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THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
LEVEL 05
FINAL EXAMINATION 2010/2011

MEX5270 – POWER ELECTRONICS AND MOTOR DRIVES

DATE: 2nd April 2011
TIME: 1400-1700 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

a) In a non-ideal static switching device, the current and voltage values during the switching transitions follow parabolic laws as stated by the following equations;

$$i = I\left(\frac{t}{t_{on}}\right)^2, v = V\left(\frac{t_{on}-t}{t_{on}}\right)^2 \text{ for ON transition}$$

$$i = I\left(\frac{t_{off}-t}{t_{off}}\right), v = V\left(\frac{t}{t_{off}}\right)^2 \text{ for OFF transition}$$

Assume that the static performance of the switch is ideal. Derive an expression for the switching power loss at a frequency of f in Hz.

b) The transition times needed by the switch are t_{on}= 2 μs and t_{off} = 4 μs. The OFF state voltage is 120V and the ON state current is 10 A. Determine and plot the switching power loss as a function of frequency for the range 0-100 kHz.

Q2

The on state voltage drop of each controlled switch in Fig. Q2 (a) is 2 V. The forward leakage current of each switch is 5 mA. The switches S_1 and S_2 are operated at a repetitive switching frequency of 500 Hz according to the timing diagram as shown in Fig. Q2 (b). Neglect the switching transition times.

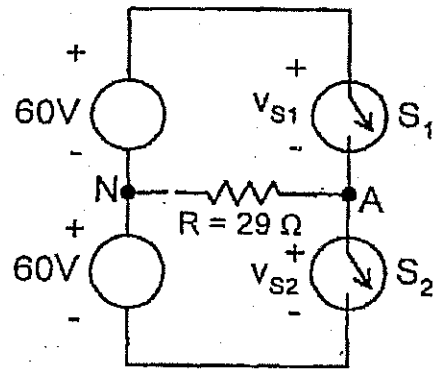


Fig. Q2 (a)

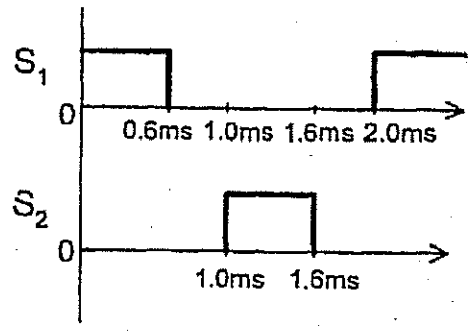


Fig. Q2 (b)

a) Sketch and dimension the load voltage, V_{AN} and the voltage drop, V_{s1} across the switch S_1.

b) Determine the peak voltage blocking capability needed for the switch S_1.

c) Determine the average and peak power dissipations in the switch S_1.

d) Determine the overall efficiency of power conversion.

Q3

a) A full – wave diode bridge rectifier has a source voltage of 230 V at 50 Hz. It is supplying to a R-L-Source load with $R = 4\ \Omega$, $L = 20$ mH, $V_{dc} = 100$ V. Determine,

i. The power absorbed by the dc source
ii. The power absorbed by the resistor and
iii. The power factor.

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

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

Q4

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

a) The dc current drawn from the source.
b) The dc current in the diode.
c) The duty cycle of the chopper.
d) The value of the inductor.

Q5

A boost converter has an input of 5V and an output of 20 W at 15 V. The minimum inductor current must not be less than 50% of the average value. The output voltage ripple must be less than 1%. Determine the duty cycle, minimum inductor value and minimum capacitor value. Sketch and dimension the corresponding inductor current and diode current. Derive the necessary equations used from the fundamental principle. Assume that the converter switching frequency is 30 kHz.

Q6

A square-wave inverter has a dc source of 125V, an output frequency of 50 Hz, and an R-L series load with R=20 Ω and L=20 mH . Determine;

a) an expression for the load current,
b) sketch the load current and indicate the time intervals when each switch component is conducting,
c) rms load current and,
d) average source current.

Q7

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 150V and is rated at 5000 W. The equivalent resistance of the generator circuit is 0.6Ω. Determine;

a) the converter delay angle for rated generator output power.
b) the power absorbed by the AC system.
c) the inductance required to limit the peak-to-peak current ripple to 10% of the average current.

Q8

a) What are the parameters to be varied for speed control of separately excited dc motors?
b) Why are the dc series motors mostly used in traction applications?
c) What is a two-quadrant dc drive?
d) What is a brushless dc motor?
e) What is a brushless ac motor?
f) What is a stepper motor?

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