

**G 7143**

M.E. DEGREE EXAMINATION, JANUARY 2006.

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. What is the main purpose using freewheeling diode in converters?
2. How is the overlap angle depending on the delay angle of converters?
3. What is the rectification mode of converters?
4. What are the advantages of dual converter operating with circulating current mode?
5. Define : Voltage ripple factor.
6. What is the effective input resistance of a chopper circuit with a load resistance of  $25 \Omega$ , duty cycle 30% and chopping frequency of 1kHz?
7. What are the basic topologies of switching regulators?
8. What is the extinction angle in a.c voltage controller?
9. What are effects of the load inductance on the performance of cycloconverters?
10. How can the harmonics in the output of cycloconverters be reduced?

PART B — (5 × 16 = 80 marks)

11. (i) Sketch the output waveform of a three phase full converter with firing angle  $\alpha = 60^\circ$  and also show the phase voltages and firing pulses. Assume continuous load current. (8)
- (ii) A three phase full converter is supplied from a three phase 400V, 50Hz supply. The load current is continuous and has negligible ripple. If the average load current is 150A and the commutating inductance is 0.1mH, determine the overlap angle for delay angle  $\alpha = 45^\circ$ . (8)

12. (a) (i) Derive an expression to show the effects of source inductance on the output voltage of a single phase converter. (8)
- (ii) A single phase dual converter is operated from a 230V, 50Hz supply and the load resistance is  $10\ \Omega$ . The circulating current inductance is 40mH. The delay angles are  $\alpha_1 = 60^\circ$  and  $\alpha_2 = 120^\circ$ . Calculate the peak circulating current and the peak current of converter 1. (8)

Or

- (b) (i) Derive the formula for average dc output voltage and the r.m.s value of fundamental component of line current for a fully controlled single phase ac/dc converter. (8)
- (ii) A single phase full converter delivers power to RLE load with  $R = 0.5\ \Omega$ ,  $L = 6.5\ \text{mH}$  and  $E = 10\text{V}$ . The a.c. supply voltage is 230V, 50Hz. For the continuous conduction, determine the load current and average output current at delay angle  $\alpha = 60^\circ$ . (8)
13. (a) An RLE type load is operating in a chopper circuit from 230V d.c. source. The load circuit parameters are  $R = 5\ \Omega$ ,  $L = 7.5\text{mH}$ ,  $E = 10$ , chopping frequency  $f = 1\ \text{kHz}$  and duty cycle = 50%. For continuous load current,
- (i) Derive the formula to find the Minimum and Peak instantaneous load current (8)
- (ii) Calculate the Minimum and Peak instantaneous load Current (4)
- (iii) Calculate Maximum peak-to-peak ripple current. (4)

Or

- (b) (i) Draw the circuit diagram of a Step up chopper and describe the principle of operation with associated output current waveform. Also derive the formula for the instantaneous output voltage. (8)
- (ii) Draw the circuit diagram of a Voltage commutated d.c. chopper and describe various modes of operation with associated equivalent circuits. (8)
14. (a) (i) Draw the circuit diagram with associated input and output waveforms and describe the principle of two types of control used in a.c voltage controller. (8)
- (ii) A three phase bi-directional delta connected controller has a resistive load of  $R = 10\ \Omega$ , If the line to line input a.c voltage is 400V, 50Hz and the delay angle is  $\alpha = 45^\circ$ . Sketch the load voltage and calculate the rms output voltage. (8)

Or

(b) A single phase AC voltage controller has a resistive load of  $R = 5\ \Omega$  and  $L = 5\text{mH}$ . The controller is supplied from a 230V, 50Hz supply. For  $\alpha = 50^\circ$ , determine

- (i) Average output voltage
- (ii) r.m.s output voltage
- (iii) Power factor
- (iv) Derive an expression for the instantaneous load current. ( $4 \times 4 = 16$ )

15. (a) (i) Draw and describe the basic block diagram for generation of gating signals for thyristors in ac-dc converters. (6)
- (ii) Draw and explain the circuit diagrams for a three phase to single phase cycloconverter with associated waveforms for resistive load. (10)

Or

(b) A Single phase cycloconverter has a resistive load  $R = 5\ \Omega$  and the load inductance  $L = 40\text{mH}$ . The converter is supplied from 230V, 60Hz. The output frequency is 20 Hz. If the converters are operated as semi converter such that  $0 < \alpha < 180^\circ$  and the delay angle is  $120^\circ$ , determine

- (i) The r.m.s value of output voltage
- (ii) The r.m.s current of thyristors
- (iii) The r.m.s output current
- (iv) The input power factor. (4 × 4 = 16)