



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF ENGINEERING AND TECHNOLOGY  
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

## UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2308: POWER ELECTRONICS.

## END OF SEMESTER EXAMINATION

**SERIES:** APRIL 2017

**TIME:** 2 HOURS

**DATE:** APRIL 2017

### Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Question ONE is Compulsory attempt any other TWO questions.

**Do not write on the question paper.**

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### Question ONE

- (a)(i). Define a cyclo converter and state any two disadvantages of a DC linked cyclo converter.
- (ii). Draw and explain the operation of a cyclo converter whose frequency conversion ratio is 2:1.
- (b). A cyclo converter circuit operating with a frequency conversion ratio of 2:1 has a maximum input voltage of 150V at 60Hz. If the circuit firing angle is set at 45 degrees and serves a load of 15Ω resistor in series with a 53 mH inductor, determine,
- (i). RMS output voltage and current. (ii). Input power factor of the circuit. **(10 Marks)**
- (c)(i). Explain the significance of three phase inverters in industries and hence state any two merits of the inverters over single phase type.
- (ii). Draw and explain the operation of a half bridge thyristor switched inverter.
- (iii). A single phase half bridge inverter is connected to a 60V power supply source and produces an alternating voltage at a frequency of 50Hz. If the load to the inverter is a  $(10 + j10)$  type, determine,
- (I). Output power at fundamental frequency. (II). RMS harmonic voltage,  $V_h$ . **(10 Marks)**

- (d). Differentiate between controlled and uncontrolled power rectification. Explain why controlled rectification is more preferable to uncontrolled type.
- (e). Identify the circuit of figure Q1 and explain its operation. Derive the circuit output RMS voltage expression.
- (f). If the lamp in figure Q1 is replaced with a short, and the thyristor fired at angle 45 degrees, determine,
- (i). RMS output voltage and current. (ii). Circuit input Voltage-Ampere rating. **(10 Marks)**

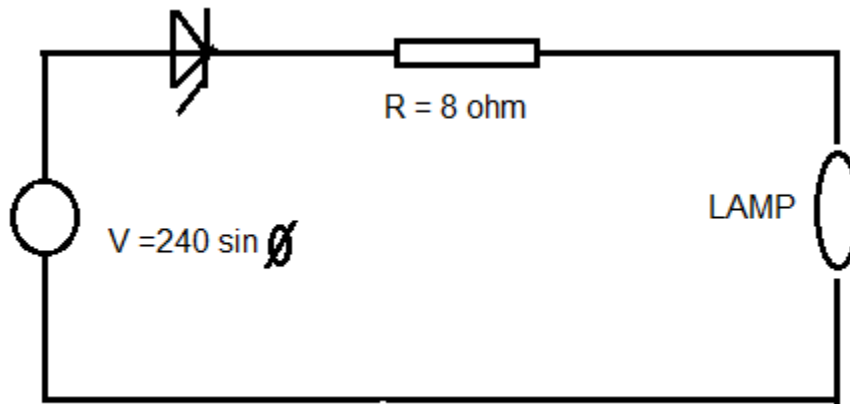


Fig Q 1

### Question TWO

- (a)(i). Define power rectification and hence state any two of its industrial applications.
- (ii). Explain why three phase power rectification is more preferable to single phase type in magnetic scrap metal hauliers. **(5 Marks)**.
- (b)(i). With the aid of a diagram and waveforms, explain the operation of a centre tapped controlled rectifier circuit.
- (ii). From the output waveforms of the circuit in (bi), derive the RMS output voltage expression. **(11 Marks)**.
- (c). A full wave controlled rectifier circuit has an input of 240V (rms) and delivers power to 10 load .If the circuit is fired at angle 30 degrees, determine,
- (i). RMS output voltage and power. (ii). Input VA and power factor. **(4Marks)**

### Question THREE

- (a)(i). Define a cyclo converter circuit and hence differentiate between the two group converter of the circuit.
- (ii). Explain the operational effect of a cyclo converter whose positive group converter fails to operate. **(4Marks)**

(b)(i).With the aid of a diagram and waveforms, explain the operation of a single phase cyclo converter with a 3:1 frequency conversion ratio.

(ii).From the output wave forms of the circuit of (bi), show that the RMS output voltage is given by the following expression.

$$V_R = V_S \{1/\pi [(\pi-\alpha) + \sin 2\alpha]\}^{0.5} \quad (12 \text{ Marks}).$$

(c).A cyclo converter is fed with an RMS input voltage of 240V at 60 Hz and feeds an inductive load of the type  $(10\Omega + jX)$ .If the inductance in the load is of 80mH,and the cyclo converter operates with a frequency conversion ratio of 3:1,determine the following if the thyristors are fired at angle 30 degrees.

(i).Peak and rms output current.

(ii).RMS output power. (4Marks)

#### Question FOUR

(ai).Distinguish between ON/OFF and phase firing technique in thyristor operation.

(ii).State any two applications of diacs and triacs.(6Marks)

(b).Draw and explain the operation of a thyristor which is subjected to a variable forward bias voltage. Use appropriate characteristics to enhance your explanation. (6Marks)

(c)(i).Identify the circuit of figure Q4 and explain its operation.

(ii).State any other application that can be applied with Q4 circuit. (8Marks)

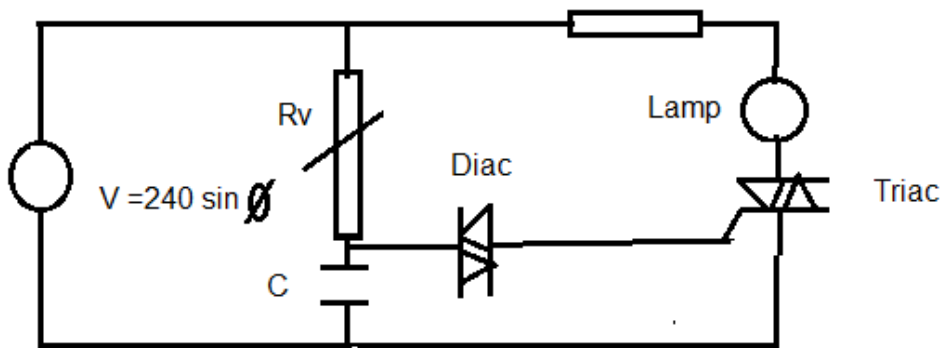


Fig Q 4

#### Question FIVE

Explain the need for inverters state any two merits of employing three phase instead of single phase inverters in industries.

(ii).Explain why inverter switches must be protected. (5 Marks).

(b). (i). Briefly explain how inverters may be employed in following applications.

(I). Un-interruptible power supplies. (II). Power frequency changing circuits.

(ii). With the aid of a diagram and waveforms, explain the operation of a three phase inverter. (Use a 120 degrees mode). **(11 Marks)**

(c). A single phase full wave inverter operates with an input voltage of 50V and delivers power to a  $10\Omega$  load resistor. Determine

(i). RMS output voltage at fundamental frequency and RMS out power.

(ii). Peak transistor switching current. **(4 Marks)**