UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2010/2011

COURSE NAME	:	POWER ELECTRONICS
COURSE CODE	:	BEE 4113
PROGRAMME	:	4 BEE
EXAMINATION DATE	:	NOVEMBER / DISEMBER 2010
DURATION	:	2 ½ HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS EXAMINATION PAPER CONSISTS OF (8) PAGES

Q1 (a) Define the power electronics and what is the goal of power electronics.

(4 marks)

(b) Semiconductor power devices such as BJT, GTO and IGBT have power dissipation during turn on and turn off. Therefore it is important to consider this matter in designing a power electronic circuit. Figure Q1(b) has shown the switching characteristic of a typical semiconductor power device. If it is given that $t_{c(on)} = 4ns$, $t_{c(off)} = 6ns$, $t_{on} = 3\mu s$, and operates at switching frequency of $100kHz$. If the total average power dissipation, P_T is 1.75 watt, current flow through the switch is 5 A and switch on-state voltage is 1 V. 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.
(iv) what is the new switching frequency if it is required to reduce the average power dissipated P_{ON} as in Q1(b)(i) by 50%.

(10 marks)

(c) Figure Q1(c) is a half-wave uncontrolled rectifier has a 120 V_{rms} source at 60Hz. The load R=500Ω, C=100uF. Assume α and θ equal to 48 and 93 degrees respectively. Determine

(i) expression for output voltage, V_o
(ii) peak-to peak ripple voltage, ΔV_o
(iii) capacitor current, I_c
(iv) Peak diode current, $I_{D,peak}$

(11 marks)

Q2 (a) (i) State the requirement or condition to turn ON of Silicon Controlled Rectifier (SCR).

(2 marks)

(ii) Crest factor is a parameter to measure the performance of a rectifier circuit. A large value of crest factor will give indication that the circuit is not efficient in delivering energy. Calculate the value of crest factor for a given output waveform in Figure Q2(a)(ii).

(5 marks)

(b) Figure Q2 (b) is a single phase half-wave uncontrolled rectifier circuit connected to resistive and inductive load (RL load). The output current will flow in the circuit even in –ve input cycle of voltage source.

(i) Draw the waveform of output voltage, V_o and output current, I_o of the circuit if the extinction angle, β is 200°.
(ii) If the output current is Discontinuous Current Mode (DCM), explain with the aid of suitable diagram to overcome this problem.

(6 marks)

(c) Figure Q2 (c) shows a single phase half-wave controlled rectifier which has a resistive load of R = 10Ω. The voltage at the secondary transformer is 240V and the firing angle α = 60°.

(i) Calculate the values of average voltage output, V_{avg} and RMS voltage output, V_{rms}.
(ii) Determine the average load current, I_{avg} and rms load current, I_{rms}
(iii) Determine the average output power
(iv) Determine the new firing angle α, if the rectifier is connected to the load which consumes half than maximum possible average output voltage
(v) Draw the output voltage, V_o and current waveforms, I_o for the new firing angle, α.

(12 marks)

Q3 (a) State two (2) advantages and disadvantages of PWM switching scheme.

(4 marks)

(b) Figure Q3(b) shows a single phase, half-bridge inverter with a resistive load R = 4Ω and the input voltage is 24 volt DC. The inverter operates at a frequency of 50 Hz. Determine;

(i) the rms output voltage, V_{rms} at fundamental frequency.
(ii) the output power, P_o
(iii) the average current of each transistor

(9 marks)

(c) A single phase, full-bridge inverter supplies has a resistive load of 12 Ω in series with an inductive load of 25 mH and a capacitive load of 500 μF. The inverter operates at a frequency of 60 Hz.

(i) Determine the value of the fundamental rms output voltage if the fundamental rms output load current is I_{orms} = 10 A
(ii) Determine the value of the DC voltage source required to establish a load current in Q3(c)(i)
(iii) If the output voltage is to be in quasi-square wave, calculate the angle α of inverter when the fundamental output voltage is 100 V.
(iv) Find the THD_v of the output voltage in Q3(c)(i).

(12 marks)

Q4 (a) Pulse Frequency Modulation (PFM) is not preferred for switching technique in DC to DC converter. State three (3) disadvantages of PFM

(3 marks)

(b) Figure Q4 (b) shows the design of a boost converter to provide an output voltage of 15V from a 5V voltage source. The load is 30W. The minimum inductor current must be no less than 75% of the average value. The output voltage ripple must be less than 1.5%. The switching frequency is 10 kHz.

(i) Formulate the expression of the output voltage, V_o.
(ii) Calculate the duty ratio of the converter. D
(iii) Determine the minimum inductor current, I_{Lmin} afterwards calculate the value of inductor, L
(iv) Determine the minimum value of capacitor.

(10 marks)

c). An engineer are requires to design and analyze a DC to DC converter that shown in Figure Q4(c) with the following specifications:

DC input voltage	: 24 V
Output voltage	: 20 V
Load	: 33 W
Ripple output voltage	: ≤ 1%
Switching frequency	: 25 kHz

The converter is expected to operate in Continuous Current Mode (CCM). Assuming all the components used are ideal:

(i) Determine the duty cycle, D
(ii) Determine the minimum value of the inductor, L_{min} to provide Continuous Current Mode (CCM) operation
(iii) Calculate the value of capacitor, C
(iv) Sketch the waveforms of V_L, i_L, i_D and input current I_s of the converter during ON-state and OFF-state conditions,
(v) What is the output voltage of the converter if the new duty cycle is 0.65?
(vi) Explain your answer Q4(c)(v) relate to V_o

(12 marks)

Q5 (a) Figure Q5(a) shows a single phase full wave ac voltage controller with resistor load. If the firing angle, α=30^0, plot the waveform (in one period) of:
(i) V_{sw}
(ii) I_o, and
(iii) V_o

(9 marks)

(b) If 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 =15 Ω and inductor load, L = 50 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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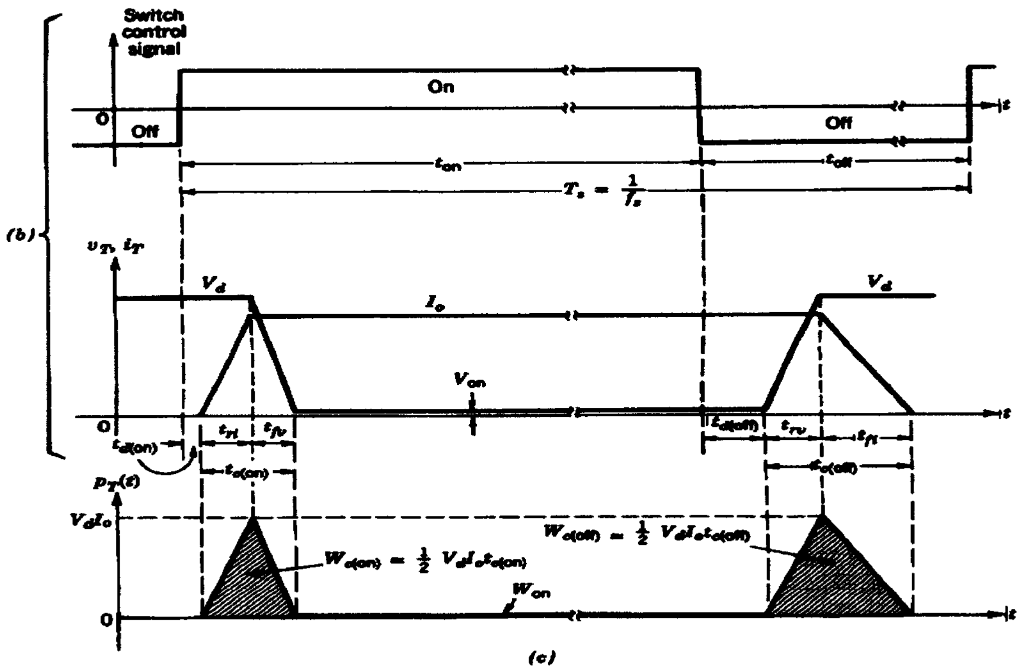

Figure Q1(b)

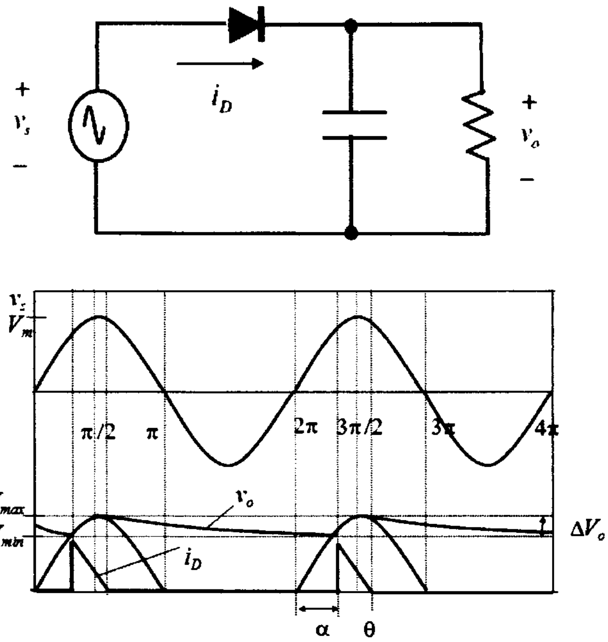

Figure Q1(c)

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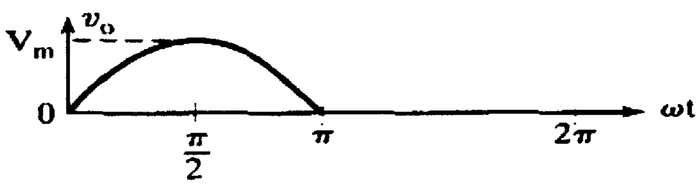

Figure Q2(a)(ii)

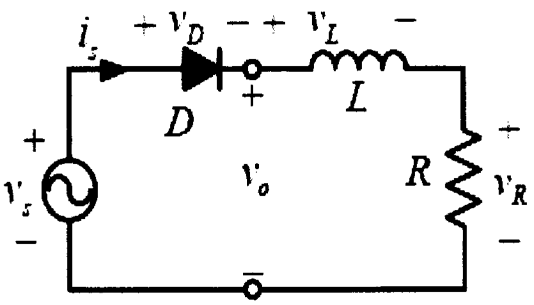

Figure Q2(b)

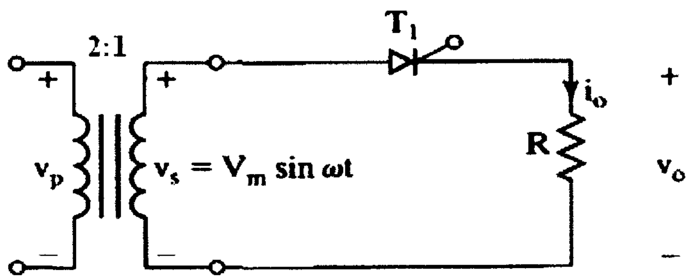

Figure Q2(c)

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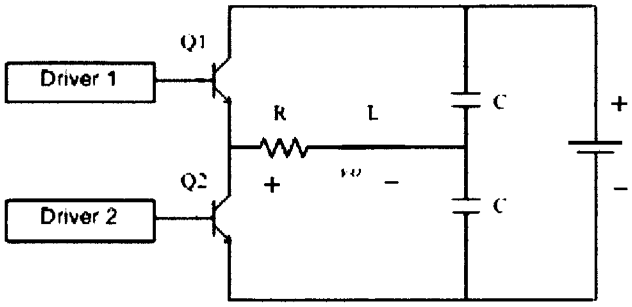

Figure Q3(b)

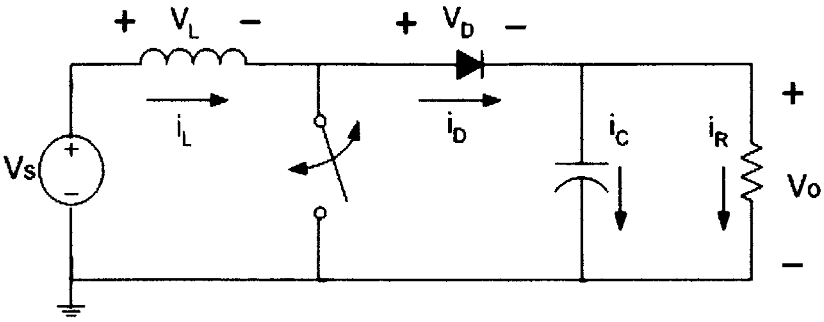

Figure Q4(b)

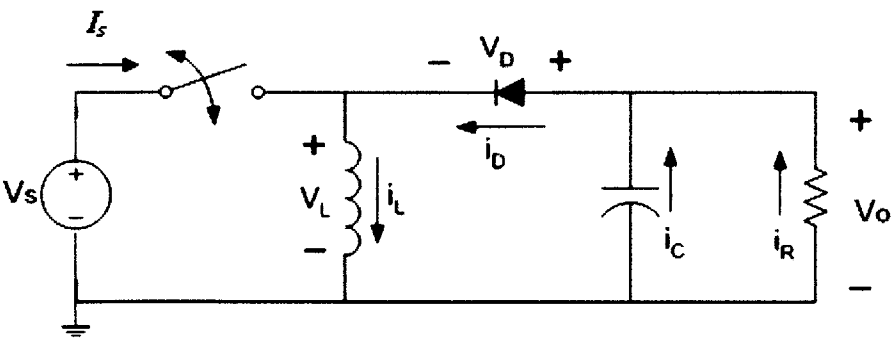

Figure Q4(c)

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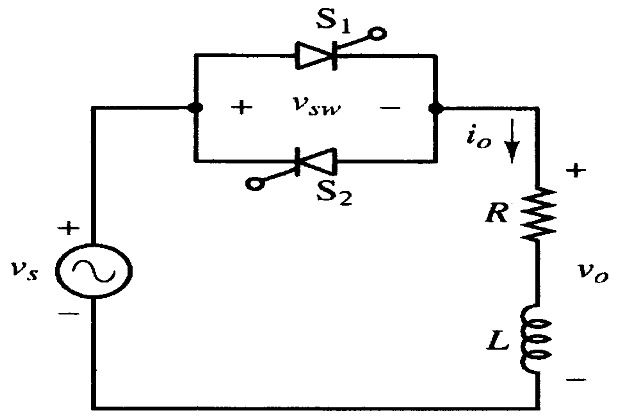

Figure Q5(a)