# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

## UNIVERSITY EXAMINATION FOR:

HIGHER DIPLOMA IN ELECTRICAL POWER ENGINEERING

EEP3105: POWER ELECTRONICS 1

END OF SEMESTER EXAMINATION

**SERIES:** SEPT 2016

**TIME: 2** HOURS

**DATE:** OCTOBER 2016

**Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID*

This paper consists of FIVE questions. Attempt **ANY THREE Questions**

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

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**Question ONE**

(a) (i) Explain the TWO transistor analogy for an SCR using suitable diagrams.

(ii) Prove that the anode current expression for SCR is :-

$$I_A = -\left[\frac{I_{CO1}+I_{CO2}}{1-(\alpha_1+\alpha_2)}\right]$$

**(10marks)**

(b) (i) For a single phase half controlled rectifier show that the mean d.c power output is:-

$$P_{mean} = \frac{V_{max}^2(1+\cos\alpha)^2}{4\pi^2\ R_L}$$

(ii) A 100Ω resistance load is driven by $240V_{r.m.s}$ voltage for firing angle of $60^0$, determine the average power output. **(10marks)**

**Question TWO**

(a)(i) Draw the transistor equivalent circuit of a TRIAC and explain its operation

(ii) With the aid of a circuit diagram explain how a TRIAC can be used to control the average a.c power to a load.

**(12 marks)**

(b)(i) Explain the importance of free wheeling diode in controlled rectification

(ii) With the aid of a diagram and waveform explain how the speed of a d.c motor can be varied using a thyristor.

**(8marks)**

**Question THREE**

(a) (i) With he aid of a diagram describe the effects of an inductive load in single phase controlled rectifier circuits

(ii) Draw the current and voltage waveforms of a(i) above if the input is sinusoidal a.c.

(iii) A half-wave rectifier circuit employing an SCR is adjusted to have a gate current limit. The forward breakover voltage is 150V for a gate current of 3mA. If a sinusoidal voltage of 400V peak is applied, determine:-

i. The firing angle
ii. The average voltage.

**(13marks)**

(b) (i) State any TWO advantages of a thyristor as a switch over mechanical switching

(ii) Draw the anode characteristics of the SCR and explain the shape. **(7marks)**

**Question FOUR**

(a) (i) Draw the V-I characteristics of a DIAC and explain its shape.

(ii) Explain with aid of a diagram any ONE application of a DIAC **(9marks)**

(b) (i) Draw the circuit diagram of a single phase cycloconvertor using a centre-tapped transformer

(ii) Draw the output waveforms of the circuit b(i) above.

c) A cycloconvertor designed for industrial application starts conducting from

$\left\{\frac{-\pi}{P}+\alpha\right\}$ to $\left\{\frac{+\pi}{P}+\alpha\right\}$

Given the general equation for a cycloconvertor to be:

$$V_O = \frac{1}{2\pi/_P} \int V_{max} cos\ wt\ dwt$$

Derive the expression for the mean voltage.

**(11marks)**

**Question FIVE**

(a) (i) Draw a labelled circuit diagram of a UJT relaxation oscillator.

(ii) Sketch the output waveforms for the circuit in a(i) and show that its output frequency is expressed as

$$f = \frac{1}{RC \ln\left(\frac{1}{1-\eta}\right)}$$ **(8marks)**

where f = frequency of the output waveform

η = intrinsic stand-off ratio

(b)(i) Derive the mean voltage expression for the circuit of figure 1

(ii) The brightness of a 60W, 240V lamp is varied by controlling the firing angle of figure 1 circuit in Q5b (i). If the r.m.s value of the a.c voltage appearing across each SCR is 240V, Calculate:-

I. $V_{r.m.s}$ in the lamp at $60^o$ firing angle
II. $I_{r.m.s}$ in the lamp at $30^o$ firing angle

**(12marks)**

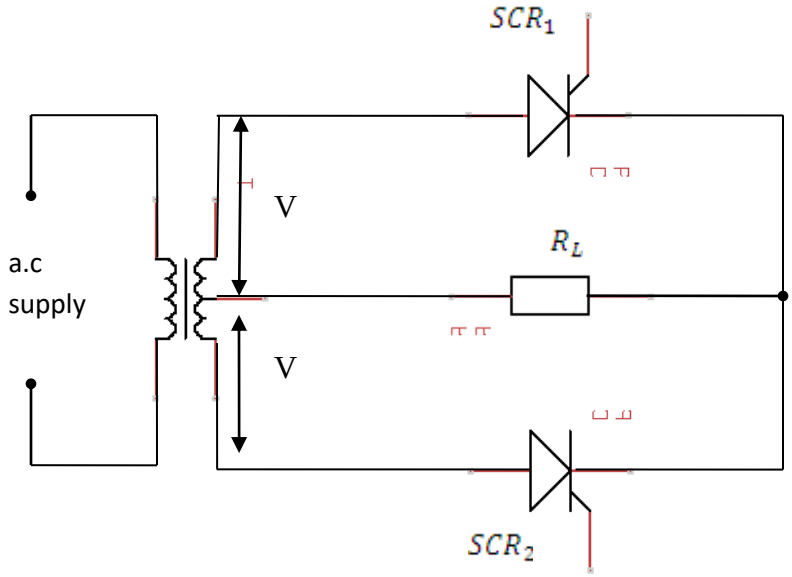


figure 1: