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FINAL
Examination Paper

(COVER PAGE)

Session	:	**April 2017**
Programmes	:	Diploma in Electrical and Electronic Engineering (DEEI)
Course	:	**EEE2112: Introduction To Power Electronics And Drives**
Date of Examination	:	4 August 2017 (Friday)
Time	:	11:00am – 1:00pm
Duration	:	2 Hours Reading Time : Nil
Special Instructions	:	

This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

IMPORTANT NOTE : **THIS PAPER SHOULD NOT BE TAKEN OUT OF THE EXAMINATION HALL BY THE STUDENTS.**

Materials Permitted :
Scientific Calculator (Model fx570 Series)

Materials Provided :
Worksheet-Q2(a)
Laplace Transformation Table

Examiner(s) : **Chan Tse Wei**

Moderator : Dr. Ooi Beng Lee

This paper consists of 8 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

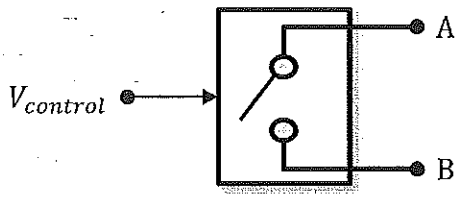
DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2112: INTRODUCTION TO POWER ELECTRONICS AND DRIVES
FINAL EXAMINATION: APRIL 2017 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks. The marks allocated to each sub-question are shown in square brackets at the right-hand margin. Present your answers neatly and clearly. The assessor reserves the rights to ignore your answers if they are ambiguous.

Question 1

a. Distinguish between linear electronics and power electronics. Quote examples to aid understandings. [8]

b. Figure-Q1(b)(i) shows a block diagram of a power electronic switching module and its characteristics. Figure-Q1(b)(ii) shows the application of the power electronic switching module to control power delivery to a 20 Ω load.



$V_{AB(sat)} = 0.3\ V$
$I_{AB(off)} = 0.2\ mA$

$V_{control} = \begin{cases} high\ state = ON \\ 0\ V = OFF \end{cases}$

$I_{control}$ = negligible

Figure-Q1(b)(i)

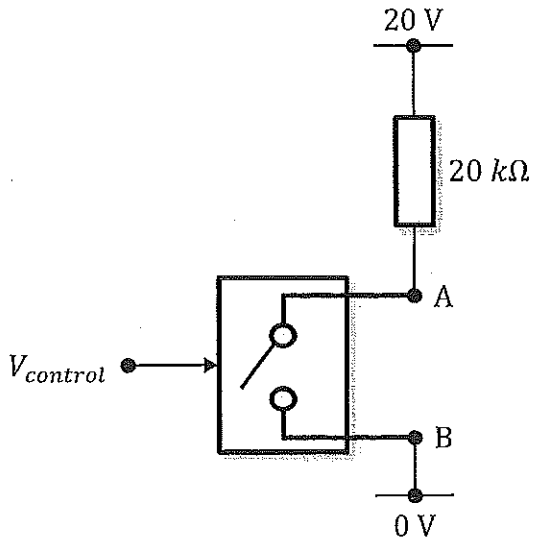


Figure-Q1(b)(ii)

i. Determine the duty cycle of $V_{control}$ in percentage, if 10 V_{RMS} is needed across the 20 Ω load. [8]

ii. For the requirement stated in part (b)(i), calculate the power efficiency of the system. [7]

iii. Calculate the power dissipation of the circuit. [2]

Question 2

a. i. Diodes and bipolar junction transistors are two commonly used semiconductor devices in the field of power electronics. Sketch the ideal IV characteristics for these two types of power electronic devices in Worksheet-Q2(a). [4]

ii. Explain each of the IV characteristic sketched in part (a)(i). [4]

b. Explain the difference between small-signal diodes and rectifier diodes. [6]

c. The following shows a datasheet extract of a power diode specifications:

Parameter (tested @ $T_A = 75°C$)	**Typ. Value**	**Unit**
Average rectified current	12	*A*
Peak forward current @ 1 ms	80	*A*
RMS current	20	*A*

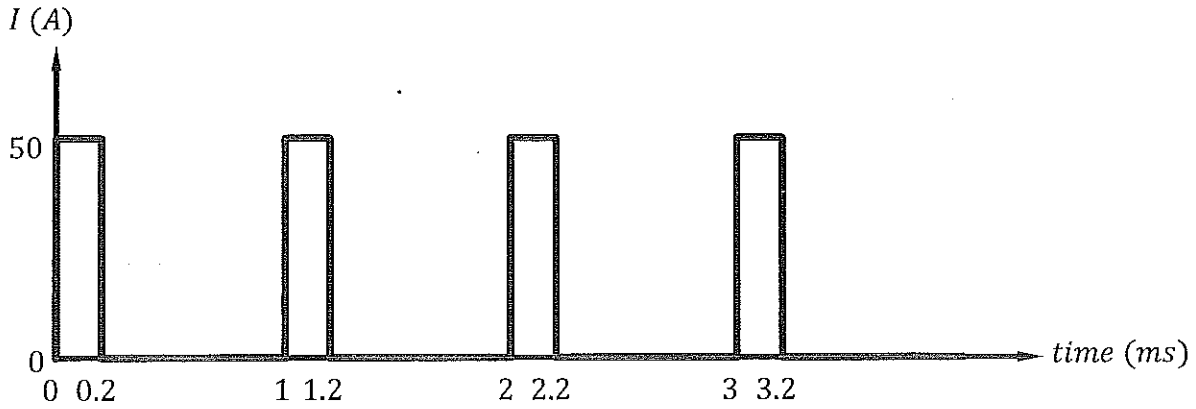


Figure-Q2(c)

In a switch-mode power supply application, the current waveform shown in Figure-Q2(c) needs to pass through a diode switch. Quantitatively evaluate if a diode with the above specifications is suitable in this application. [11]

Question 3

a. Distinguish between uncontrolled and controlled rectifiers. [6]

b. Figure-Q3(b) shows a full wave rectifier with an inductive load. The resistive part of the load, R is 20 Ω and the source voltage, v_s is 240 V_{RMS} at 50 Hz. The load inductance, L is very large.

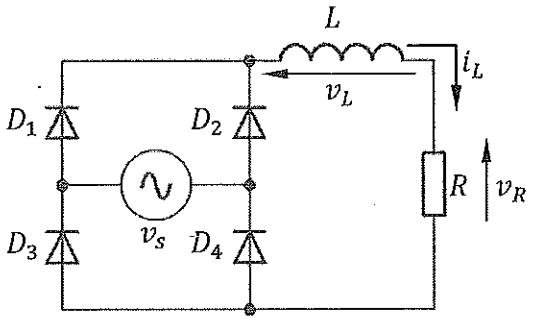


Figure-Q3(b)

i. Calculate the average load current, $i_{L(DC)}$ [3]

ii. Calculate the RMS load current, $i_{L(RMS)}$ [3]

iii. Calculate the average power to the load, $P_{load(avg)}$ [3]

iv. Calculate the average current flowing in each diode, $i_{D(avg)}$ [4]

v. Sketch the timing diagram of $v_L(t) + v_R(t)$, $i_{D1}(t)$ and $i_L(t)$ for two cycles of the input voltage. [6]

Question 4

a. State two examples of thyristor and explain its advantage and disadvantage as a switching element in power electronics as compared to power MOSFETs. [6]

b. Figure-Q4(b) shows a controlled rectifier circuit. The gate control circuit has a delay angle, α.

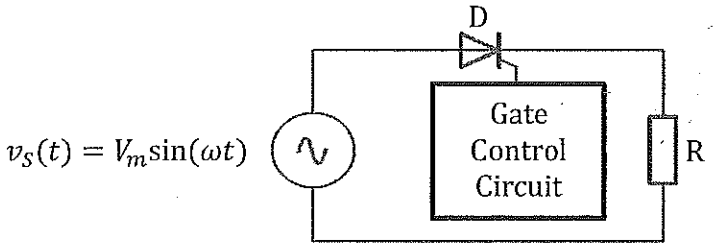


Figure-Q4(b)

i. State the two conditions that must be met before element D can conduct current. [4]

ii. Show that the average (DC) voltage across resistor R can be expressed as,

$$V_{R(DC)} = \frac{V_m}{2\pi}(\cos(\alpha) + 1)$$ [7]

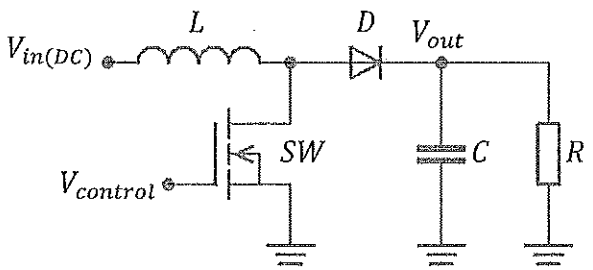
iii. Show that the power absorbed by resistor R can be expressed as,

$$P_R = \frac{V_m^2}{4R}\left[1 + \frac{\sin(2\alpha) - 2\alpha}{2\pi}\right]$$ [8]

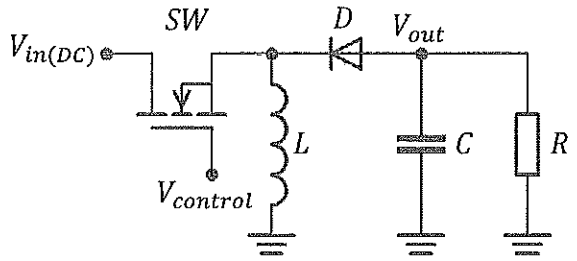
Question 5

a. i. Explain the function of choppers in power electronics. [2]

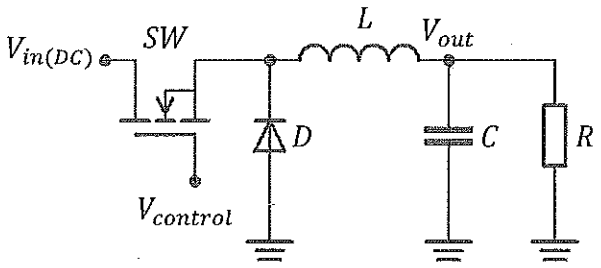
ii. Identify the three types of chopper shown in Figure-Q5(a)(i), (ii) and (iii). [3]



(i)



(ii)



(iii)

Figure-Q5(a)

b. Design a chopper to fulfill the following design specifications:

- $V_{in(DC)} = 48\ V$
- $V_{out(DC)} = 18\ V$
- $V_{out(ripple)} \leq 1\%\ of\ V_{out(DC)}$
- $R_{load} = 10\ \Omega$
- $f_{switching} = 40\ kHz$
- Continuous inductor current

Sketch the ideal timing diagram of the source current. [20]

Question 6

a. Figure-Q6(a) shows a basic drive circuit utilizing a MOSFET. State two disadvantages of this driver circuit configuration. [4]

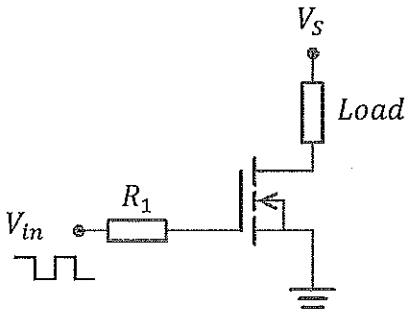


Figure-Q6(a)

b. Figure-Q6(b) shows an improved drive circuit for the one shown in Figure-Q6(a). Clearly explain the operation of the improved circuit. [6]

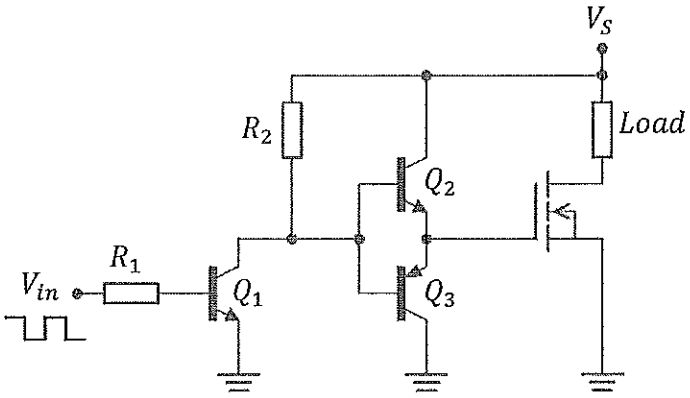


Figure-Q6(b)

c. Figure-Q6(c) shows a light dimmer circuit.

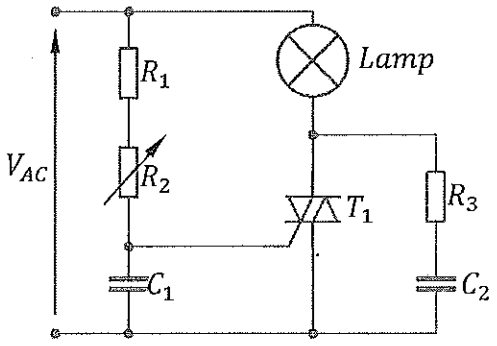


Figure-Q6(c)

i. Identify the component(s) that form a snubber circuit. [2]

ii. Explain the function of the snubber circuit identified in part (c)(i). [3]

iii. Explain the likely effect of removing the snubber circuit from the light dimming circuit. [4]

iv. Suggest a simple approach to remove excessive heat from the switching device used in the light dimming circuit. [2]

v. Sketch and clearly label the IV characteristic of the switching device used in the light dimming circuit. [4]

~ The End ~