

2507/205

MEASUREMENT TECHNOLOGY

Oct./Nov. 2023

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING
(AVIONICS OPTION)

MODULE II

MEASUREMENT TECHNOLOGY

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Drawing instruments;

Non-programmable scientific calculator.

This paper consists of EIGHT questions.

Answer any FIVE of the EIGHT questions in the answer booklet provided.

All questions carry equal marks.

Maximum marks for each part of a question are as indicated.

Candidates should answer the questions in English.

This paper consists of 6 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. (a) Explain each of the following dynamic characteristics of instruments:

- (i) fidelity;
- (ii) dynamic error;
- (iii) response time.

(6 marks)

(b) A 0 - 200 V voltmeter has a guaranteed accuracy of 1.5 percent of full scale reading. If the measured voltage is 100 V, determine the:

- (i) relative error;
- (ii) percentage limiting error.

(7 marks)

(c) With the aid of a labelled diagram, explain the operation of a toothed rotor tachometer generator. (7 marks)

2. (a) List **three** features of pressure in a fluid. (3 marks)

(b) Figure 1 shows a schematic diagram of a tube and well manometer. Derive an expression for h_2 in terms of P_1 and P_2 . (6 marks)

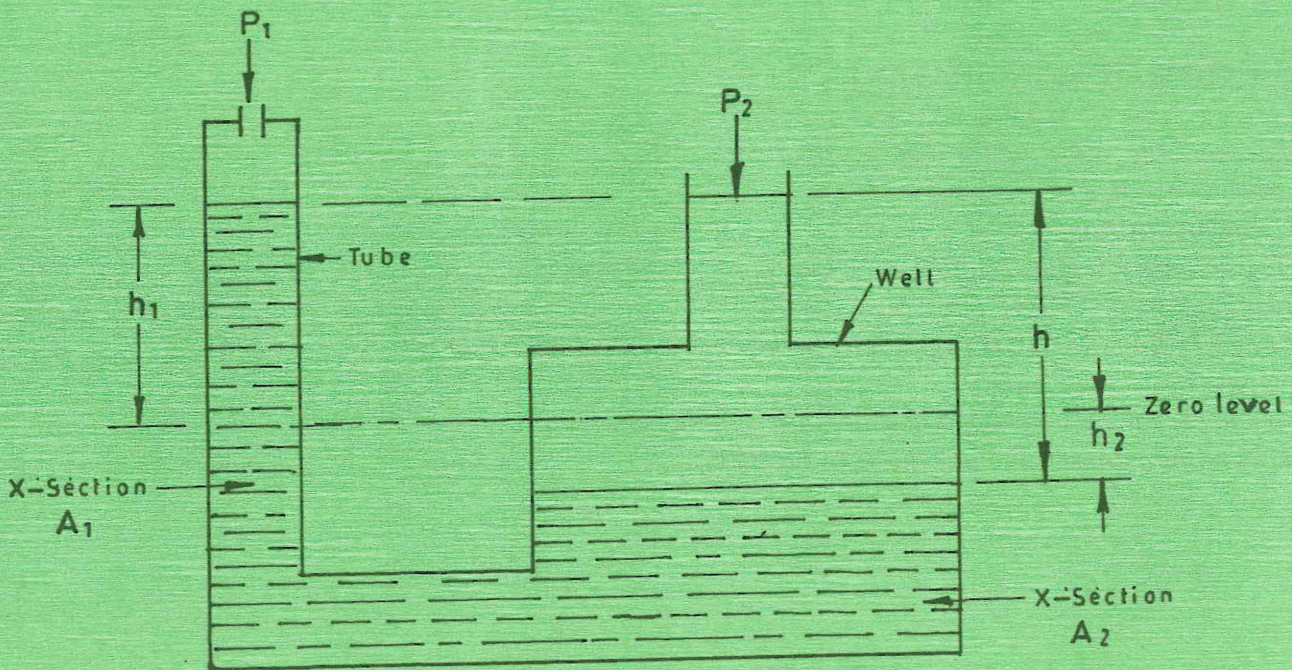
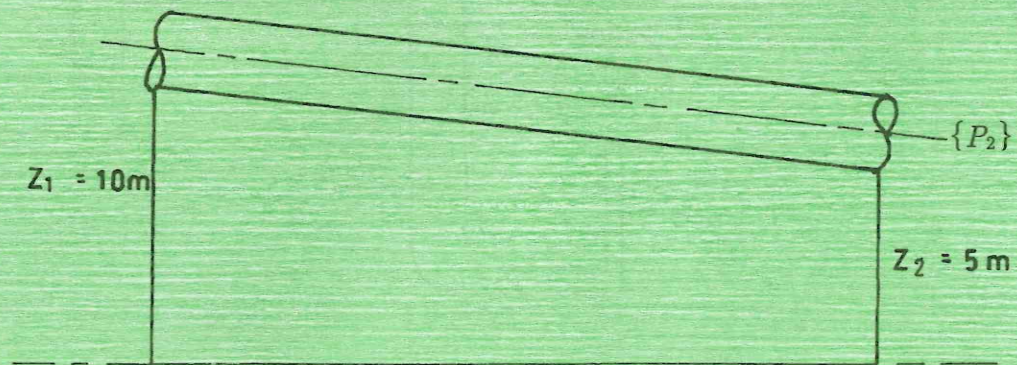


Fig 1

- (c) With the aid of a labelled diagram, explain the calibration of a pressure measuring instrument using the dead weight tester. (8 marks)
- (d) List **three** features of metallic diaphragms when used in pressure measurements. (3 marks)
3. (a) With the aid of a labelled diagram, explain the operation of cable and counter float method of level measurements in a liquid. (8 marks)
- (b) When measuring level of a liquid of specific gravity 3 and height of 4 m, the gravity force was 10 kg. Determine the pressure at this height. (2 marks)
- (c) List **four** features of bimetallic thermometer. (4 marks)
- (d) A bimetallic thermometer in a circuit uses a chromel-alumel thermocouple which gives an emf of 33.3 V when measuring a temperature of 800 °C with reference temperature being 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 R_e of junctions and leads is 12 Ω . Determine the:
- (i) resistance of series resistor if a temperature of 800 °C is to give full scale deflection.
- (ii) approximate % error due to change of 1 Ω in R_e . (6 marks)
4. (a) (i) State **three** energy components of a flowing liquid.
- (ii) Figure 2 shows an inclined pipe with liquid flowing through it. Determine the pressure at point P_2 . (6 marks)

$$\{P_1 = 100 \text{ N/m}^2, V = 2 \text{ m/s}\}$$



take $\rho = 1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$

$Z = \text{height from datum level}$

Fig.2

- (b) With the aid of a labelled diagram, describe the rotating impeller gas meter. (7 marks)
- (c) (i) State two merits of LVDT accelerometer.
- (ii) An LVDT accelerometer has a signal output of 0.31 mV/mm with a $\pm 20 \text{ mm}$ core displacement. If the spring constant is 240 N/m and the core mass is 0.06 kg , determine the:
- (I) natural frequency;
 - (II) maximum acceleration;
 - (III) sensitivity of accelerometer.
- (7 marks)

5. (a) (i) State **three** causes that may reduce the sensitivity of a force balance differential pressure cell.
- (ii) Figure 3 shows a force balance pneumatic differential pressure cell. Describe its operation. (7 marks)

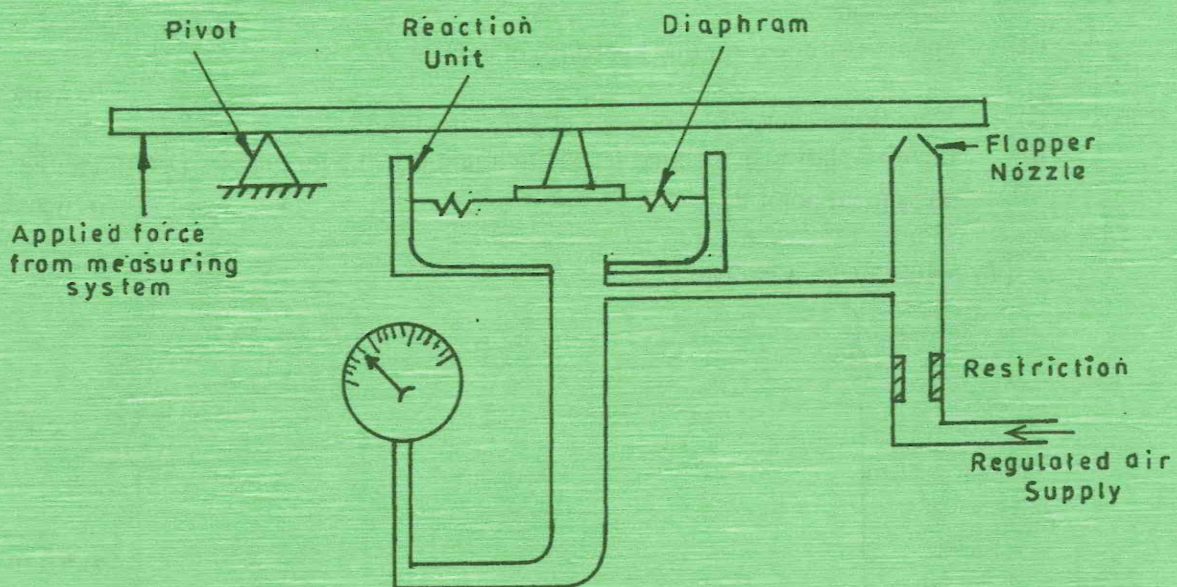


Fig. 3

- (b) (i) State **three** properties of sealing liquid used in manometer.
- (ii) With the aid of a diagram, explain the operation of bourdon tube pressure gauge. (7 marks)
- (c) With the aid of a labelled diagram, explain the operation of a hydraulic load cell. (6 marks)

6. (a) (i) Draw a labelled block diagram of an optical measurement link.
(ii) State **three** optical sources of radiation. (7 marks)
- (b) With the aid of a diagram, describe the operation of photo conductive cell as a photo detector. (7 marks)
- (c) A photovoltaic cell produces 0.4 V on open circuit when illuminated by 15 w/m^2 radiant incidence. Determine the open circuit voltage when illuminated by incident radiation of 30 w/m^2 . (3 marks)
- (d) List **three** different combinations of material used in optical fibre construction. (3 marks)
7. (a) With the aid of a diagram, explain the operation of Golay pneumatic detector for infrared spectrum. (7 marks)
- (b) Figure 4 shows a schematic diagram of a coincidence range finder.

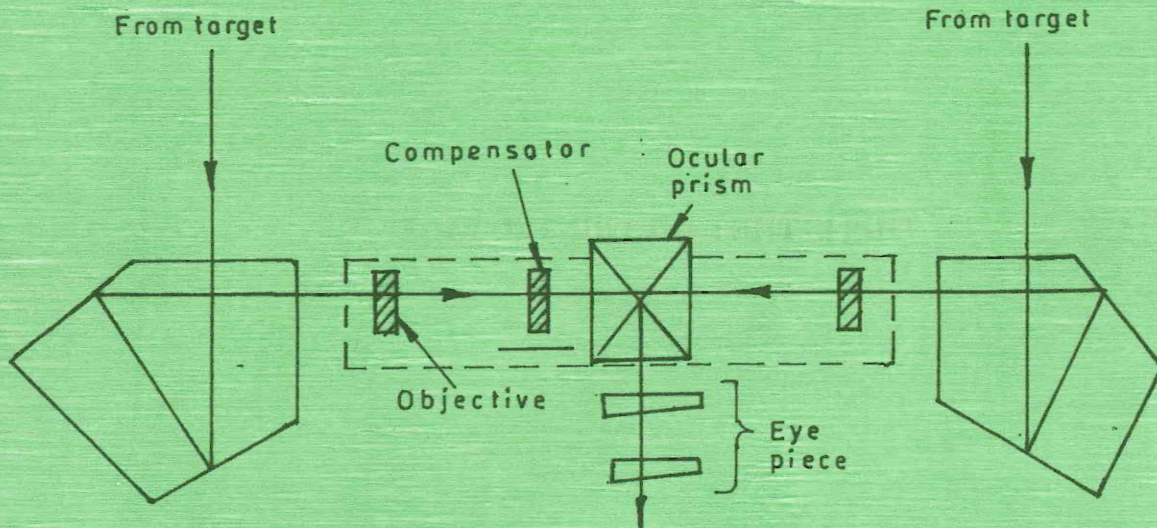


Fig. 4

- (i) explain its operation;
(ii) list **four** applications of the range finders. (9 marks)
- (c) State **four** x-ray detectors. (4 marks)

8. (a) State **three** industrial applications of ultrasonic waves. (3 marks)
- (b) (i) List **three** advantages of ultrasonic flowmeter over other types.
- (ii) With the aid of a diagram, explain the doppler effect in flow measurement. (10 marks)
- (c) When measuring flow using ultrasonic method, the following parameters were obtained;
- transmitter frequency = 20 kHz
 - receiver frequency = 35 kHz.
 - Speed of sound in fluid is 2 m/s and the velocity of liquid is 3 m/s.
- Determine the angle of inclination of the ultrasonic ray during measurement. (5 marks)
- (d) State **two** advantages of hydraulic systems over pneumatic systems. (2 marks)

THIS IS THE LAST PRINTED PAGE.