TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

Bachelor of Science in Electrical and Electronic Engineering

EEE 2404: POWER ELECTRONICS II

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Answer any THREE Questions.

Do not write on the question paper.

Question ONE

a) Figure Q1 shows a circuit that is used to control the load power. Describe its operation. Include the waveforms of the six, voltages and currents indicated. (**8 marks**)

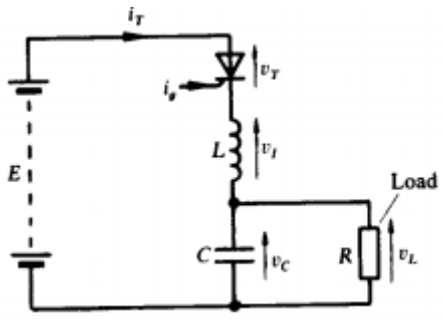

Figure Q1

b) An ideal chopper operating at a frequency of 500 Hz supplies a load of 3Ω having an inductance of 9 mH from a 60 V battery. Assuming the load is shunted by a perfect commutating diode, and the battery is lossless,

(i) Determine the load current waveform for on/off ratios of:
I 1/1
II 4/1
III 1/4

(ii) Calculate the mean voltage and current at each setting in (i). (**12 marks**)

Question TWO

a) Draw the circuit diagram of a buck converter using ideal switch and ideal diode and explain its operation. Sketch the equivalent circuit for the operational conditions assuming continuous conduction mode. (**9 marks**)

b) Figure Q2 is a circuit diagram of an ideal synchronous buck regulator using ideal switches. Given that it is switching at 200 kHz, input voltage is **27.2V,** output voltage is **13.6V**, output load is 1.36Ω and peak to peak ripple current in inductor is 4A, determine:

(i) Period, Duty cycle, T_{off}, T_{on} of the low side switch.
(ii) Output power, Average Input current.
(iii) The Value of the inductance, Average inductor current.
(iv) The value of the capacitance needed to obtain a 20mVpp ripple.
(v) Draw the inductor current waveform for two periods. (**11 Marks**)

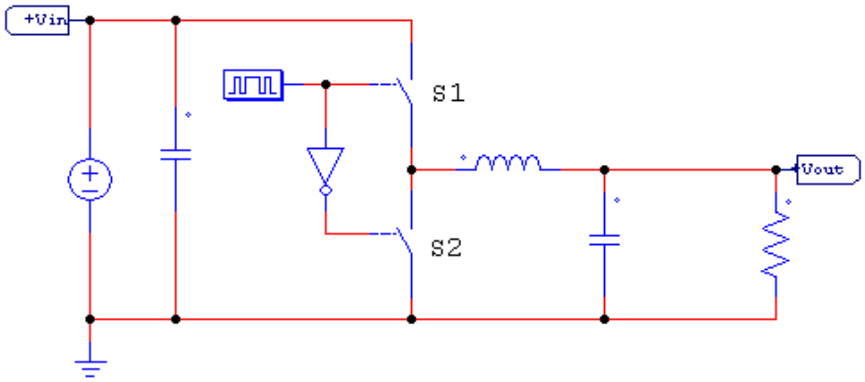

Figure Q2

Question THREE

a) With reference to full bridge dc-dc converter,

(i) differentiate between PWM with bipolar voltage switching and PWM with unipolar voltage switching.
(ii) Explain the term 'blanking time' (**3 marks**)

b) In a full-bridge dc-dc converter utilizing PWM bipolar voltage switching, $\upsilon_{control}$ = 0.5 V_{tri}. Obtain V_o and $I_d$in terms of given V_d and I_o. By Fourier analysis, calculate the amplitudes of the switching-frequency harmonics in υ_o and i_d. Assume that $i_o(t) = I_o$.

Question FOUR

a) Give ONE disadvantage and TWO disadvantages of high switching frequency in inverters.
(**3 marks**)

b) In the circuit of Figure Q4, $V_d = 300$, $m_a = 0.8$, $m_f = 39$, and fundamental frequency is 47 Hz. Use Table Q4 to calculate the rms voltage values at:

(i) the fundamental frequency
(ii) harmonic frequencies of 37, 77 and 115. (**8 marks**)

Table Q4: Generalized Harmonics of v_{Ao} for a Large m_f.

h \ m_a	0.2	0.4	0.6	0.8	1.0
1 Fundamental	0.2	0.4	0.6	0.8	1.0
m_f	1.242	1.15	1.006	0.818	0.601
$m_f \pm 2$	0.016	0.061	0.131	0.220	0.318
$m_f \pm 4$					0.018
$2m_f \pm 1$	0.190	0.326	0.370	0.314	0.181
$2m_f \pm 3$		0.024	0.071	0.139	0.212
$2m_f \pm 5$				0.013	0.033
$3m_f$	0.335	0.123	0.083	0.171	0.113
$3m_f \pm 2$	0.044	0.139	0.203	0.176	0.062
$3m_f \pm 4$		0.012	0.047	0.104	0.157
$3m_f \pm 6$				0.016	0.044
$4m_f \pm 1$	0.163	0.157	0.008	0.105	0.068
$4m_f \pm 3$	0.012	0.070	0.132	0.115	0.009
$4m_f \pm 5$			0.034	0.084	0.119
$4m_f \pm 7$				0.017	0.050

Note: $(\hat{V}_{Ao})_h/\frac{1}{2}V_d$ [$= (\hat{V}_{AN})_h/\frac{1}{2}V_d$] is tabulated as a function of m_a.

c) In a single-phase full-bridge PWM inverter, the input dc voltage varies in the range 295-325V. Due to low distortion requirements in the output voltage υ_o, $m_a = 1.0$.

(i) Determine the highest V_{o1} that can be obtained and indicated on its nameplate as its voltage rating.
(ii) Its nameplate volt-ampere rating is specified as 2000 VA, that is V_{o1}max x $I_o$max, where i_o is assumed to be sinusoidal. Calculate the combined switch utilization ratio when the inverter is supplying its rated volt-ampere. (**9 marks**)

Question FIVE

a) Differentiate between ;
(i) Equation solvers and circuit oriented simulations.
(ii) Differentiate between load – resonant and resonant – switch converters
(**4 marks**)

b) Draw a diagram of a half-bridge series loaded converter and explain its operation.
(**6 marks**)

c) Explain the effects of the following disturbances:
   (i) Overvoltage
   (ii) Voltage spikes
   (iii) harmonics. (**3 marks**)

d) A parallel capacitor chopper of Figure Q5(d) has a load of 5Ω supplied from a 24V battery. The required turn-off time for thyristor T_1 is 60μS. Determine:
   (i) the size of capacitor.
   (ii) the appropriate minimum on-time for thyristor T_1 if $R_2 = 5R_1$ (**7 marks**)

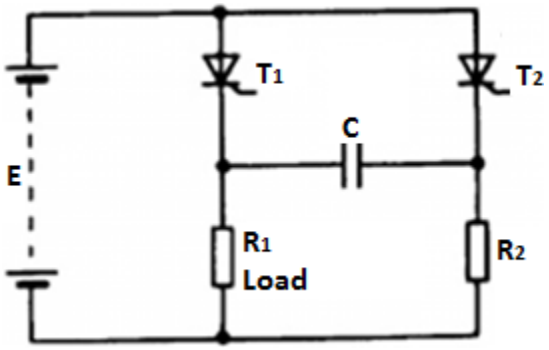

Figure Q5(d)