Reg. No. :

W 6379

M.E. DEGREE EXAMINATION, JANUARY 2008.

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. Draw the control characteristics of a 3ϕ full converter.

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

3. What is the relation between the delay angles of the converters in dual converter system?

4. Discuss the impacts of the converters on the ac system.

5. What are the control strategies for operating the switches in DC-DC converter?

6. Mention the applications of choppers

7. What is the control range of the delay angle for 3-phase bidirectional controllers?

8. Mention the advantages and disadvantages of delta connected controllers.

9. What are the factors which influence the exact wave shape of the output voltage of a cyclo converter?

10. Draw the power circuit of a single-phase mid-point cycloconverter.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Discuss the operation of a single-phase converter with neat circuit and waveforms for a highly inductive load case. Derive the expression for average and rms output voltage. (12)

(ii) Make a comparative study of the half controlled and full controlled converters. (4)

Or

(b) (i) A single-phase bridge converter with a free wheeling diode feeds an R-L load. The load resistance is 7.5 Ω and inductance is very large providing ripple free load current. The converter is supplied by 120 V, single-phase supply at a frequency of 50 Hz. Determine the average load, voltage, load current and power factor at a firing angle of 60°. (8)

(ii) Discuss in detail the operation of single-phase dual converter and derive an expression for the circulating current with necessary waveforms. (8)

12. (a) (i) A three-phase fully controlled bridge rectifier contains six ideal thyristors and is fed from an ideal three-phase supply of balanced sinusoidal voltages. The load consists of a resistor R in series with a large filter inductor. Show that for all values of thyristor firing angle, the average load voltage is given by $E_{average} = \dfrac{3\sqrt{3}}{\pi} E = \cos\alpha$.(9)

(ii) Calculate the Fourier coefficients a and b of the fundamental component of the supply current for the above said converter in 12 (a) (i). Use these to show that the displacement angle is equal to the thyristor firing angle α. (7)

Or

(b) (i) A 3ϕ full converter charges a battery from a 3ϕ supply of 230 V, 50 Hz. The battery emf is 200 V and its internal resistance is 0.5 Ω. On account of the inductance connected in series with the battery, the charging current is constant at 20 A. Compute the firing angle delay and the supply power factor. (8)

(ii) Discuss in detail any two methods of improving power factor in a phase controlled converter circuit. (8)

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13. (a) (i) Analyse the first quadrant class A chopper during the on and off periods to obtain the expressions for Io(max) and Io(min).   (12)

    (ii) Enumerate the merits and demerits of load commutated chopper. (4)

Or

(b) (i) Explain in brief how the average output voltage across the load is made more than the dc input voltage using chopper. Derive the expressions for the average output voltage.   (7)

    (ii) A current commutated chopper controls a battery powered car. The battery voltage is 100 V, starting current of 100 A, thyristor turn off time is 20 μs and chopping frequency is 400 Hz. Compute the values of commutating capacitor and inductor. As $\dfrac{I_{cp}}{I_{om}} = 3$.   (6)

    (iii) Discuss the advantages of resonant converters.   (3)

14. (a) (i) With a neat circuit diagram and waveforms, describe the operation of a single phase bidirectional ac voltage controller feeding a resistive load. Also derive the expression for the RMS output voltage.   (10)

    (ii) Explain the need for continuous gating pulses for ac voltage controller with RL load.   (6)

Or

(b) (i) Give the various configurations of three-phase ac voltage controllers. List out the important points of comparison between these circuits.   (10)

    (ii) Discuss the working of 2 stage sequence control of ac voltage regulator with R load. What are the advantages of this controller over a single stage controller?   (6)

15. (a) (i) Explain how a single phase low frequency output voltage can be fabricated from the segments of three-phase input voltage waveform using a three-phase half-wave cycloconverter circuit.   (8)

    (ii) Show a complete cycle of low voltage output voltage.   (3)

    (iii) Give a comparison between the cycloconverter and a dc link converter.   (5)

Or

(b) (i) Show that the fundamental RMS value of per phase output voltage of low frequency for an m-pulse cycloconverter is given by $E_{or} = E_{ph}\left(\dfrac{m}{\pi}\right)\sin\left(\dfrac{m}{\pi}\right)$. Also explain E_{or} in terms of voltage reduction factor. (10)

(ii) Draw and explain the control circuit block diagram for a cycloconverter with non-circulating current mode. (6)

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