**CONFIDENTIAL**

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2011/2012

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|---|---|---|
| COURSE NAME | : | POWER ELECTRONICS |
| COURSE CODE | : | BEX 42303/BEE4113 |
| PROGRAMME | : | BEE |
| EXAMINATION DATE | : | JUNE 2012 |
| DURATION | : | 2 HOURS 30 MINUTES |
| INSTRUCTIONS | : | ANSWER **FOUR (4)** QUESTIONS ONLY |

THIS EXAMINATION PAPER CONSISTS OF **SIX** (6) PAGES

**Q1** (a) Differentiate three characteristic differences between ideal and practical switches.

(6 marks)

(b) Discuss the function of :

(i) Snubber circuit
(ii) Gate driver circuit

*Note : Use relevant diagrams where appropriate*

(6 marks)

(c) The voltage and current for a device (using the passive sign convention) are periodic function with T=100ms described by :

$v(t) = 10V$ for $0<t<70ms$
$v(t) = 0V$ for $70ms<t<100ms$
$i(t) = 0A$ for $0<t<50ms$
$v(t) = 4A$ for $50ms<t<100ms$

Determine:

(i) The average power
(ii) The energy absorbed by the device in each period

(5 marks)

(d) A power semiconductor device specifies the following switching times corresponding to the linearized characteristics shown in Figure Q1(d). From the clamped-inductive switching: $t_{c(off)} = 0.6\mu s$. If the device operates at the switching frequency of 75 kHz, the turn-on time, $t_{on}$ is 2% of its switching period, current flow through the switch 3A, on-state voltage is 1.2V and the total average power dissipation is 2.5 watt. Determine :

(i) The average power dissipated during on-state, $P_{on}$
(ii) The average switching power losses, $P_s$
(iii) The input voltage, $V_d$

(8 marks)

**Q2** (a) A single-phase controlled half-wave rectifier with RL load is shown in Figure Q2(a).

(i) Sketch the waveform of $V_S$, $V_O$, $i_O$ and $V_T$. (Assume the firing angle $\alpha=\pi/6$)
(ii) Describe the circuit operation.

(8 marks)

(b) Design a centre-tapped transformer full wave un-controlled rectifier to produce an average current of 10.0A connected to a resistive load of 15Ω. Say the primary source is $120V_{rms}$, 60Hz sources is available. Specify the important diode ratings and the turn ratio of the transformer.

(7 marks)

(c) A full-wave controlled rectifier circuit has $v_s(t)=170 \sin(377t)$ V and a load resistance R=35Ω. Calculate the followings for $\alpha=\pi/4$:

(i) The average load current
(ii) The rms load current
(iii) The power absorbed by the load
(iv) The apparent power supplied by the source
(v) The power factor of the circuit

(10 marks)

**Q3** (a) A Buck-Boost Converter circuit has a DC input voltage source of $V_i$ as shown in Figure Q3(a).

(i) Sketch the equivalent circuit during the switch is in on state and derive $(\Delta i_L)_{closed}$.
(ii) Sketch the equivalent circuit during the switch is in off state and derive $(\Delta i_L)_{open}$.
(iii) Hence derive the expression for output voltage $V_O$.
(iv) Discuss its operation

(12 marks)

(b) Design a boost converter that will have an output voltage of 24V connected to a DC source of 15V with the power absorbed by the load is 8W. With switching frequency of 100kHz, design for continuous current mode with an output ripple voltage of less than 1.5%. Determine the maximum and minimum inductor current. Sketch the final diagram of the boost converter and label completely.

(13 marks)

**Q4** (a) Referring to Figure Q4(a), what is the purpose of diode connected parallel to the switch in an inverter as shown.

(2 marks)

(b) Describe about harmonics and why harmonics are recommended to be removed in power electronic inverter?

(6 marks)

(c) Using relevant diagram, describe the sinusoidal pulse-width modulated (SPWM) inverter switching technique.

(4 marks)

(d) A single-phase full-bridge inverter has an RLC load connected in series with R = 20Ω, ωL = 18.5Ω and 1/ωC = 25.34Ω. The inverter frequency is 50Hz and the DC input voltage is 110V. Solve the followings:

i) Express the instantaneous load current in Fourier series up to $9^{th}$ order harmonic
ii) The rms load current at the fundamental frequency
iii) The THD of load current
iv) Power absorbed by the load and fundamental power
v) The average DC supply current

(13 marks)

**Q5** (a) Although the half-wave AC phase controller can vary the output voltage by varying the delay angle α, it is not generally used in practical applications. State two disadvantages of single phase half-wave AC phase controllers.

(4 marks)

(b) Figure Q5(b) shows a single phase full wave ac voltage controller is being employed for controlling the power flow from 220 $V_{rms}$, 50 Hz source into a load circuit consisting of a 4Ω load resistor and a 6 Ω load inductance.

(i) Calculate the control range of the firing angle α.
(ii) Sketch the gate current $i_{g1}$, $i_{g2}$, output current, $i_o$, and the output voltage $v_o$, at the minimum value of the firing angle α = θ.
(iii) Determine the maximum value of RMS load current.
(iv) Determine the maximum value of output power and power factor.
(v) Determine the maximum value of average and RMS thyristor current.

(21 marks)

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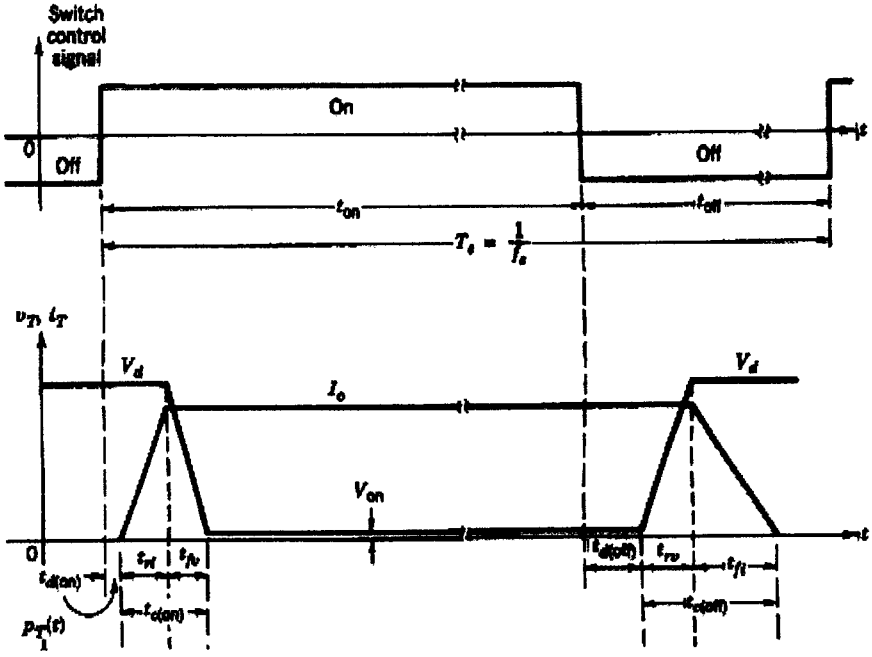


**Figure 1(a)**

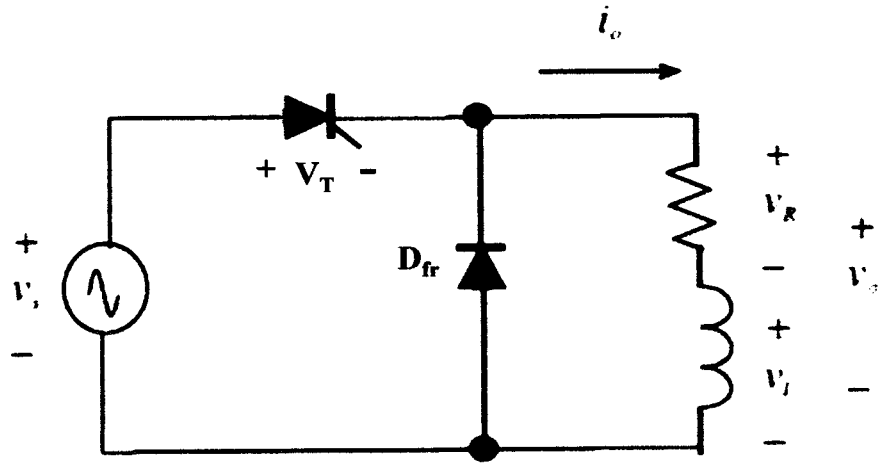


**Figure 2(a)**

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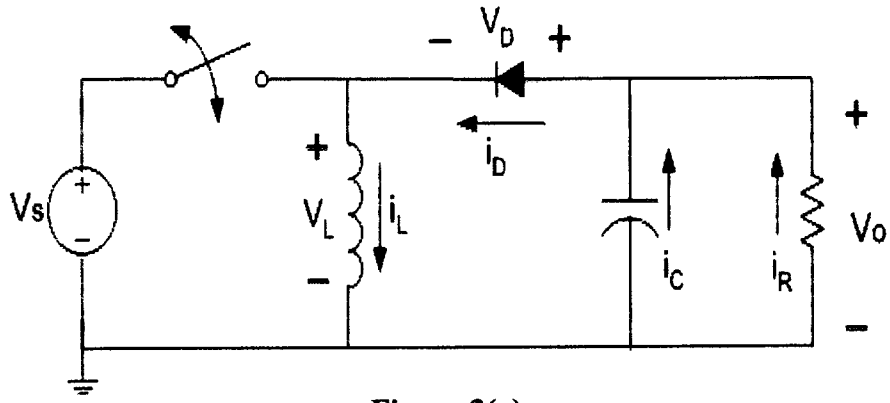


**Figure 3(a)**

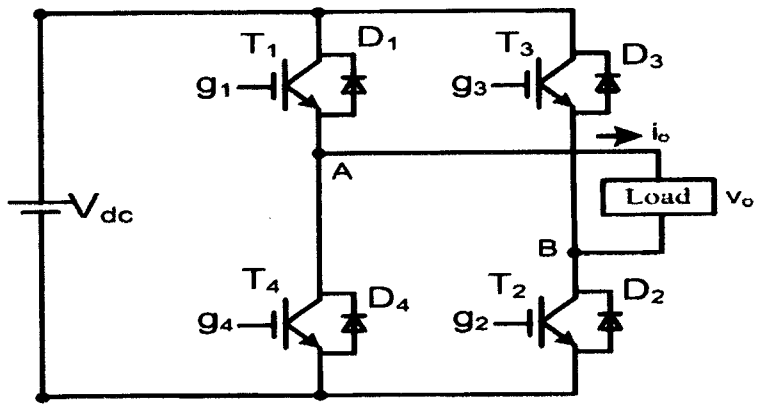


**Figure 4(a)**

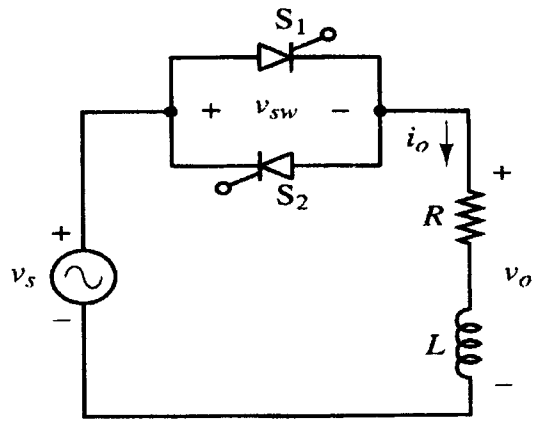


**Figure 5(b)**