



TECHNICAL UNIVERISTY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY (ELECTRICAL POWER ENGINEERING)
DEPE4

EEP 2206: POWER ELECTRONICS I

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2014

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*

This paper consists of **FIVE** questions. Answer any **THREE** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One

- a) Draw the thyristor static characteristics and use it to define the following terms:
(i) Holding current
(ii) Break over forward voltage
(iii) Hatching current (6 marks)
- b) (i) Explain any TWO means of power loss in a thyristor.
(ii) Distinguish between integral cycling and phase control in thyristor firing. (6 marks)
- c) With the aid of a circuit, and waveform diagrams, show that the output voltage from a three phase half wave controlled rectifier circuit supplying a resistive load is given by:
- $$V_{mean} = \frac{3\sqrt{3}}{2\pi} V_{max} \cos \alpha$$
- Assume the thyristors volt drop is negligible (8 marks)

Question Two

- a) (i) Draw and explain the operation of a TRIAC
(ii) Using the TWO transistor analogy, derive the expression for the anode current I of a thyristor in terms of leakage currents (ignore the effect of gate current) (10 marks)
- b) (i) With the aid of a construction diagram explain the operation of a UJT
(ii) Draw a diagram of a inunction transistor pulse generator and derive its periodic time (T) equation. (10 marks)

Question Three

- a) (i) With the aid of a diagram, describe the effects of an inductive load in a single phase controlled rectification.
(ii) Draw the current and voltage output waveforms of a(i) above if the input is a sinusoidal a.c.. Assume a firing angle of 30°.
(iii) A half-wave rectifier circuit employing an SCR is adjusted to have a gate current limit. The forward break over voltage is 100V for a gate current of 1mA. If a sinusoidal voltage of 200V peak is applied, determine:
(i) The firing angle
(ii) The average voltage (14 marks)
- b) (i) Explain the importance of a commutating diode in rectifier circuits.
(ii) Explain any TWO advantages of electronic switches over the mechanical ones. (6 marks)

Question Four

- a) (i) Given a single phase controlled rectifier with a firing angle α , show that the output voltage is given by:

$$V_{mean} = 0.225V_{r.m.s}(1 + \cos \alpha)$$

(ii) Explain any TWO requirements of firing circuits in Thyristor control

(iii) With the aid of a diagram, show how simultaneous firing of two thyristors used in fully controlled circuit is achieved. **(12 marks)**

- b) (I) Explain why a simple star connection in controlled rectification is not used in practice and show how the problem is overcome.

(II) Separately illustrate the following in three phase controlled rectifiers:

(i) Overlap angle

(ii) Inversion mode of Thyristor operation

(8 marks)

Question Five

- a) (I) State the THREE main sources of voltage loss in rectifier circuit.

(II) Explain the operation of the circuit of figure 1

(i) Draw its output wave form for a sinusoidal input and

(ii) Derive the expression for its mean output voltage, $V_{d.c}$ at a firing angle of 30°

Resistive load

(12 marks)

- b) (I) Draw and explain how a DIAC static characteristics is achieved.

(II) Explain any TWO applications of a DIAC

(8 marks)