University of Ruhuna- Faculty of Technology

Bachelor of Engineering Technology

Level 2 (Semester 2) Examination, August 2020

Course Unit: ENT2232 – Instrumentation & Calibration

Time Allowed: 2 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **five** questions.
3. Answer **every** question.
4. All questions carry equal marks.
5. **Always start a new question from a new page.**
6. Present necessary, but relevant facts and information briefly. Any missing information can be sensible and reasonably assumed, provided that you state them clearly.

Q1.

i. Define the term "Instrumentation".

ii. Explain the recording function of the measurement system by giving an example.

iii. Draw the element block diagram of the measuring system and describe the elements of the block diagram.

iv. Derive dimensions for the following quantities;

a. Kinetic Energy (K.E) $K.E = \frac{1}{2}mv^2$,

b. Electric permittivity (ε_0) $F = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1 q_2}{r^2}\right)$, and

c. Universal gas Constant (R) $PV = nRT$.

Q2.

i. Define the term "Measurement Error".

ii. Write three necessary solutions to avoid gross errors in measurement systems.

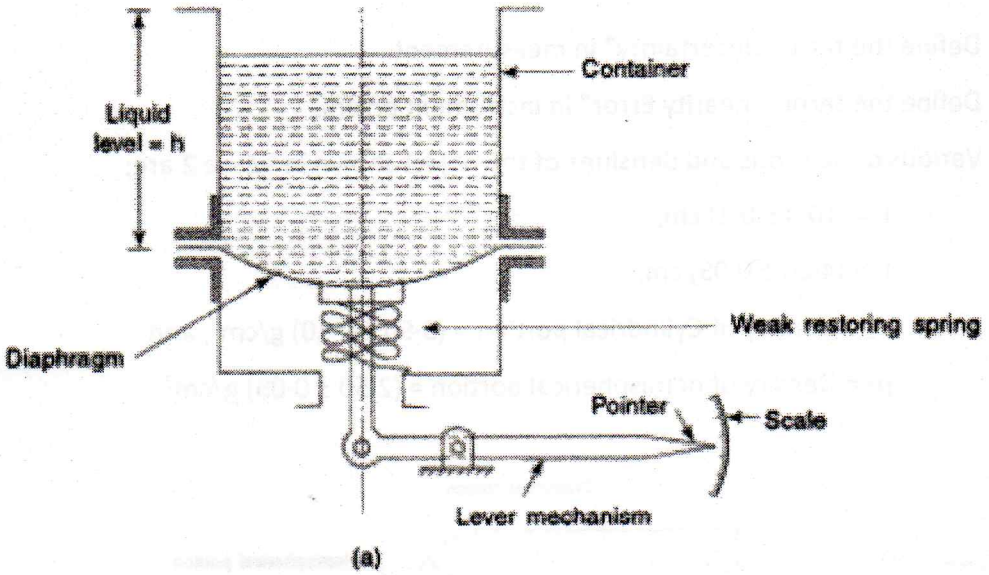
iii. Define the following terms related to instrumental errors;

a. Inherent shortcomings of instruments,

b. Misuse of instrument, and

c. Loading effect.

iv. Construct the block diagrams with essential elements for the following measuring systems in figure 1(a) and figure 1(b).



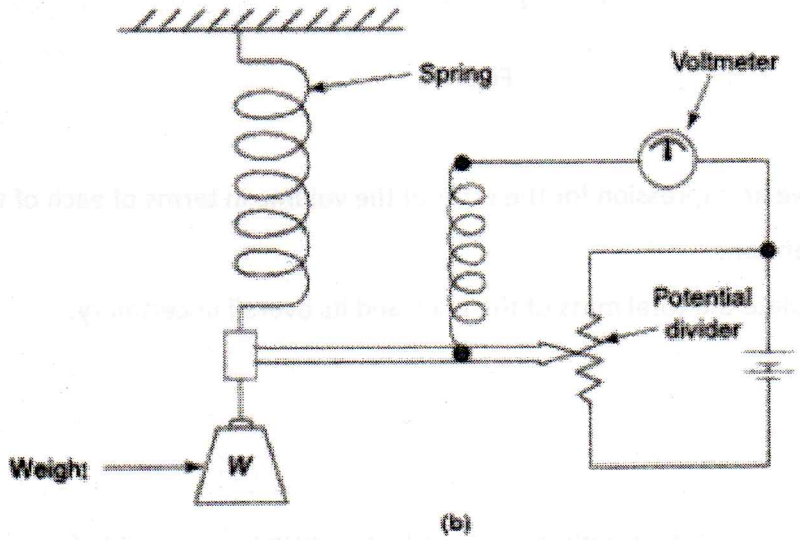


Figure 1: (a) Diaphragram type liquid level gauge, (b) Spring balance with electrical read out.

Q3.

i. Define the term "Uncertainty" in measurement.

ii. Define the term "linearity Error" in instrument errors.

iii. Various dimensions and densities of the object shown in figure 2 are;

$L = (10{\cdot}0 \pm 0{\cdot}1)$ cm,

$R = (4{\cdot}00 \pm 0{\cdot}05)$ cm,

ρ_1 = Density of Cylindrical portion = $(3{\cdot}50 \pm 0{\cdot}10)$ g/cm^3, and

ρ_2 = Density of hemispherical portion = $(2{\cdot}50 \pm 0{\cdot}05)$ g/cm^3.

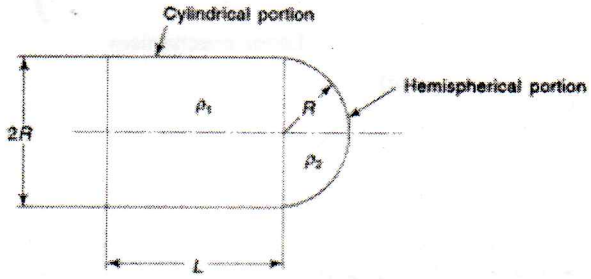


Figure 2

a. Derive an expression for the error of the volume in terms of each of the dimensions.

b. Calculate the total mass of the body and its overall uncertainty.

Q4.

i. State the two established institutions in sri lanka which is responsible for disseminating National Measurement Standards.

ii. Compare and contrast the accuracy and precision of a measuring instrument according to the following parameters;

a. Definition,

b. Measurements, and

c. Uses.

iii. The output voltage of a particular thermocouple sensor is registered to be 42·3 mV at temperature 105°C. It had previously been set to emit a zero voltage at 0°C. Determine;

a. the transfer function of the thermocouple, and
b. the temperature corresponding to a voltage output of 15·8 mV.

iv.

a. Describe the measuring mechanism of the weight measuring instrument with a simple sketch.
b. Construct the block diagram for that weight sensor measuring instrument using components such as sensor, variable conversion element, signal processing, transmission, and display unit.

Q5.

i. Define the term "Calibration".
ii. State the five importance of doing periodic calibration.
iii. Define following terms related to calibration standards;

a. Primary Measurement Standard,
b. International Measurement Standard,
c. National Measurement Standard,
d. Reference Measurement Standard, and
e. Working Standard.