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**CONFIDENTIAL**

**SET A**

# UNIVERSITI KUALA LUMPUR
## Malaysia France Institute

## FINAL EXAMINATION

## JANUARY 2014 SESSION

| | | |
|---|---|---|
| **SUBJECT CODE** | : | **FLD 30103** |
| **SUBJECT TITLE** | : | **POWER ELECTRONICS** |
| **LEVEL** | : | **DIPLOMA** |
| **TIME / DURATION** | : | **2.5 HOURS** |
| **DATE** | : | |

### 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. **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) question only.**
6. **Answer all questions in English.**
7. **Fomula is appended.**

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

**SECTION A (Total: 60 marks)**

**INSTRUCTION: Answer ALL questions.**
**Please use the answer booklet provided.**

**Question 1**

(a) **Draw** the symbols **thyristor** and **explain two** methods that can turn on the thyristor.

(4 marks)

(b) **Draw** the symbols and **explain** the construction of IGBT. **Explain** the method to turn on the IGBT.

(6 marks)

(c) **Give** the definition of power electronics and **describe** the system using block diagram.

(10 mark)

**Question 2**

(a) **List** two different types of diode and draw the symbols. **Explain** the forward and reverse bias of a diode.

(5 marks)

(b) **Draw** a single-phase full wave with centre a tap transformer rectifier circuit and **explain** the operation of the rectifier.

(5 marks)

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

Where $V_{dc} = \left[ \frac{1}{T} \int_{o}^{T/2} \left( V_m \sin \omega t \right) \, dt \right]$

(10 marks)

## Question 3

(a) **Draw** a circuit diagram for Boost Converter and **explain** the operation of the circuit when switch in the circuit is on and off.

(5 marks)

(b) **Explain** the principles of phase control for AC voltage controller in **Figure 1**.

(5 marks)

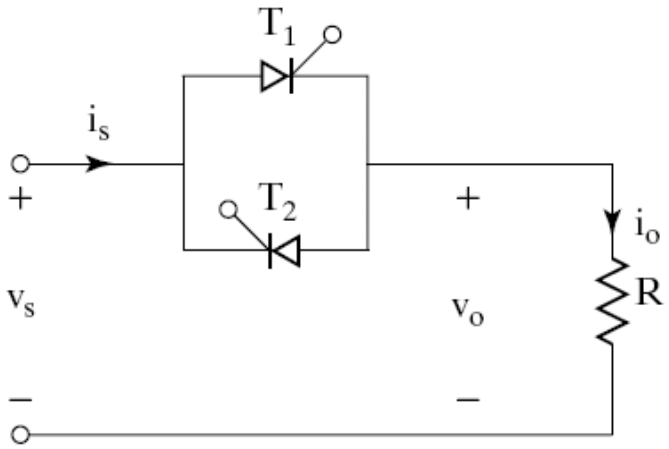


**Figure 1**

(c) **Give** the definition and **list** two applications of dc to ac converter (inverter).

(4 marks)

(d) **Draw** the a circuit diagram for single-phase inverter and **explain** the operation.

(6 Marks)

**SECTION B (Total: 40 marks)**

**INSTRUCTION: Answer TWO (2) questions only**

**Please use the answer booklet provided.**

**Question 4**

A three–phase full-wave un-controlled rectifier in **Figure 2** has a purely resistive load of R = 20 Ω. The rectifier delivers an average current of 24 A at an average output voltage of $V_{dc}$= 240 V. Determine

(a) the rectification efficiency,

(b) the form factor,

(c) the ripple factor,

(d) the transformer utilization factor,

(e) the peak inverse voltage of each diode and

(f) the peak current through a diode (given : $I_{dc} = 0.3183\ I_m$).

(20 marks)

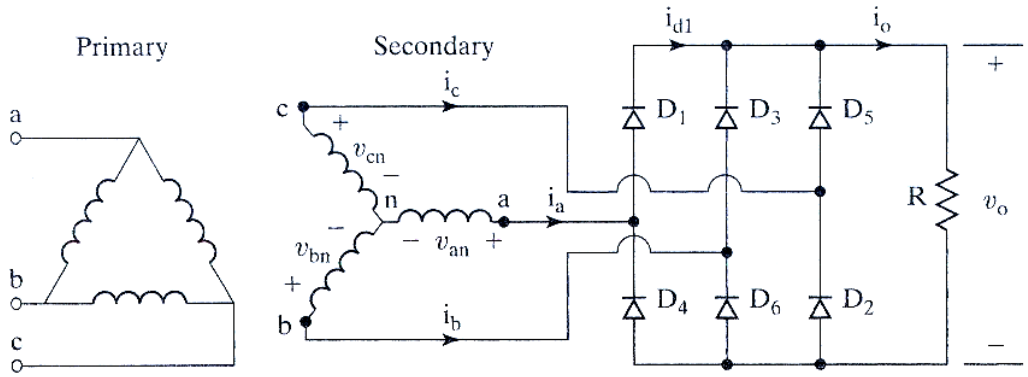


**Figure 2**

## Question 5

(a) Explain the relation between the duty cycle and power factor for ac voltage controller in **Figure 3.**

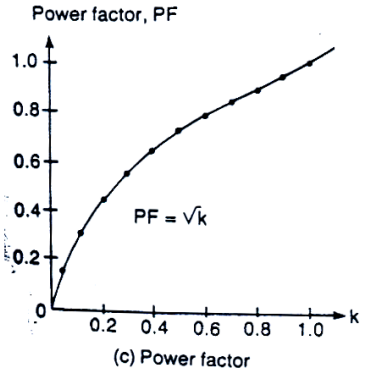


**Figure 3**

(4 marks)

(b) The ac voltage controller in **Figure 5** uses on-off control for heating a resistive load of R = 10 Ω and the input voltage is Vs = 110 V (rms), 60 Hz. If the desired output power is Po = 2 kW, determine :

i. the duty cycle k

ii. the input power factor

(6 marks)

(c) The ac voltage controller in **Figure 4** is used for heating a resistive load of R = 10 Ω and the input voltage is $V_s$ = 240 V (rms). The thyristor is on for n = 60 cycles and is off for m = 40 cycles. Determine :

i. the rms output voltage $V_o$

ii. the input power factor

iii. the average and rms thyristor currents

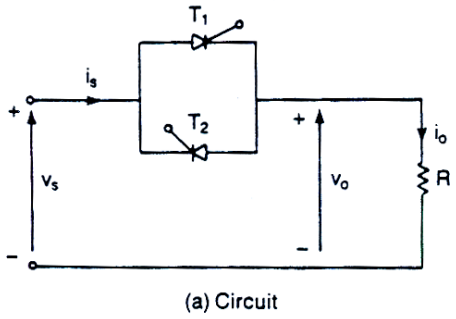


**Figure 4**

(10 marks)

## Question 6

(a) **Explain** the function of capacitor in **Figure 5** and the operation of the circuit.

(5 marks)

(b) The Buck converter of **Figure 5** has the following parameters:

*Supply voltage Vs* = 110 V
*Duty cycle D* = 0.6
*Inductor L* = 400 H
*Capacitor C* = 100 _F
*Switching frequency f* = 20 kHz
*Load resistor R* = 10 Ω

Assuming ideal components, calculate:

(*a*) the output voltage *Vo*,
(*b*) the maximum and minimum inductor current and
(*c*) the output voltage ripple.

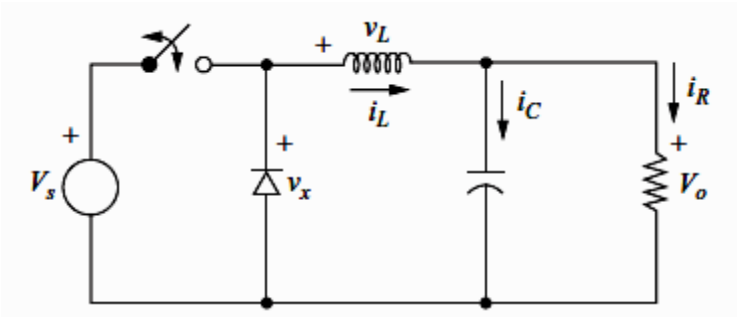


**Figure 5**

(15 marks)

**END OF QUESTION PAPER**

## APPENDIX

### Performance Parameters of Rectifiers Formulas

1. $P_{DC} = I_{DC} V_{DC}$
2. $P_{AC} = I_{RMS} V_{RMS}$
3. $\eta = \frac{P_{DC}}{P_{AC}}$
4. $V_{AC} = \sqrt{V_{rms}^2 - V_{rms}^2}$
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. $PF = \frac{V_s I_{s1}}{V_s I_s} COS\varphi$

### Trigonometro Function

$$\int \sin nx dx = \frac{\cos nx}{n}$$

### Three-phase full-wave un-controlled rectifier

1. $V_{dc} = \frac{3\sqrt{3} V_m}{\pi}$

2. $V_{rms} = \left[\frac{3}{2} + \frac{9\sqrt{3}}{4\pi}\right] V_m$

3. $I_m \sqrt{3} V_m / R$

4. Rms value of diode current $I_R$=0.5518 $I_m$
5. Rms value of transformer secondary current $I_S$ = 0.7804 $I_m$

**DC to DC (Buck) Converter**

**1.** *Vo=VsD*

**2.** $I_{\max} = V_o\left(\frac{1}{R} + \frac{1-D}{2Lf}\right)$

**3.** $I_{\min} = V_o\left(\frac{1}{R} - \frac{1-D}{2Lf}\right)$

4. $\frac{\Delta V_o}{V_o} = \frac{1-D}{8LCf^2}$

***AC Voltage Controller***

**1.** $k = \frac{n}{n+m}$

**2.** $V_0 = \sqrt{k}$

**3.** $Pf = \frac{V_0}{V_s I_s}$

**4.** $I_A = \frac{kI_m}{\pi}$

**5.** $I_R = \frac{I_m \sqrt{k}}{2}$