THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY-LEVEL 05
FINAL EXAMINATION 2009/2010

MEX5270 – POWER ELECTRONICS AND MOTOR DRIVES

DATE: 21st MARCH 2010
TIME: 1330-1630 HRS
DURATION: THREE HOURS

READ THE FOLLOWING INSTRUCTIONS CAREFULLY BEFORE ANSWERING THE QUESTION PAPER

The question paper has **eight** questions
Answer **five** questions only.

Q1

Figure Q1 shows an inverter configuration using four static switches for converting a dc voltage input across PQ into an ac voltage across AB. Each switch is treated to be non ideal with a forward characteristic given by,

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

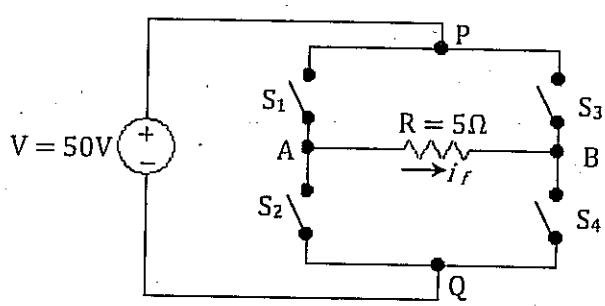


Figure Q1

The respective switching frequency is 500 Hz. In each switching cycle, the sequence is as follows. S_1 and S_4 are both turned on as t = 0. Both are turned off as t = 0.6 ms. S_2 and S_3 are then turned on at t = 1.0 ms as turned off t = 1.6 ms. Neglect all power losses in the switch expect that due to 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,
b) The maximum instantaneous power output from the convertor and its average efficiency.

Q2

a) 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.

b) Two identical transistors are mounted on a common heat-sink, which has a thermal resistance of 2^0 C/W. If the thermal resistance of each transistor from the junction to case, $R_{\Theta(jc)}$, is 2^0 C/W and the contact thermal resistance between the transistor and the heat sink, $R_{\Theta(cs)}$, is 0.2^0 C/W. Determine the maximum power that can be dissipated

   i. With all the power dissipated in one transistor and,

   ii. The power being equally divided between the two transistors.

Assume an ambient temperature of 55^0 C and maximum junction temperature of 125^0 C.

Q3

A full-wave controlled converter operating as an inverter is used to transfer power from a wind generator to a single-phase 240 V rms 60 Hz AC system. The generator produces a DC output of 150 V and is rated at 5000 W. The equivalent resistance of the generator circuit is 0.6 Ω.

a) Determine the converter delay angle for rated generator output power.

b) Determine the power absorbed by the AC system.

c) Determine the inductance required to limit the peak-to peak current ripple to 10% of the average current.

Q4

Show that the controlled full-wave bridge rectifier with a resistive load has a power-factor of

$$pf = \sqrt{1 - \frac{\alpha}{\pi} + \frac{\sin 2\alpha}{2\pi}}$$

Q5

A buck converter has an input voltage, V_d = 15 V. The required average output voltage V_o = 5 V and the peak-to-peak output ripple voltage is 10mV. The switching frequency is 20KHz. the peak-to-peak ripple current of the inductor is limited to 1A. The converter is operating in continuous current mode. Determine:

a) the duty cycle D,

b) the filter inductor L,

c) the filter capacitor C,

d) and the boundary current I_{LB}.

Q6

A boost converter has an input voltage, $V_d = 6V$. The average output voltage $V_o = 15V$ and the average load current is $I_o = 1A$. The switching frequency is 10 KHz. If L= 250μH and C = 440 μF. Determine:

a) the operation mode
b) the duty cycle D,
c) the ripple current of the inductor ΔI_L,
d) and the ripple voltage of the capacitor ΔV_c.

Q7

Propose and design a AC-AC power converter circuit to deliver power in the range of 750W to 1500W to a 30Ω resistive load from a 230V at 50 Hz source. Determine the corresponding maximum firing angle of the device, rms and average currents of the device and the corresponding worst case power factor on the supply side.

Q8

a) What are the three types of dc drives based on the input supply?
b) What is a speed regulation of dc drives?
c) What is a four-quadrant dc drive?
d) Discuss the principle of regenerative braking of dc-dc converter-fed dc motor drives.

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