*(University of Choice)*
## MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

### MAIN CAMPUS

### UNIVERSITY EXAMINATIONS
### 2021/2022 ACADEMIC YEAR

### FOURTH YEAR FIRST SEMESTER EXAMINATIONS

### FOR THE DEGREE
### OF
### BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

**COURSE CODE:** MIE 451
**COURSE TITLE:** INDUSTRIAL MEASUREMENTS AND INSTRUMENTATION

**DATE: Tuesday, April 19ᵗʰ , 2022**          **TIME: 3.00- 5.00 PM**

**INSTRUCTIONS TO CANDIDATES**

Question ONE (1) is compulsory
Answer Any Other THREE (3) questions

TIME:   3 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

Question 1 is compulsory.

1. (a) State any two advantages of electronic measurement. (2mks)

   (b) State and explain static and dynamic characteristics of Instruments (4mks)

   (c) Using a block diagram, describe a generalized measurement system and the functions of each element. (3mks)

   (d) Explain 3 sources of errors in instruments (3 mks).

   (e) In a test on a Bakelite sample at 20 kV, 50 Hz by a Schering Bridge, having a standard capacitor of 106 pF, balance was obtained with a capacitance of 0.35 μF in parallel with a non-inductive resistance of 318 Ω, the non-inductive resistance in the remaining arm of the bridge being 130 Ω. Determine

   (i) Capacitance (3mks)

   (ii) Power factor (3mks)

   (iii) Equivalent series resistance. (3mks)

   (f) With the aid of a neat and well labelled diagram of a Maxwell Wien Bridge, derive the expression of how an inductance of an unknown value could be calibrated. (7mks)

   (g) Define a wave analyzer. (2mks)

2. (a) What is a Transducer? (1mk)

   (b) (i) Explain various classifications of transducers. (2 mks).

      (ii) State the key requirements of good transducers. (2 mks).

      (iii) Why is mercury-in-glass not preferred in measuring temperature? (2mks)

   (c) A thermocouple circuit uses Chrome- Alumel thermocouple which gives an emf of 35mV when measuring a temperature of $800^\circ$ C with reference temperature of $0^\circ$ C. The resistance of the meter coil $R_m$ is 50 Ω and a current of 0.1 mA gives full scale deflection. The resistance of junction and leads, $R_e$ is 12 Ω. Calculate.

   (i) The resistance of the series resistance if a temperature of $800^\circ$ C is to give full deflection. (2 mks)

   (ii) The approximate error due to rise of 1.25 Ω in $R_e$. (2mks)

(iii) The approximate error due to rise of $10^\circ$ C in the copper coil of the meter. The resistance temperature coefficient of the coil is 0.0045/$^\circ$ C. (2mks)

(d) What are thermopiles and where are they used? (2 mks)

(e) With the help of diagrams, describe the working principle and application of a linear Variable Differential Transformer (5 mks).

3. (a) With the help of a block diagram, describe the building block of a digital instrument. (3mks)

(b) Using a clearly labelled block diagram of a basic digital multimeter, describe how current and resistance are measured. (6 mks).

(c) Using a block diagram of microprocessor based instrument, explain how impedance measurement can be obtained. (6 mks).

(d) A barium titanate pickup has the dimensions of 5 mm by 5 mm by 1.25 mm. The force acting on it is 5N. The charge sensitivity of barium titanate is 150 pC/N and its permittivity is 12.5 X $10^{-9}$ F/m. If the modulus of elasticity of barium titanate is $12 \times 10^6$ N/m$^2$. Calculate the strain, the charge and capacitance of the crystal. (5mks).

4. (a) Draw Wheatstone's bridge and describe how it is used to measure resistance under balanced conditions. (5mks).

(b) With reference to (a) above, given that R1 and R2 have a common point with the switch and connected to positive terminal of DC supply while R3 and Rx have a common point with the neutral of the DC supply.
Calculate Rx where R1=10k$\Omega$, R2=15k$\Omega$ and R3=40k$\Omega$. (3mks)

(c) State the limitations of Wheatstone's bridge (3mks).

(d) A Maxwell Bridge is used to measure the inductive impedance. The bridge constants at balance are: C1= 0.01 μF, R1=470 k$\Omega$, R2=5.1 k$\Omega$, R3=100 k$\Omega$. Find the series equivalent of the unknown impedance. (5mks).

(e) An ac bridge has the following constants. (Refer to Fig 1).
Arm AB – capacitor of 0.5 μF in parallel with 1 k$\Omega$ resistance.
Arm AD- resistance of 2 k$\Omega$.

Arm BC- capacitor of 0.5 µF.

Arm CD- Unknown capacitor Cx and Rx in series.

Frequency - 1 kHz.

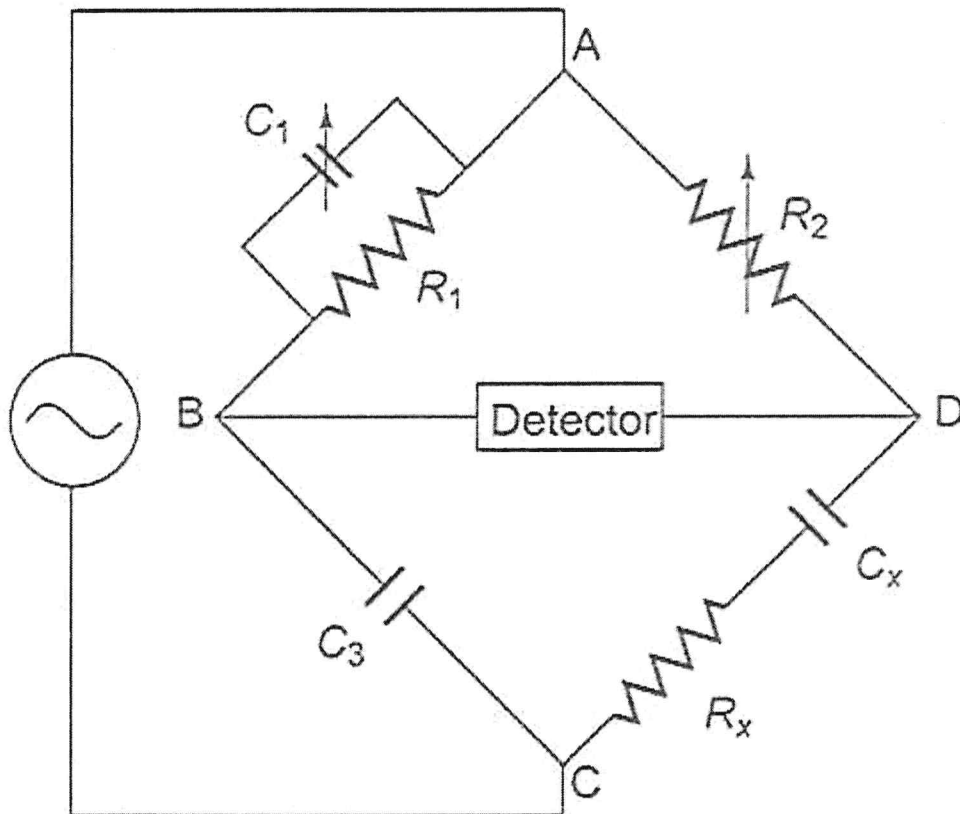Determine the unknown capacitance and dissipation factor. (4 mks)



Fig 1.

5. (a) List the major components of a CRT. (2 mks).

(b) Draw the basic block diagram of an Oscilloscope and state the functions of each element. (6mks).

(c) List the advantages of using negative voltage in a CRO. (2mks).

(d) Describe with the help of a diagram the operation of Dual Trace Oscilloscope. (5 mks).

(e) State and explain the general classifications of digital displays. (5mks)