00059

The Open University of Sri Lanka
Faculty of Engineering Technology

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**MEX5270 Power Electronics and Motor Drives**
Academic Year	:	2015/2016
Date	:	**11th December2016**
Time	:	**9.30am – 12.30pm**
Duration	:	3 hours

General instructions

1. Read the question carefully before answering the questions
2. This paper consists of 8 questions. All questions carry equal marks.
3. Answer **any 5 questions only.**

Q1.

(i). The voltage across a 10Ω resistor is v(t) = 170sin(377t) V. Determine ,

a) an expression for instantaneous power absorbed by the resistor, (2 Marks)

b) the peak power and, (2 Marks)

c) the average power. (2 Marks)

(ii). The voltage and current for a device (using the passive sign conversion) are periodic functions with T= 100ms described by

$$v(t)\begin{cases}10V & 0 < t < 70ms \\ 0 & 70ms < t < 100ms\end{cases}$$

$$i(t)\begin{cases}0 & 0 < t < 50ms \\ 4A & 50ms < t < 100ms\end{cases}$$

Determine,

a) the instantaneous power (2 Marks)

b) the average power and , (2 Marks)

c) the energy absorbed by the device in each period. (2 Marks)

(iii). Discuss at least **four** applications of power electronic converters. (8 Marks)

Q2.

(i). Sketch a turn – off snubber circuit configuration which could be used to reduce turn-off switching loss in a power semiconductor switch feeding a constant current load. (4 Marks)

(ii). Figure Q2 shows an inverter configuration using four static switches for converting a dc voltage input across the PQ into an ac voltage across AB. Each switch is treated to be non-ideal with a forward characteristic given by,

$$u_f = 1.6 + 0.1 * i_f \; V$$

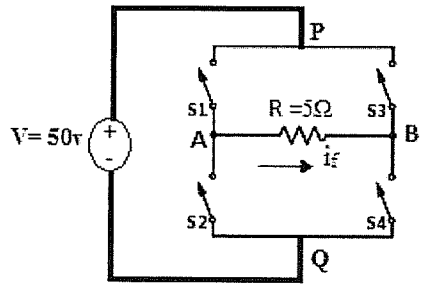


Figure Q2

The repetitive switching frequency is 500Hz. In each switching cycle, the sequence is as follow. S_1 and S_4 are both turned on at t = 0. Both are turned off at t = 0.6ms. S_2 and S_3 are then turned on at t = 1.0ms and turned off at t = 1.6ms. Neglect all power losses in the switch except that due the forward voltage drop in the ON state. Determine,

a) the maximum instantaneous power loss in any one switch and also the average power loss in it and, (8 Marks)

b) the maximum instantaneous power output from the converter and its average efficiency. (8 Marks)

Q3.

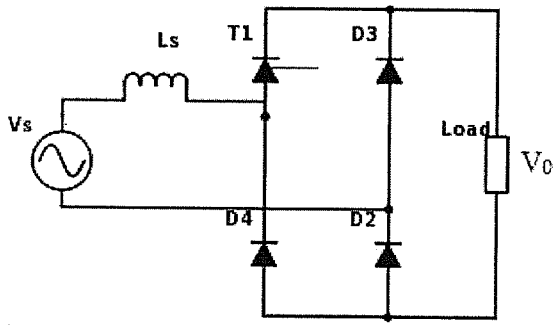


Figure Q3

(i). A single - phase controlled bridge converter consists of one controlled switch (T_1) and three diodes (D_2, D_3, D_4) as shown in Figure Q3.
Show that the average output voltage under the assumption of continuous current is

$$V_o = \frac{V_m}{2\pi}(3 + \cos\alpha)$$ Where V_m – peak value of the source voltage.

α - firing angle of switch (T_1)

(10marks)

(ii). If the load consists of a series R = 5Ω, L = 8mH and a battery V_{dc} = 100V. For an ac source voltage of 230 V, 50Hz and a firing angle of 45^0, determine the average output current and power delivered to the battery. (10 marks)

Q4. We wish to charge a 120V battery from a 600V dc source using a dc chopper. The average battery current should be 20A, with a peak – to – peak ripple of 2A. If the chopper frequency is 200Hz, calculate the following:

(i). The dc current drawn from the source. (5 marks)
(ii). The dc current in the diode. (5 marks)
(iii). The duty cycle of the chopper. (4 marks)
(iv). The value of the inductor. (6 marks)

Q5. A one quadrant chopper is feeding RL load with input voltage V_d = 220V. The load R=5Ω, L = 15.5mH. The switching frequency is 1 kHz. The duty cycle is 40%. Calculate:

(i).	the minimum instantaneous load current.	(6 marks)
(ii).	the peak instantaneous load current.	(6 marks)
(iii).	the peak – to – peak ripple load current.	(3 marks)
(iv).	the average load current and average load voltage	(5 marks)

Q6. An inverter which produces an output voltage as shown in Figure Q6 is used to supply an R – L series load with R = 10 Ω and L = 35mH. The dc input voltage is 250V and the output frequency is 60Hz.

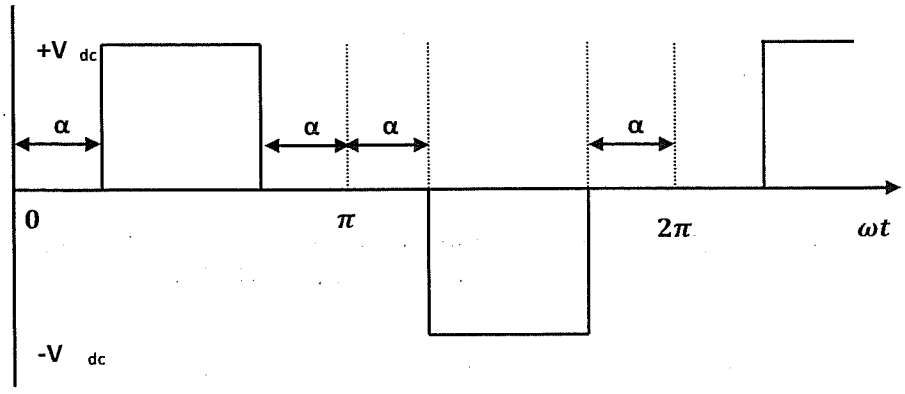


Figure Q6

(i). Determine the rms value of the fundamental frequency of the load current when $\alpha = 0$. (11 marks)

(ii). If the output fundamental frequency is lowered to 30Hz, determine the value of α required to keep the rms current at the fundamental frequency at the same value as in part (a). (9 marks)

Q7. The full – bridge inverter has a switching sequence which produces a square – wave voltage across a series R – L load. The switching frequency is 50 Hz, V_{dc} = 100V, R=10Ω and L = 25mH.

Determine,

(i).	an expression for the load current,	(6 marks)
(ii).	power absorbed by the load,	(7 marks)
(iii).	average current drawn from the dc source.	(7 marks)

Q8. A 750hp, 250V, 1200 r/min dc motor is connected to a 208V, 3 – phase, 60Hz line using a 3- phase bridge converter (Figure Q8). The full –load armature current is 2500A and the armature resistance is 4mΩ.

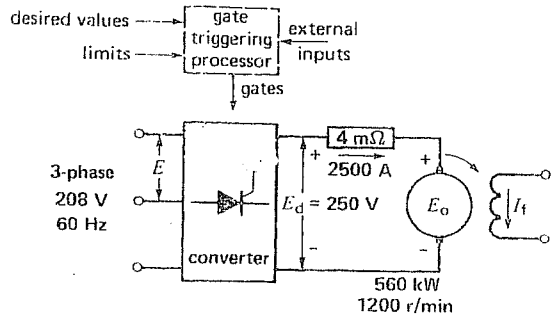


Figure Q8

Calculate,

(i). the required firing angle α under rated full – load conditions. (7 marks)

(ii). the firing angle required so that the motor develops its rated torque at 400r/min (7 marks)

(iii). the reactive power absorbed by the converter when the motor develops full torque at 400 r/min. (6 marks)