

W 2683

M.E. DEGREE EXAMINATION, JANUARY 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. A three phase full converter charges a battery from a three phase supply of 230 V, 50 Hz. The battery emf is 200 V and its internal resistance is 0.5 ohm. The load current is constant and maintained at 20A. Compute the firing angle delay?
2. What do you mean by sequence control of inverters?
3. What are the advantages of non-circulating current mode of operation over circulating current mode in Dual Converters?
4. What is overlap angle?
5. What is time ratio control?
6. What are the differences between Buck-Boost and Cuk converters?
7. Draw the input and output voltages of a single phase full wave AC voltage controller with RL load for a firing angle of 30°?
8. What do you mean by integral cycle control in AC voltage regulators?
9. Mention some applications of Cycloconverter?
10. What is the difference between force commutated and line commutated Cycloconverters?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Describe the basic principle of working of single phase to single phase bridge type step down Cycloconverter for continuous conduction. Draw the relevant waveforms? (8)

- (ii) A 3-phase to single phase Cycloconverter employs a 6-pulse bridge circuit. This device is fed from 400 V, 50Hz supply through a delta/star transformer whose per-phase turns ratio is 3 :1. For an output frequency of 2 Hz, the load reactance is 3 ohms. The load resistance is 4 ohms. The commutation overlap and the thyristor turn-off time limit the firing angle in the inversion mode to 165° . Compute the peak value of rms output voltage and output power? (8)

Or

- (b) (i) A three-phase cycloconverter is used to feed a RLE load with variable voltage and variable frequency output signal. Whether the frequency of the signal could be reduced up to zero Hertz? Explain your answer. (8)
- (ii) Explain the working principle of three - phase cycloconverters with necessary power circuit and gating signals. (8)
12. (a) (i) A single phase full converter feeding RLE load has the following data. Source voltage = 230 V, 50 Hz; $R = 2.5$ ohms, $E = 100$ V, Firing angle = 30° . If the load inductance is large enough to make the load current virtually constant, then
- (1) Sketch the time variations of source voltage, source current, load voltage, load current, current through one SCR and voltage across it,
 - (2) Compute the average value of load voltage and load current,
 - (3) Compute the input p.f. (10)
- (ii) Briefly describe any one of the power factor improvement methods of Converters. (6)

Or

- (b) (i) Explain the principle of operation of single phase Dual Converter? (8)
- (ii) A single phase one-pulse SCR controlled converter feeds an RL-load with a freewheeling diode across the load. Discuss the role of freewheeling diode. Sketch waveforms for supply and load voltages, load current, supply current, freewheeling diode current and voltage across SCR. (8)
13. (a) Discuss the effect of source inductance in the performance of 3-phase Full converter. Derive expression for its output voltage in terms of firing angle and overlap angle. Draw relevant waveforms. (16)

Or

- (b) (i) Two three phase full-converters are connected in antiparallel to form a 3-phase Dual converter of the circulating current type. The input to the dual converter is 3-phase, 400 V, 50 Hz. If peak value of circulating current is to be limited to 20A, find the value of inductance needed for the reactor for firing angle of $\alpha_1 = 60^\circ$. (8)
- (ii) A 3-phase semiconverter is connected to RL load. For a firing angle delay of 30° , mark the ON duration of the various elements present in the semiconverter. Draw input voltage, output voltage and load current waveforms in case load current is continuous. (8)
14. (a) (i) Describe in detail the principle of operation of Cuk converters. Derive the expression for average output voltage, input current and switching period. (8)
- (ii) Give a short note on Current Limit Control of chopper circuits. (8)

Or

- (b) A step down chopper is feeding an RL load with $V_s = 220$ V, $R = 5$ ohms, $L = 7.5$ mH, $f = 1$ KHz and 0.5 dutycycle. Calculate the minimum instantaneous load current, peak instantaneous load current, the maximum peak-to-peak load ripple current average and rms values of load voltage. (16)
15. (a) A single phase full wave ac voltage controller has a resistive load of $R = 0.5$ ohms and the input voltage is $V_s = 120$ V (rms), If the desired output power is $P_o = 7.5$ kW, determine
- (i) the duly angles of the thyristors T1 & T2
- (ii) the rms output voltage, V_o
- (iii) the input p.f
- (iv) average thyristor current and
- (v) rms value of the thyristor current. (16)

Or

- (b) Draw and explain the principle of operation of 3-phase bidirectional controller with Y connected load. Draw the waveforms of input phase voltage, input line voltage and one of the output phase voltages for $\alpha = 60^\circ$. Clearly mark the ON duration of various thyristors. (16)