



TECHNICAL UNIVERSITY OF MOMBASA

Engineering

Electrical Department

UNIVERSITY EXAMINATION FOR:

ECL 2202: MEASUREMENTS AND FAULT DIAGNOSIS paper 2

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

DATE: SEPTEMBER 2018

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. In addition attempt any Other **TWO** Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

Question1

(a) (i) Define reliability of a measuring system and describe the bathtub curve for electronics component s

(ii) Describe the following terms as used with reliability

(I) mean time between failures (MTBF)

(II) Availability

(iii) If the meantime to failure of an instrument is 50000 hours, calculate the probability that it will not fail during the first 10000 hours of its operation **(10mks)**

(b)(i) State the difference between electromagnetic and electrostatic units

(ii) Derive the units of charge in electromagnetic and electrostatic systems and show that the relationship between electrostatic and magnetic system can given by $velocity = \frac{1}{\sqrt{\mu\epsilon}}$

(iii) Derive an expression for determination of relative permittivity during permittivity measurement. **(10)mks**

(c)(i)With aid of sketch of De Sauty bridge describe how to measure capacitance and derive an equation for the capacitance C.

(ii) In a modified DeSauty bridge measurement the following readings are obtained $R_1 = 1000\Omega, R_2 = 1000\Omega, R_3 = 2000\Omega, R_4 = 2000\Omega, C_1 = 1\mu F, f = 1000Hz, r = 10\Omega(c_1)$. Find the phase angle errors , and unknown capacitance.

(iii)With aid of a sketch describe the ammeter-voltmeter method of measurement of resistance and derive an equation for the resistance R. **(10mks)**

Question TWO

(a) (i) With aid of a block diagram describe the application of a measuring system in control process and operations

(ii) Describe the following stages of a measuring system

(I) Signal conditioning element

(II) Variable manipulation element

(III) Primary sensing element **(10mks)**

(iii) In measurement of a resistance R by the voltmeter method the two connections are used. The resistance of the ammeter is 0.05Ω and that of the voltmeter is 1500Ω . In case of B the current measured is 5A and the voltage is 350V. Find the percentage error in calculating R as the quotient of the of the readings and the true value of R. Also find the readings of voltmeter A if the current indicted by the ammeter is 7A

(b)(i) With aid of a sketch describe measurement of inductance by Maxwell Bridge, and derive the equation of the parameters at balance conditions

(ii)With aid of a circuit diagram describe how you can measure the resistance of the earth connections

(iii) A resistance of approximately 80Ω is to be measured by voltmeter-Ammeter method, using a 1A ammeter having a resistance of 2Ω and a 50V voltmeter having a resistance of 5000Ω . Suggest which one of the two methods discussed should be used. Suppose in the suggested method the following measurements are made $I=0.42A$, $V=35.5V$. What is the resulting error if the accuracy of the instrument is $\pm 0.5\%$ at full scale and the errors are standard deviations **(10mks)**

Question THREE

(a)(i) State two requirements of a measuring instrument

(ii) Describe AC power and with aid of a sketch show that the total power in two wattmeter power measurement is given by $P = W_1 + W_2$

(iii) A 3phase 500V motor load has a power factor of 0.4. The two wattmeter connected to measure power show input to be 30Kw. Find the reading on each wattmeter. **(10mks)**

(b)(i) Define earth fault loop

(ii) With aid of a circuit diagram how to measure the earth resistance area

(iii) In measurement of resistance by potentiometer, the voltage drop across a resistor under test and across a 0.02Ω . Standard resistor voltage were found to be 0.735 and 0.98 respectively. Draw the circuit diagram and determine the value of the resistor under test. **(10mks)**

Question FOUR

1 (a) (i) Define measurement s as used in measurement s and fault diagnosis

(ii) State the difference between fundamental and derived units

(iii) Derive the dimensions units of energy

(iv) Three voltmeters for single phase power measurement give the following reading; $V_1 = 200V$ (Across inductive load), $V_2 = 1800V$ (across non inductive load), $V_3 = 300V$ (across the two loads in series). Draw the circuit diagram and determine the power factor of the inductive load **(10mks)**

(b)(i) With aid of a sketch describe the construction of a moving coil instrument

(ii) Show that at steady state conditions deflection of a moving coil instrument is given by $\theta = \frac{GI}{K}$,

where $G = \text{a constant} = NBA$, and $\theta = \text{deflection}$

(iii) A moving coil voltmeter with resistance of 20Ω gives a full scale deflection of 120degrees when a potential difference of 100mV is applied across it. The moving coil has a dimensions of 30mmx25mm and is wound with 100turns. The control spring constant is $0.375 \times 10^{-6} NM / \text{deg}$. Find the flux density in

the air gap. Find also diameter of copper wire of coil winding if 30% of the instrument resistance is due to coil winding. Specific resistance of copper is $1.7 \times 10^{-8} \Omega/M$ **(10mks)**

Question FIVE

- (a)(i) Describe THREE Methods that can be used to improve the reliability of a measuring system
- (ii) The author of a digital processing algorithm forms a software component within a measurement system that adds 12 deliberate faults in the program, of these detected errors the program author recognizes 10 of them as being seeded errors. Estimate the original number of errors present in the software
- (iii) Describe how you can measure reliability of a given system and state FOUR duties of an employer to safeguard safety (10mks)
- (b)(i) Describe the random and static tests as used in fault diagnoses
- ii) Describe the input and output methods as used in fault diagnoses
- (iii) Describe the half split method **(10mks)**