



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

MAIN CAMPUS

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

FOURTH YEAR FIRST SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATIONS

**FOR THE DEGREE
OF**

BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 451

COURSE TITLE: INDUSTRIAL MEASUREMENTS AND INSTRUMENTATION

DATE: Wednesday, October, 5th, 2022

TIME: 9-11

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.

INDUSTRIAL MEASUREMENTS AND INSTRUMENTATION EXAMINATIONS.

(MIE 451) QUESTION ONE IS COMPULSORY AND ANSWER ANY OTHER TWO QUESTIONS

1. (a) What is electronic measurement in the context of instruments? (3 mks)
- (b) Using a block diagram, describe a generalized measurement system and the functions of each element. (7mks)
- (c) State and explain static and dynamic characteristics of Instruments (7mks)
- (d) Explain 3 sources of errors in instruments (3 mks).
- (e) The table shows the set of 5 measurements. It is recorded in a laboratory .Calculate the precision of the 3rd measurement. (10 mks)

Measurement Number	Value of Measurement
1	49
2	51
3	52
4	50
5	49

2. (a) What is a Transducer? (1mk)
- (b) (i) Explain various classifications of transducers. (3 mks).
- (ii) 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° C with reference temperature of 0° 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° C is to give full deflection. (1 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° C in the copper coil of the meter. The resistance temperature coefficient of the coil is 0.0045/ $^{\circ}$ C. (2mks)

- (d) With the help of diagrams, describe the working principle and application of a linear Variable Differential Transformer (4 mks).
- (e) 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 12.5×10^{-9} F/m. If the modulus of elasticity of barium titanate is 12×10^6 N/m². Calculate the strain, the charge and capacitance of the crystal. (5mks).
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) State the advantages of digital instruments over analog instruments. (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 Ω , R2=15k Ω and R3=40k Ω . (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 μ F, R1=470 k Ω , R2=5.1 k Ω , R3=100 k Ω . 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 μ F in parallel with 1 k Ω resistance.
Arm AD- resistance of 2 k Ω .
Arm BC- capacitor of 0.5 μ F.
Arm CD- Unknown capacitor Cx and Rx in series.
Frequency - 1 kHz.

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

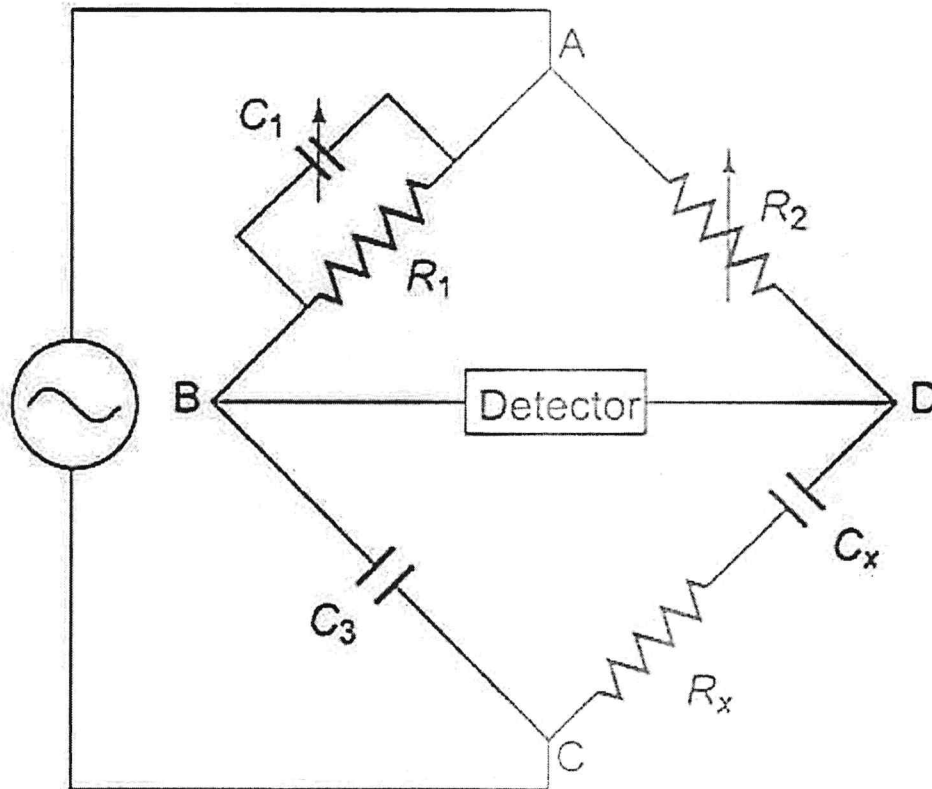


Fig 1.

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. (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 beam CRO. (5 mks).
- (e) Explain the operating principle of a function generator. (5mks)