



# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

## *Faculty of Engineering and Technology*

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

### **DIPLOMA IN TECHNOLOGY**

Electrical Power Engineering

Instrumentation & Control Engineering

Electronics Engineering

Telecommunication & Information Engineering

Computer Science Engineering

### **EEC 2209**

## **ELECTRICAL MEASUREMENT & FAULT DIAGNOSIS**

END OF SEMESTER EXAMINATION

**SERIES:** OCTOBER – FEBRUARY 2011 SERIES

**TIME:** 2 HOURS

### **Instructions to Candidates:**

1. You are required to have the following for this examination;
  - Answer booklet
  - Scientific calculator
  - SMp Table
2. Answer Question **ONE (COMPULSORY)** which carries 30 marks and any other **TWO** Questions for Q2 to Q5 which carry 20 marks each.

(COMPULSORY)

**Question ONE**

- a) i) Highlight the historical process of metric systems transition from EPS to SI systems.  
ii) State the SI definition of the following quantities:  
I) Current of 1A  
II) Luminous Intensity of 1Ca (5marks)
- b) i) Distinguish between systematic and Random errors in Electrical measurements.  
ii) A meter rule is calibrated in millimetres. Determine the least count error and express a 38.7cm measurement reading with the acceptable level of error margin. (4 marks)
- c) i) State the purpose of each of the main THREE parts of MI and MC instruments.  
ii) A 5mA, 1kΩ coil sensor was to be applied in measurement of high current and voltage. Determine:  
I) Multiplier Resistance required to measure 100V.  
II) Shunt resistance required to measure 50A. (7 marks)
- d) i) Below is a Maxwel Bridge circuit used in measurement of inductance

Show that the inductance  $L_x$  is given by

$$L_x = \frac{\left[ \frac{R^2 R_s w C_s - R_x}{w(s + jR_s)} \right]}{jw}$$

Hence calculate the value of  $L_x$  if  $R_x = 10\Omega$ ,  $R = 1k\Omega$ ,  $R_s = 2m\Omega$ ,  $C_s = 3.183pF$ . (7 marks)

- e) i) List ONE advantage and ONE disadvantage of the following bridges used in measurement of Resistance and capacitance respectively.  
I) Wheatsone's Bridge  
II) Wien's Bridge  
ii) Symmetrical balance was obtained in a Wheatsone's Bridge with  $R_x$  and 12kΩ Resistor on one Branch and TWO 6 kΩ Resistors on the other branch. Calculate the value of  $R_x$  and draw the bridge. (7 marks)

(ANSWER ANY OTHER TWO QUESTIONS)

**Question TWO**

- a) i) Distinguish between the following units:  
I) Base and Derived units  
II) Auxiliary and Supplementary units  
ii) Derive the dimensions of the following quantities  
I) Pressure  
II) Voltage (8 marks)

- b) A certain physical quantity was arbitrarily suggested to be given by:

$$\beta\alpha = \frac{E \times V \times I}{L \times C \times R}$$

Where E	=	10,000KJ	L	=	0.001 $\mu$ H
V	=	0.002MV	C	=	500,000KF
I	=	500,000mA	R	=	0.10G $\Omega$

- c) Voltage and current of a 132kv 1000A 3,  $\phi$  line were required measured with a voltmeter and Ammeter of maximum ranges of 200V and 50A respectively.  
i) Calculate the turns ratios for the current and potential transformers required for the task.  
ii) Draw the corresponding instrumentation circuit. (6 marks)

**Question THREE**

- a) i) Distinguish between the following in electrical measurements.  
I) Precision and Accuracy  
II) True and observed value.  
ii) List any TWO sources for each of the following types of errors  
I) Systematic Errors  
II) Random Errors (8 marks)
- b) Students in a university college obtained the following TWO sets of measurements using calibrated and uncalibrated voltmeters respectively.

Calibrated Voltmeter Readings

10.1V  
10.0V  
10.2V  
10.1V  
10.5V  
10.3V  
9.9V  
10.1V  
10.1V  
9.6V  
10.0V  
10.2V

Uncalibrated Voltmeter Readings

10.4V  
10.5V  
10.3V  
10.8V  
10.4V  
10.4V  
10.6V  
10.4V  
10.2V  
9.9V  
10.3V  
10.5V

- i) Identify and eliminate TWO readings from each set which were likely to contain Cross errors.
- ii) Estimate the systematic error of uncalibrated instrument.
- iii) Show that NOT sufficient number of readings were taken to guarantee True values.

(12marks)

**Question FOUR**

- a)
  - i) List the steps followed in setting up an oscilloscope for phase measurement.
  - ii) State any ONE precaution taken in handling of each of the following parts of an oscilloscope.
    - I) Power cables
    - II) Signal cables
    - III) Buttons & I/O accessories.
- b) Engineering students obtained the following plot of voltage and current on a CRT screen.

Given that the corresponding vertical and horizontal knobs were set to 10v/01v and 0.08mS/Div respectively:

- i) Determine the Amplitude of voltage waveform.
- ii) The frequency of each waveforms.
- iii) The phase angle between the two signals.
- iv) The wavelength of the waveform given that they were travelling in a superconductor (vacuum).

### **Question FIVE**

- a)
  - i) With the aid of a suitable sketch, describe the construction and operation of any one of the following:
    - I) C.R.T.
    - II) Electrodynamic wattmeter
    - III) Pulse Digital Meter
  - ii) State any THREE advantages of Digital Instruments over Analogue counterparts. (8 marks)
  
- b)
  - i) Explain the following terms as applied to measurement instruments
    - I) Sensitivity
    - II) Zero setting
  - ii) Sketch a circuit showing how a DC voltmeter may be used to measure AC.
  - iii) A DC voltmeter was modified through a bridge rectifier to measure AC sine wave. \ The voltage reading was found to be 216V. Determine the R.M.S value of the quantity. (12marks)