



THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

Faculty of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

DIPLOMA IN TECHNOLOGY

Electrical Power Engineering Semester 5

Electronics & Automation Semester 4

EEE 2205 / EEE 2307

INDUSTRIAL ELECTRONICS 1

POWER ELECTRONICS 1

SERIES: FEBRUARY 2011 SERIES

TIME: 2 HOURS

Instructions to Candidates:

1. You are required to have the following for this examination;
 - Answer booklet
 - A non-programmable calculator
2. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions. Question ONE carries 30 marks, Questions TWO to FIVE carry 20 marks each.

(COMPULSORY)

Question ONE

- a) i) Draw a labelled circuit diagram of a UJT relaxation oscillator.
ii) Sketch the output waveform for the circuit in (a) (i) and show that its output frequency is expressed as:

$$f = \frac{1}{Rc \ln \left(\frac{1}{1-\eta} \right)}$$

Where f = frequency of oscillation

μ = intrinsic stand-off ratio.

(7 marks)

- iii) Draw the UJT characteristics and explain its shape. (5 marks)
- b) i) State the THREE main sources of voltage loss in rectifier circuits. (3 marks)
- ii) Explain the operation of the circuit of fig 1.
I) Draw its output waveform for a sinusoidal input and phase angle control.
II) Derive the express for its mean output voltage $V_{d.c}$ and a firing angle of 30^0 .

(10marks)

Fig 1

- c) State with reasons the most appropriate type of electric heating to be applied for each of the following:
- i) Surface hardening metals
ii) Cooking pot
iii) Curing of sand cores in foundaries. (6 marks)

(ANSWER ANY OTHER TWO QUESTIONS)

Question TWO

- a) Draw the thyristor static characteristics and use it to define the following terms:
- i) Holding current
 - ii) Forward Breakover voltage
 - iii) Latching current (6 marks)

- b) i) Explain any TWO means of power loss in a thyristor.
ii) Distinguish between integral cycling and phase angle control. (6 marks)

- c) With the aid of 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 thyristor volt drop is negligible. (8 marks)

Question THREE

- (a) With the aid of a block diagram describe an alarm system.
- (b) Explain proximity sensing using the capacitance effect. (10marks)
- (c) Fig 2 shows an alarm circuit; describe its operation. (6 marks)

Fig 2

- d) Describe any FOUR features of a good alarm system. (4 marks)

Question FOUR

- a) i) Explain any TWO applications of a TRIAC.
ii) With the aid of construction diagram, explain the operation of a TRIAC. (10marks)
- b) i) Draw the DIAC static characteristics and explain the shape.
ii) Using the TWO transistor analogy derive the expression for the anode current of thyristor under leakage currents. (10marks)

Question FIVE

- a) i) Explain the term “skin effect” in induction heating.
ii) With the aid of sketches, explain the operation of eddy currents heating. (8 marks)
- b) i) Describe the THREE modes of heat transfer.
ii) A coil has 200,000 AT/M and dissipates 800kw/m^2 in a material being heated having a $0.035\ \mu\Omega/\text{m}^2$ resistivity. Determine the depth of heat penetration. (12marks)