming the constant output current, find the following performance parameters if the supply voltage is 230 V? The firing angle is $\pi/6$ and $R = 5\,\Omega$ and $L = 10$ mH :

(1) Average output voltage

(2) RMS supply current

(3) Supply fundamental RMS current

(4) Fundamental power factor

(5) Input power factor

(6) Voltage ripple factor. (8)

Or

(b) (i) Given a choice between the multiple pulse width modulation method and that of sequence control of rectifiers, which is preferable and why? (8)

(ii) Define ripple factor. Derive formula for ripple factor of a single phase full converter. Explain how the ripple factor decreases with an increase in the number of phases of a rectifier transformer. (8)

12. (a) (i) Draw the circuit and wave forms of a three phase full wave, half controlled bridge rectifier assuming the load to be highly inductive and derive an expression for the average load voltage. (10)

(ii) A six pulse thyristor converter, connected to a 400 V_{rms} three phase, 50 Hz ac system is supplying power to a 420 V, 110 A dc motor. Calculate the firing angle of the converter if the terminal voltage at the output of the thyristor converter is 420 V. Also calculate AC terminal power. (6)

Or

(b) (i) Describe different modes of operation in practical dual converters with associated wave forms. (10)

(ii) A three phase fully controlled bridge converter is connected to three phase AC supply of 400 V, 50 Hz and operates at a firing angle $\alpha = 30°$. The load current is maintained constant at 12 A and the load voltage is 330 V, find

(1) Source inductance

(2) Load resistance

(3) Overlap angle (μ). (6)

13. (a) (i) For a buck-boost converter, derive the expression for peak to peak ripple current and ripple voltage in terms of circuit components, frequency and supply voltage. (10)

(ii) A step up chopper has a supply voltage of 250 V while the output voltage is 500 V. If the period of chopper be 100 μ sec. Determine the pulse width of the output voltage. If the pulse width is reduced to one third for constant frequency operation, find the output voltage. (6)

Or

(b) (i) Describe the limitations of ZCS converter for its proper functioning. (8)

(ii) Explain the operation of a ZVS quasi resonant buck converter. (8)

14. (a) (i) For a single phase ac voltage controller with resistive load, show that power factor is given by $P.F. = \left[\frac{1}{\pi}\left(\pi - \alpha + \frac{\sin 2\alpha}{2}\right)\right]^{1/2}$. (8)

(ii) A single phase voltage controller used for controlling the power flow from 230 V, 50 Hz source into a load circuit consisting of $R = 3\,\Omega$ and $wL = 4\,\Omega$. Determine (8)

(1) The control range of firing angle

(2) Maximum value of RMS load current

(3) The maximum power and power factor

(4) The maximum values of average and RMS thyristor currents.

Or

(b) Explain the operation of three configurations of three phase bidirectional AC voltage controller. Draw the output voltage wave forms. (16)

15. (a) (i) Discuss why a three phase to single phase cyclo converter requires positive and negative group phase controlled converters. Under what conditions, the group work as inverters or rectifiers. How should the firing angles of the two converters be controlled? (10)

(ii) Show that the fundamental rms value of per-phase output voltage of low frequency for an m-pulse cyclo converter is given by (6)

$$V_{or} = V_{ph}\left(\frac{m}{\pi}\right) \sin\left(\frac{\pi}{m}\right).$$

Or

(b) Describe three phase to three phase cyclo converter with relevant circuit arrangements using 18 SCRs and 36 SCRs. What are the advantages of 3-phase bridge circuit cyclo converter over 18-thyristor circuit? (16)
