PPI

# TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering & Technology

Department of Electrical & Electronic Engineering

## UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE (ELECTRICAL & ELECTRONIC ENGINEERING)

EEE 4317: SENSORS AND INSTRUMENTATION

END OF SEMESTER EXAMINATION

**SERIES: JULY 2025**

**TIME: 2** HOURS

**DATE:** JULY 2025

**Instructions to Candidates**

You should have the following for this examination
*-Answer Booklet, examination pass and student ID*
This paper consists of FIVE questions. Attempt Question **ONE** and any other **Two** Questions.
**Do not write on the question paper.**

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**Question ONE**

**a)** Define the following terms
(i) hysteresis
(ii) transfer function

[6 marks]

**b)** Derive the sensitivity of a capacitive sensor of Figure Q1b

[8 marks]

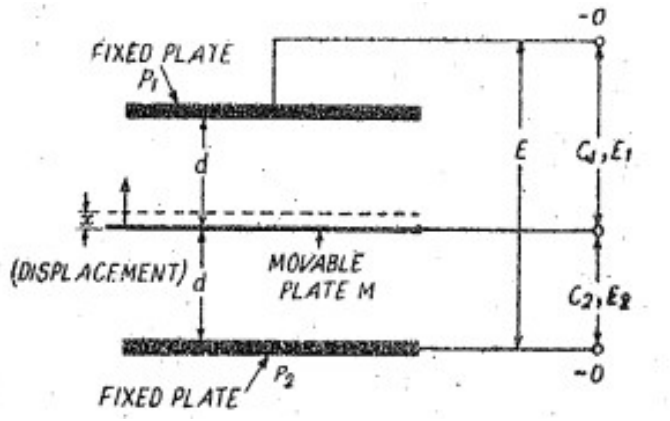


Figure Q1b

**c)** State and explain briefly any Two sources of error in a measurement system

[4 marks]

**d)** A 230V single phase, watt hour meter has a constant lead of 4 A passing through it for 6 hours at a unity power factor. If the meter disc makes 2208 revolutions during this period, determine the:
(i) meter constant in revolutions per kWh
(ii) power factor of load if the number of revolutions are 1472 when operating at 230V and 5A for 4 hours

[6 marks]

**e)** Briefly explain the following as applied to industrial tariffs
(i) kilowatt hour tariff
(ii) maximum demand tariff
(iii) power factor tariff

[6 marks]

**Question TWO**

**a)** Figure Q2a is a strain gauge element, given that the resistivity is ϱ, derive the formula for the gauge factor

[10 marks]

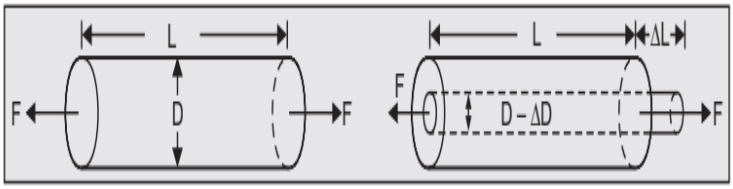


**Figure Q2a**

**b)** A resistance, wire strain gauge with a gauge factor of 2 is bonded to a steel structural member subjected to a stress of 100 $MN/m^2$. The modulus of elasticity of steel is 200 $GN/m^2$. Determine the percentage in value of the gauge resistance due to the applied stress.

[4 marks]

**c)** With the aid of diagrams illustrate any three types of thermistors

[6 marks]

**Question THREE**

**a)** For the bridge of Figure Q3a, determine the expression for
(i) capacitance $C_x$
(ii) resistance $R_x$
(iii) power factor
(iv) dissipation factor

[14 marks]

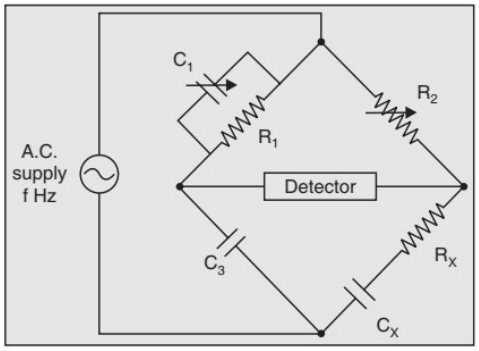


**Figure Q3a**

**b)** The Schering Bridge of Figure Q3a above has the following constants $R_1$ = 1.5 kΩ, $C_1$ = 0.4 mF, $R_2$ = 3 kΩ and $C_3$ = 0.4 mF at frequency 1 kHz. Determine

(i) the unknown resistance and

(ii) capacitance of the bridge circuit and

(iii) dissipation factor

[6 marks]

**Question FOUR**

**a)** Show that change in capacitance ΔC in a single gap, parallel plate variable permittivity (dielectric constant) displacement transducer is given by

$$\Delta C = \epsilon_0 \frac{bx}{t} (\epsilon_{rm} - 1) \text{ farads}$$

where $\epsilon_0$ =permittivity of free space =8 854 X 10-12 F/m

$\epsilon_{rm}$=dielectric of medium (other than air) which is displaced by the mcasurand by an amount *x*

b = width of each parallel plate

t = distance between the plates

*x* = distance moved by the dielectric in a direction parallel to the plane of plate's so that area of the plates between which the dielectric lies changes.

[12marks]

**b)** The diaphragms of a pressure measuring transducer are 2 cm2 in ·area of 2.5 mm apart, and the system has a capacitance of 250 x 10-12 farads. When a pressure of $10^4$ is applied diaphragm, there results a deflection of 0.25 mm in the ·diaphragm. Determine a change in the capacitance of the system.

[8marks]

**Question FIVE**

**a)** Briefly explain **Two** precautions that can be taken to prevent False positive detection

[4 marks]

**b)** With the aid of diagrams explain the principle of capacitive occupancy sensors

[8 marks]

**c)** With the aid of diagrams explain the construction and principle of operation of a thermal lagged maximum demand meter

[8 marks]