UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	POWER ELECTRONICS
COURSE CODE	:	BEE 4113
PROGRAME	:	4 BEE
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS EXAMINATION PAPER CONSISTS OF (6) PAGES

Q1 (a) (i) What is a converter and state the types of power converter?

(4 marks)

(ii) The diode cannot be used in high frequency application if the reverse recovery time (t_{rr}) and reverse recovery charge (Q_{rr}) of power diode is high. State the three effects of reverse recovery for a diode.

(3 marks)

(iii) Power electronic switches are used in power electronic converters to convert one level of signal to another level. In general, it can be categorized into three types, which are: Uncontrolled, Semi-Controlled and Fully Controlled. List the power electronic switches used for each type of those converters.

(3 marks)

(b) A 240V single-phase half-wave rectifier are connected in series with a diode and a load resistor 100Ω as shown in Figure Q1(b). Calculate the current flowing through the load and its power consumed.

(6 marks)

(c) The switching characteristic of a typical semiconductor power device is shown in Figure Q1(c). It is given that $t_{c(on)} = 4ns$, $t_{c(off)} = 6ns$, $t_{on} = 3\mu s$, and operates at switching frequency of $50kHz$. If the total average power dissipation, P_T is 1.75watt, current flow through the switch is 5A and switch on-state voltage is 1V. Calculate:

(i) The average power dissipated during on-state, P_{ON}.
(ii) The average switching power loss, P_S.
(iii) The input voltage (voltage across the switch during off-state), V_d.

(9 marks)

Q2 A single phase full-wave controlled rectifier has a resistive load of R = 12.5Ω, the voltage at the primary transformer is 240V with ratio 2:1, and the firing angle of thyristor is 30°.

(i) Draw the circuit explain in this question.
(ii) Derive and find the average output voltage.
(iii) Determine the average load current
(iv) Determine average output power
(v) Determine the new firing angle, α. if the rectifier is connected to the load which consumes 50% less than maximum possible average output voltage
(vi) Draw the input voltage, output voltage and output current waveforms for the new firing angle α.

(25 marks)

Q3 (a) (i) List three common types of inverter and draw its block diagram.

(ii) State the advantages and disadvantages of PWM switching scheme.

(10 marks)

(b) A single phase, full-bridge inverter supplies a load of 10 Ω in series with an inductance of 15 mH. The inverter is supplied from a 100 volts DC source. The inverter is operates at the frequency of 100 Hz.

(i) Calculate the rms value of the fundamental output voltage of a square-wave waveform.

(ii) Determine the power absorbed by the load resistor due to the fundamental component.

(iii) Find the total harmonics distortion (THD) of the load current. Consider up to 7^{th} order harmonics.

(iv) If the output voltage is to be in quasi-square wave, calculate the angle α of inverter when the fundamental rms output voltage is 50 V.

(15 marks)

Q4 (a) Explain briefly two modes of operation in DC-DC Converters based on inductor current.

(4 marks)

(b) Design a boost converter to provide an output of 36V from constant dc source supply for continuous current mode with duty cycle 0.666. The load is 100W and the output voltage ripple must be less than 1%. Assuming for the ideal components and the switching frequency is 25 kHz.

(i) Using volt-second balance technique, prove that the output voltage of the buck-boost converter is

$$V_o = \frac{V_s}{1-D}$$

(ii) Determine the dc input voltage.

(iii) Determine the capacitor size

(iv) Find the average inductor current

(v) Derive the expression of the minimum inductor current $I_{Lmin,}$ during the switch is closed

(vi) Derive and determine minimum inductor $L_{min,}$ for continuous current mode operation

(21 marks)

Q5 (a) Figure Q5(a) employed for controlling the power flow from 240 Vrms, 50 Hz source into a load circuit consisting of a resistor load, R =7 Ω and the average output voltage is 160V.

(i) Derive the average output voltage and find the firing angle.
(ii) Determine the RMS output voltage.

(9 marks)

(b) If an inductance load is added in series connection with R load in question Q5(a), L = 100 mH.

(i) Calculate the control range of the firing angle, α.
(ii) Determine the maximum value of RMS load current, I_{orms}
(iii) Determine the maximum value of output power, P_o and power factor, PF
(iv) Derive the maximum value of RMS thyristor current, I_{TM}

(16 marks)

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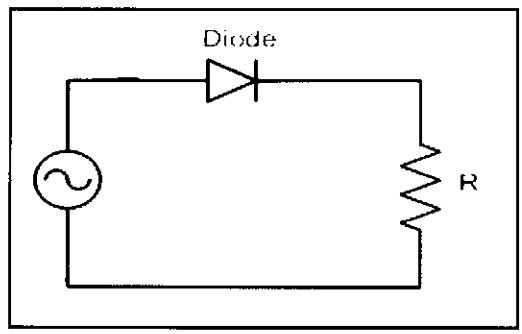

Figure Q1 (b)

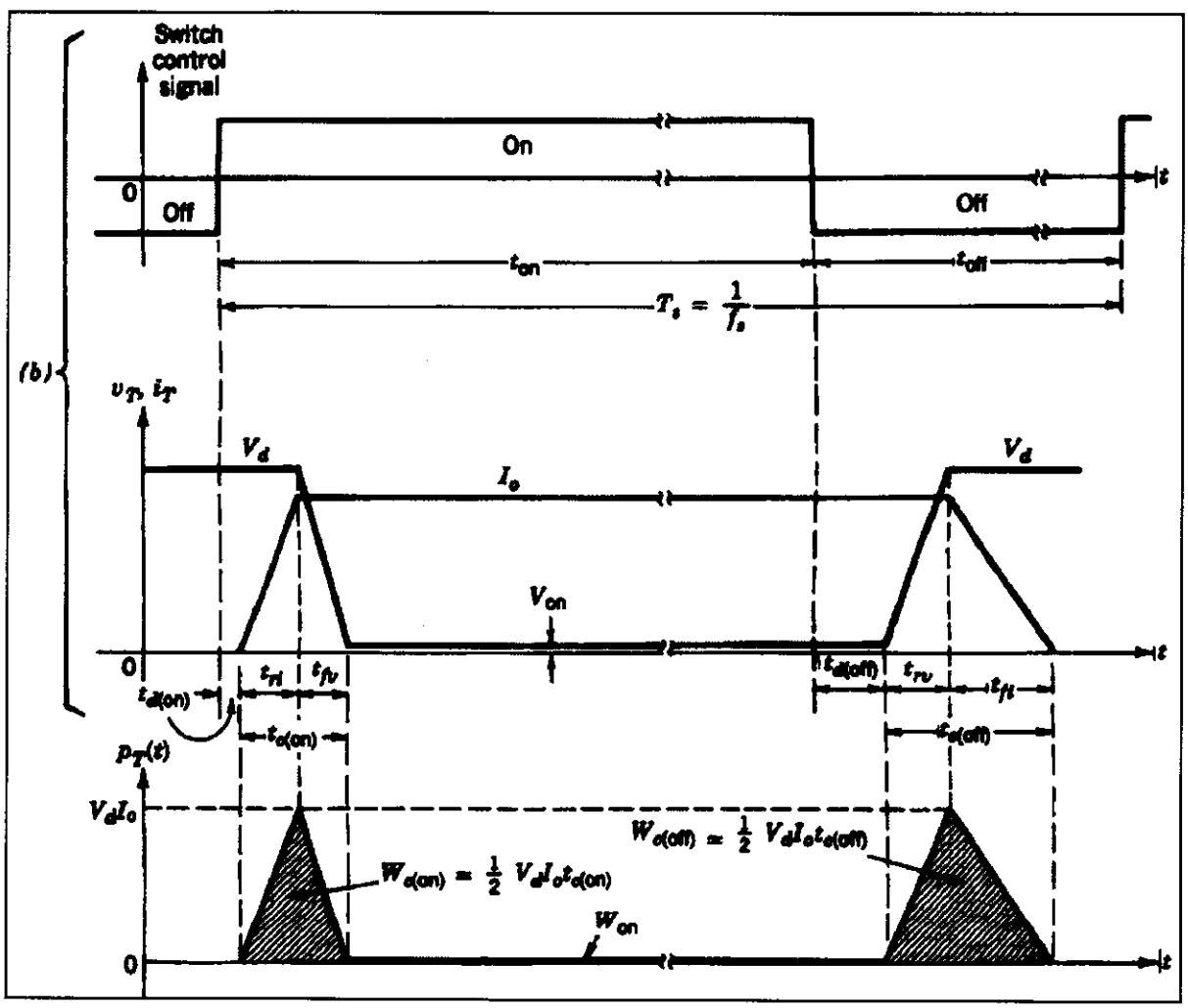

Figure Q1(c)

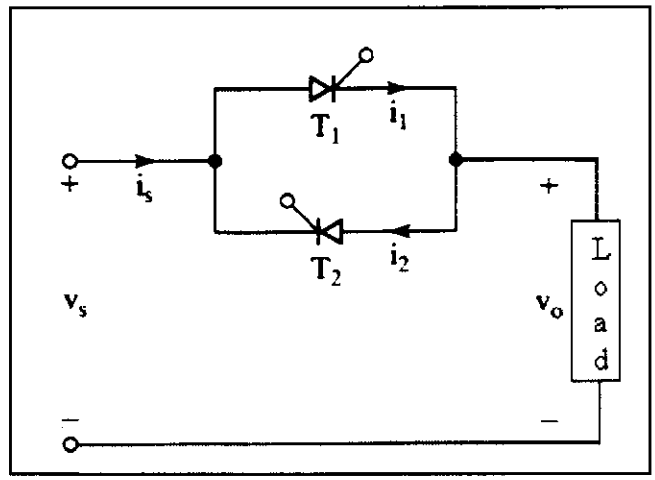

Figure Q5(a)