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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2011 SESSION

SUBJECT CODE	: FLD 30102
SUBJECT TITLE	: POWER ELECTRONICS
LEVEL	: DIPLOMA
TIME / DURATION	: 9.00am – 11.30am (2.5 HOURS)
DATE	: 03 MAY 2011

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answers 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) question only.
6. Answer all questions in English.
7. Fomula is appended.

THERE ARE 5 PAGES OF QUESTIONS, AND 1 PAGE OF APPENDIX, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

(a) **Figure 1** shows the power electronics system. Name each of the block and explain the system

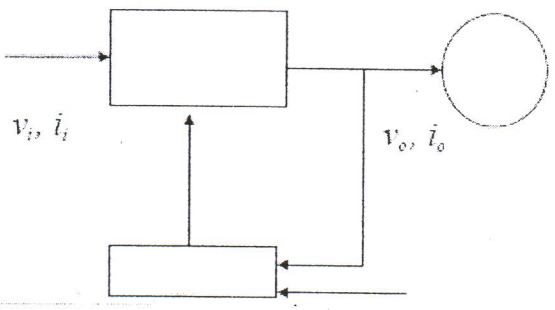

Figure 1

(8 marks)

(b) List two applications of rectifier, dc-dc converter, ac voltage controller and inverter

(8 marks)

(c) List 6 various types of thyristor and draw the symbol of each type.

(6 marks)

Question 2

(a) Explain the operation and function of D2 in **Figure 2**. Sketch the output Vo and Io

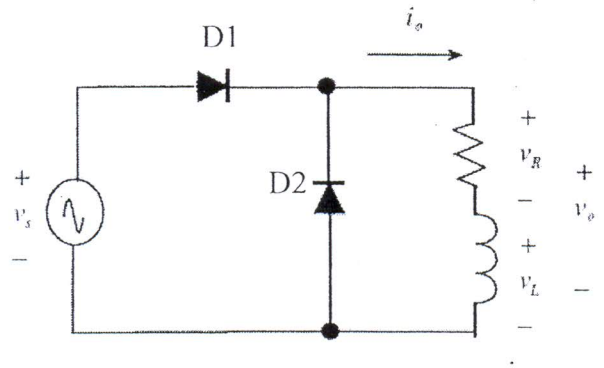

Figure 2

(5 marks)

(b) Explain the significance of the

(i) Form Factor of rectifier

(ii) ripple factor of rectifier

(iii) efficiency of rectifier

(5 marks)

(c) Prove that the average output voltage (V_{dc}) of a full-wave single phase rectifier with resistive load $V_{dc} = \frac{2V_m}{\pi}$.

$$V_{dc} = \frac{2}{T}\int_0^{T/2} V_m \sin \omega t dt$$

(10 marks)

Question 3

(a) **Figure 3** shows the square-wave inverter. If the input is Vdc = 150 V, an output frequency of 60Hz and a resistive load of 30 Ω.

(i) Sketch the current in the load

(ii) Sketch the current in each switch

(ii) Determine the average and

(iii) Rms output voltage

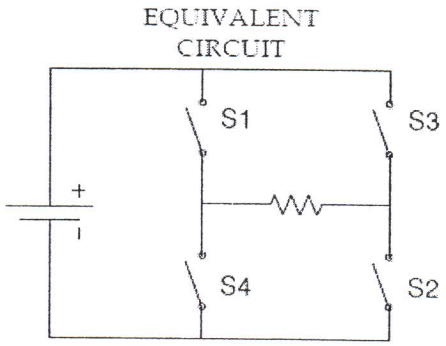

Figure 3

(6 marks)

(b) Name the dc to dc converter in **Figure 4** and explain the operation

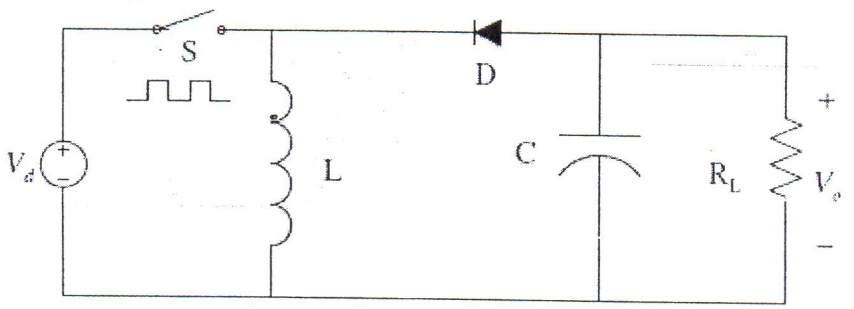

Figure 4

(8 marks)

(c) Explain the concept of phase control for AC voltage controller

(6 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer TWO (2) questions only

Please use the answer booklet provided.

Question 4

The DC converter in the **Figure 5** has a resistive load, R_L = 40 Ω and input voltage, V_s = 110 V. When the converter switch remains on, its voltage drop is V_{ch} = 1.5 V and the chopping frequency is 4 kHz. If the duty cycle is 60%, determine

(a) the average output voltage

(b) the rms output voltage V_0

(c) the converter efficiency

(d) the effective input resistance R_i

(20 marks)

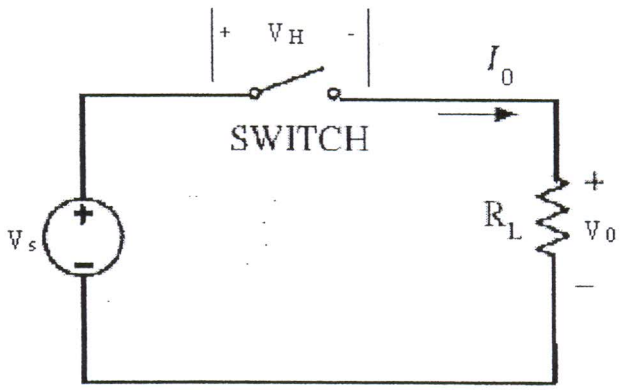

Figure 5

Question 5

A single-phase half-wave controlled rectifier is connected to 240 Vac, 60 Hz source. The output of the rectifier is connected to a 20 ohm resistive load. If the average output voltage is 40% of the maximum possible output voltage, determine:

(a) the delay angle α

(b) the rms and average output current

(c) the average and rms thyristor current

(d) the input power factor

(20 marks)

Question 6

A Three-phase full wave controlled rectifier is operated from a three-phase Y-connected 240-V, 60 Hz supply and the load resistance is 20 ohm. If it is required to obtain an average output voltage of 60 % of the maximum possible output voltage, calculate:

(a) the delay angle α

(b) the rms and average output currents

(c) the average and rms thyristor currents (rms current of thyristor $I_R = I_{rms}\sqrt{2/6}$)

(d) the rectification efficiency

(e) the transformer utilization factor (rms input line current $I_s = I_{rms}\sqrt{4/6}$)

(f) the power factor

Given, $V_{dm} = \frac{3\sqrt{3}}{\pi} V_m$, $V_{rms} = \sqrt{3}Vm\left(\frac{1}{2} + \frac{3\sqrt{3}}{4\pi}\cos 2\alpha\right)^{1/2}$

and $V_n = \frac{V_{dc}}{V_{dm}} = \cos\alpha$

(20 marks)

END OF QUESTION PAPER

APPENDIX

Performance Parameters of Rectifiers Formula

1. $P_{DC} = I_{DC} V_{DC}$
2. $P_{AC} = I_{RMS} V_{RMS}$
3. $\eta = \frac{P_{DC}}{P_{AC}}$
4. $V_{AC} = \sqrt{(V^2_{RMS} - V^2_{DC})}$
5. $FF = \frac{V_{RMS}}{V_{DC}}$
6. $RF = \frac{V_{AC}}{V_{DC}}$
7. $TUF = \frac{P_{DC}}{I_S V_S}$
8. $DF = Cos\varphi$
9. $HF = \left(\frac{I_S^{\ 2} - I_{S1}^2}{I_{S1}^2} \right)^{\frac{1}{2}}$
10. $CF = \frac{I_{S(PEAK)}}{I_S}$
11. $PF = \frac{P_{REAL}}{P_{RMS}} = \frac{P_0}{VI} = COS\varphi$

Single phase half-wave controlled rectifier:

$$V_n = \frac{V_{dc}}{V_{dm}} = 0.5(1 + \cos\alpha), \quad V_m = \sqrt{2} * Vs, \quad V_{dc} = \frac{V_m}{2\pi}(1 + \cos\alpha)$$

$$V_{rms} = \frac{V_m}{2}\left[\frac{1}{\pi}\left(\pi - \alpha + \frac{\sin 2\alpha}{2}\right)\right]^{1/2}, \quad P_f = P_o/VA$$