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University Examinations 2013/2014

SECOND YEAR, SECOND SEMESTER EXAMINATION FOR DIPLOMA IN ELECTRICAL
ENGINEERING

EEE 0234: POWER ELECTRONICS

DATE: APRIL 2014

TIME: 1 ½ HOURS

INSTRUCTIONS: Answer question *one* and any other *two* questions

QUESTION ONE – (30 MARKS)

(a) Fig. 1 shows a thyristor device

- (i) Name the device of Fig. 1 (1 Mark)
- (ii) Draw its operation (1 Mark)
- (iii) Describe its operation (2 Marks)
- (iv) Draw its V – I characteristics (2 Marks)
- (b) (i) State the meaning of a thyristor. (1 Mark)
- (ii) Give the constructional details of a thyristor, its schematic diagram and symbol. (4 Marks)

(iii) Describe the different modes of operation of a thyristor with the help of its static V-1 characteristics. (5 Marks)

(iv) Discuss the conditions which must be satisfied for turning on an SCR with gate signal. (4 Marks)

(c) Explain in relation to a thyristor

(i) Line commutation (1 Mark)

(ii) Forced commutation (1 Mark)

(d) Define

(i) Holding current (1 Mark)

(ii) Latching current (1 Mark)

(e) Fig 2 is a converter.

(i) Derive the expression to the mean dc power to the load R_L . (2 Marks)

(ii) A $40K\Omega$ resistive load is driven by $230 V_{rms}$. For a firing angle of 45° during each positive cycle, determine the average dc power. (5 Marks)

QUESTION TWO – (15 MARKS)

(a) Define the following terms as used in filters

(i) Filter network (2 Marks)

(ii) Characteristic impedance (2 Marks)

(iii) Alternation (1 Mark)

(b) Derive the expression for the cut-off frequency of T-type high pass filter. (3 Marks)

(c) A T-type high pas filter having a cut-off frequency of 8KHZ is to be used in a transmission line having an impedance of $500L\theta\pi$. Assuming the elements to be non-

dissipative, determine the values of the shunt and series elements. Draw the resultant filter network. (5 Marks)

(d) A two transistor analogy of a SCR has the following data, gain of PNP transistor is 0.42, gain of NPN transistor is 0.54 and rated gate triggering current = 68mA.

(i) Derive the expression for the anode current. (1 Mark)

(ii) Calculate the value of anode current. (1 Mark)

QUESTION THREE – (15 MARKS)

(a) Explain choppers

(i) Step up (1 Mark)

(ii) Step down (1 Mark)

(b) Fig.3 is RL converter

(i) Explain the operation of the FD in fig. 2 (3 Marks)

(ii) State and explain the modes of the circuit operation. (3 Marks)

(c) For the chopper in Fig. 4

- (i) Explain the principle of operation of fig. 4 (1 Mark)
- (ii) Name a device used in place of chopper switch. (1 Mark)
- (iii) Show waveforms of input current and voltage and output current and voltage. (1 Mark)
- (iv) Calculate output voltage when input is 50V and duty cycle is 5ms. (2 Marks)
- (v) Distinguish between pulse width modulation and frequency modulation. (2 Marks)

QUESTION FOUR – (15 MARKS)

- (a) State the meaning of a controller. (1 Mark)
- (b) Sketch diagram of a full wave controller. Show the waveforms of V_0 and i_0 of the device. (2 Marks)
- (c) For the controller in (b) it is given that source voltage is given 230V at frequency 50HZ and load resistance in 3ohms. Calculate for any firing angle alfa:
 - (i) Average current. (1 Mark)
 - (ii) RMS current (1 Mark)
 - (iii) Minimum turn off time (1 Mark)
- (d) For a chopper explain;
 - (i) Pulse modulation (1 Mark)
 - (ii) Frequency modulation (1 Mark)
- (e) It is predicted that in future automation may use choppers for brake and speed control. (-- Marks)
- (f) State two advantages offered by the chopper in such application. (2 Marks)
- (g) Sketch a chopper diagram with RL load plus FD and use it to answer the following question;
 - (i) Which device can be used to represent the switch? (1 Mark)
 - (ii) Explain the operation of the chopper above. (1 Mark)
 - (iii) Discuss the principle of operation of chopper above. (1 Mark)
 - (iv) Given for the above chopper that turn-on time is 0.02sec and turn-off time is 0.05 sec and source voltage is 230V. Calculate
 - Output voltage. (1 Mark)
 - Chopping period (1 Mark)
 - Duty cycle (1 Mark)