UNIVERSITI KUALA LUMPUR
Malaysian Institute Of Marine Engineering Technology

FINAL EXAMINATION
JANUARY 2016 SESSION

SUBJECT CODE	:	LED 30403
SUBJECT TITLE	:	POWER ELECTRONICS AND DEVICES
LEVEL	:	DIPLOMA
TIME / DURATION	:	9.00 AM / 3 HOURS
DATE	:	

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper has information printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer TWO (2) questions only.
6. Answer all questions in English.

THERE ARE 8 PAGES OF QUESTIONS, INLUDING THIS PAGE.

PART A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

a. State the function of power electronics circuits.

[3 marks]

b. List 4 among the diversity of knowledge to make the study of power electronics challenging as well as interesting.

[4 marks]

c. State the parameters need to be consider while selecting IGBT.

[3 marks]

d. Explain about the gate drivers. Why they are so important to Power Electronics?

[5 marks]

e. Draw the symbol of power electronic components listed in **Table 1**

Diode
Thyristor
IGBT
GTO
Mosfet

Table 1

[5 marks]

Question 2

a. Define a rectifier

[3 marks]

b. Draw a circuit diagram of single phase uncontrolled bridge rectifier, explain the operation and sketch the output of the rectifier. Sketch the related waveform of the output voltage V_O , output current I_o, input current $i_{D1\&D2}$ and voltage across the diode, $V_{D1\&D2}$

[9 marks]

c.

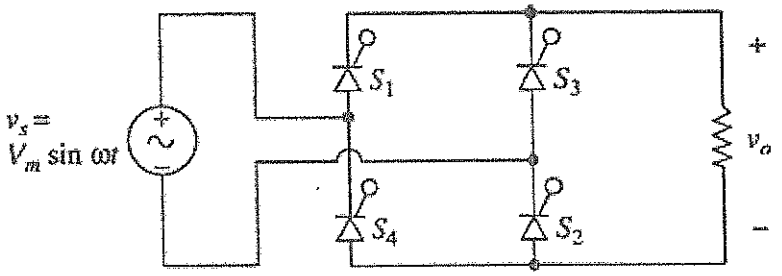

Figure 1

A full-wave bridge controlled rectifier as shown in **Figure 1** is supplied form 240 V source with a load resistance of 50Ω. If the firing angle $\alpha = 30°$, determine

i. The average load voltage

[2 marks]

ii. The average load current

[2 marks]

iii. The RMS load current

[2 marks]

iv. The power supplied by the load

[2 marks]

Question 3

a. State the function of buck converter and boost converter.

[2 marks]

b. i. Sketch circuit diagrams for buck converter. Label important parameters in the circuits.

[2 marks]

ii. Sketch circuit diagrams for boost converter. Label important parameters in the circuits.

[2 marks]

c. A boost converter with parameters L = 500μH, C = 50μF and R = 50Ω is supplied with 100V input and operated with 0.4 duty ratio. Its switching frequency is 20 kHz. Calculate :

i. The output voltage

[3 marks]

ii. The average, maximum and minimum inductor currents

[4 marks]

iii. The output capacitor voltage ripple

[3 marks]

d. i. Sketch the inductor current waveform over one (1) period. Mark the minimum and maximum values of inductor current based on calculation made in Part (c) (ii)

[3 marks]

ii. Sketch the output voltage waveform and show the voltage ripple on graph based on calculation made in Part (c) (iii)

[1 mark]

PART B (Total: 40 marks)

INSTRUCTION: Answer only TWO (2) questions.
Please use the answer booklet provided.

Question 4

a. Two types of PWM switching scheme are bipolar and unipolar. Explain about these switching schemes and state the differences between bipolar and unipolar switching scheme.

[8 marks]

b. A square-waver inverter as shown in **Figure 2** has an RL load with R = 15 Ω and L = 10mH. The inverter output frequency is 400Hz.

i. Determine the value of the dc source required to establish a load current that has a fundamental frequency component of 8A rms

[4 marks]

ii. Determine the THD of the load current

[5 marks]

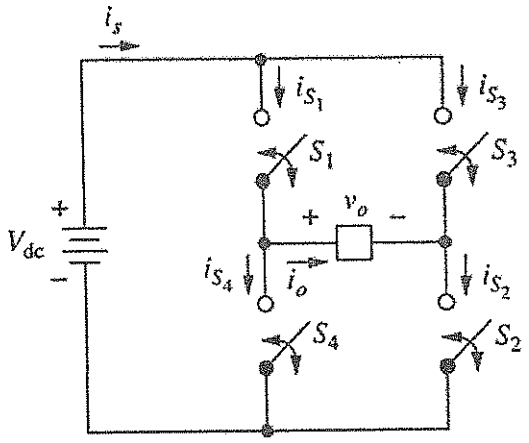

Figure 2

c. State three (3) reasons why need to consider harmonics

[3 marks]

Question 5

a. State the function of buck-boost converter

[2 marks]

b. The output voltage equation of buck-boost converter is given below. Referring to the given equation, state the condition where the value of duty ratio affects the value of output voltage is :

$$V_O = -V_S\left(\frac{D}{1-D}\right)$$

[4 marks]

c. A common buck-boost converter circuit diagram is shown in **Figure 3**. With the aid of suitable equivalent circuit diagrams, explain briefly the operation of buck-boost converter during the switch is closed and opened.

[6 marks]

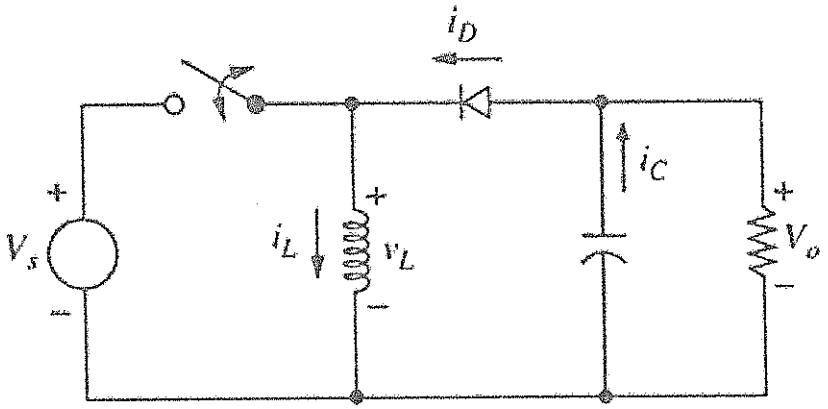

Figure 3

d. A buck-boost converter in **Figure 3** is supplied with 60V input and produces an output power of 200W. Its maximum inductor current is 10.3 A. Calculate the duty ratio (assume the value of output voltage is negative) and the minimum inductor current

[8 marks]

Question 6

a. State two (2) applications of AC Voltage controller

[2 marks]

b. AC voltage controller is a type of thyristor power converter which is used to convert a fixed voltage, fixed frequency ac input supply to obtain a variable voltage ac output. Sketch the waveform for V_s , I_o, V_o and V_{sw} the circuit shown in **Figure 4**

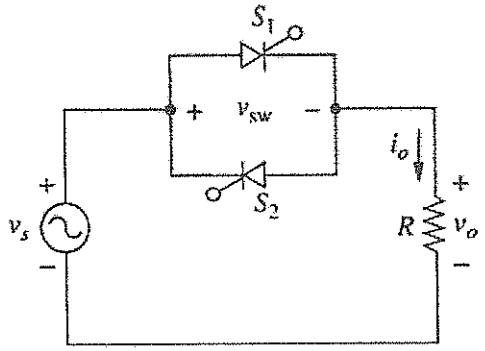

Figure 4

[7 marks]

c. The single-phase AC voltage controller of **Figure 4** has 480 V rms 60 Hz source and a load resistance of 50 Ω. The delay angle α is 60°. Determine

i. The RMS load voltage, V_o

[3 marks]

ii. The power absorbed by the load

[2 marks]

iii. The power factor

[2 marks]

iv. The average and RMS currents in SCRs

[2 marks]

v. The THD of the source current.

[2 marks]

FORMULA'S

HALF-WAVE RECTIFIER

$$V_O = \frac{V_m}{\pi}$$

$$I_0 = \frac{V_0}{R} = \frac{V_m}{\pi R}$$

$$V_{RMS} = \frac{V_m}{2}$$

$$I_{RMS} = \frac{V_m}{2R}$$

$$V_a = \frac{V_m}{2\pi}[1+\cos\alpha]$$

$$V_{o(RMS)} = \frac{V_m}{2}\sqrt{1-\frac{\alpha}{\pi}+\frac{\sin(2\alpha)}{2\pi}}$$

FULL-WAVE RECTIFIER

$$V_O = \frac{2V_m}{\pi}$$

$$I_O = \frac{V_O}{R} = \frac{2V_M}{\pi R}$$

$$V_O = \frac{Vm}{\pi}(1+\cos\alpha)$$

$$I_O = \frac{V_O}{R} = \frac{V_m}{\pi R}(1+\cos\alpha)$$

FULL-WAVE CONTROLLED RECTIFIER

$$V_{dc} = \frac{V_m}{}(1+\cos\alpha)$$

$$V_{o,rms} = V_m\sqrt{\frac{1}{2}-\frac{\alpha}{2\pi}+\frac{\sin 2\alpha}{4\pi}}$$

AC SINGLE PHASE CONTROLLER WITH R-LOAD

$$V_O = \frac{V_m}{\sqrt{2}}\sqrt{1-\frac{\alpha}{\pi}+\frac{\sin(2\alpha)}{2\pi}}$$

$$I_{O,RMS} = \frac{V_{0,RMS}}{R}$$

$$pf = \sqrt{1-\frac{\alpha}{\pi}+\frac{\sin(2\alpha)}{2\pi}}$$

$$I_{SCR,avg} = \frac{V_m}{2\pi R}(1+\cos\alpha)$$

$$I_{rms,scr} = \frac{I_{O,RMS}}{\sqrt{2}}$$

BUCK BOOST CONVERTER

$$V_O = \frac{V_S}{1-D}$$

$$I_L = \frac{V_S}{(1-D)^2 R}$$

$$I_{\max} = \frac{V_S}{(1-D)^2 R} + \frac{V_S DT}{2L}$$

$$I_{\min} = \frac{V_S}{(1-D)^2 R} - \frac{V_S DT}{2L}$$

$$\frac{\Delta_O}{V_O} = \frac{D}{RCF}$$

$$I_D = I_O = \frac{V_O}{R}$$