

2507/205

MEASUREMENT TECHNOLOGY

Oct./Nov. 2017

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING
(AVIONICS OPTION)

MODULE II

MEASUREMENTS TECHNOLOGY

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Non-programmable scientific calculator.

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.

Take speed of light = 3×10^8 m/s

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) Define the following terms in relation to measuring instruments:
- (i) resolution;
 - (ii) repeatability;
 - (iii) dead zone. (3 marks)
- (b) A voltage source has an open circuit voltage of 20 volts and an output impedance of $0.5 + j1 \Omega$. The voltage source is connected to the load through a transmission network having an impedance of $1.5 + j4 \Omega$. For maximum power transfer, determine:
- (i) load impedance;
 - (ii) load current;
 - (iii) total power loss. (10 marks)
- (c) With the aid of a diagram, describe the shaft speed measurement using a stroboscope. (7 marks)

2. (a) (i) State **three** features of a piezo-electric accelerometer.
- (ii) Figure 1 shows a diagram of a piezo-electric accelerometer, explain its operation.

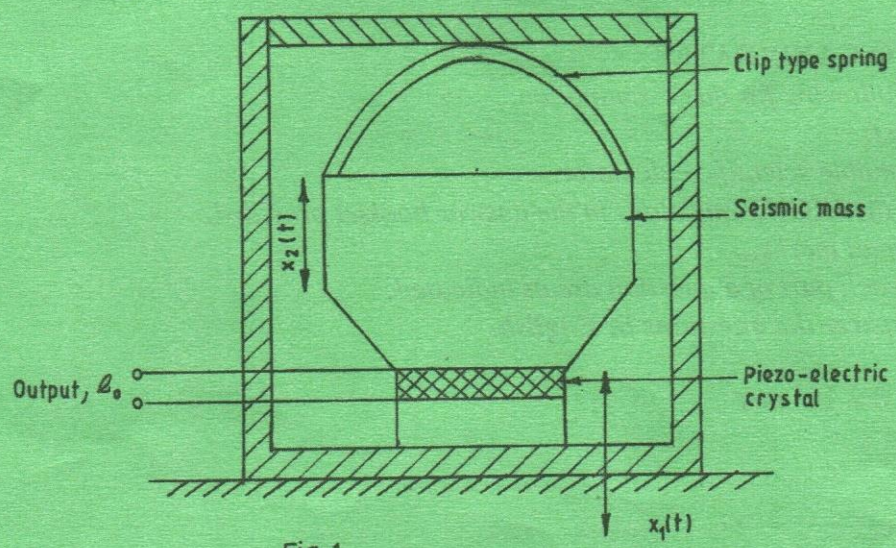


Fig.1

- (iii) An accelerometer has a seismic mass of 0.08 kg, a spring constant of $4 \times 10^3 \text{ N/m}$ and a maximum displacement of $\pm 0.04 \text{ m}$. Determine the:
- (I) maximum acceleration;
 - (II) natural frequency, in Hz. (12 marks)

- (b) With the aid of a diagram, explain the principle of operation of a thermocouple thermometer. (5 marks)
- (c) For a resistance thermometer, state **three** reasons for not using ordinary wheatstone bridge in measurement of changes in resistance. (3 marks)

3. (a) Distinguish between laminar and turbulent flow in liquids. (2 marks)

- (b) (i) State **three** advantages of electromagnetic flowmeter over venturi-meter in fluid flow measurements.
- (ii) With the aid of a schematic diagram, explain the principle of operation of an electromagnetic flowmeter. (10 marks)

(c) A horizontal venturi meter measures flow of oil of specific gravity 0.9 in a 75 mm diameter circular pipe. The pressure difference between the full bore and throat tappings is 34.5 kN/m^2 , the area ratio is 4 and discharge constant, $C_d = 0.97$. Determine the volume flow rate, at the:

- (i) bore;
- (ii) tapping. (8 marks)

4. (a) Define the following terms with respect to pressure measurement:

- (i) gauge pressure;
- (ii) absolute pressure. (2 marks)

(b) (i) With the aid of a diagram, describe atmospheric pressure measurement using a mercury barometer.

(ii) Figure 2 shows a U-tube manometer used to measure the pressure difference between points A and B.

The liquid at A and B is water of specific weight, $W_1 = 9.81 \text{ N/m}^3$, and specific gravity of metering liquid, C is 13.6. Determine the pressure difference, $P_A - P_B$, in N/m^2 . (10 marks)

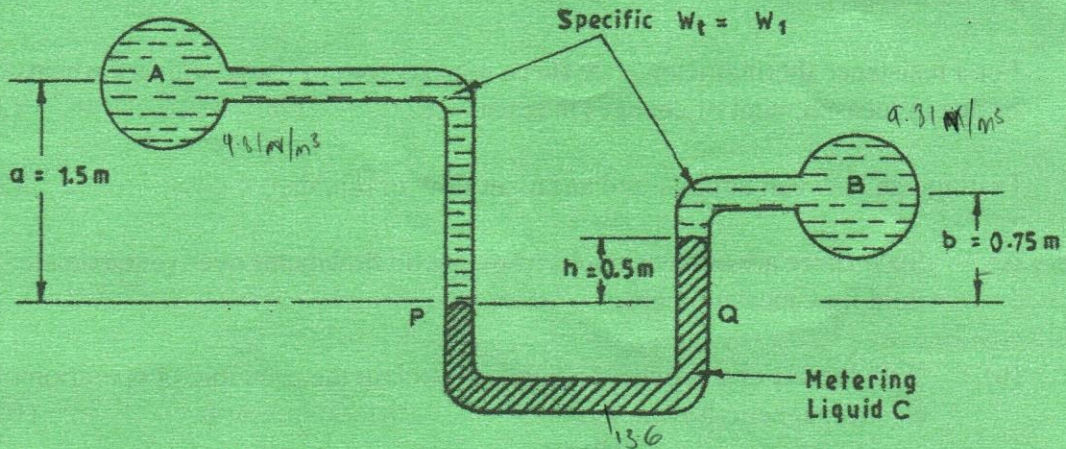


Fig. 2

(c) With the aid of a stress-strain curve, explain the operation of a strain gauge pressure transducer. (8 marks)

5. (a) (i) State **three** basic requirements for pneumatic transmission system in measurements. (10 marks)
- (ii) With the aid of a schematic diagram, explain the operation of a force balance pneumatic transmitter.

(b) (i) Figure 3 shows a diagram of a tank with a liquid whose level is to be measured using the capacitive method. Explain how the level is measured.

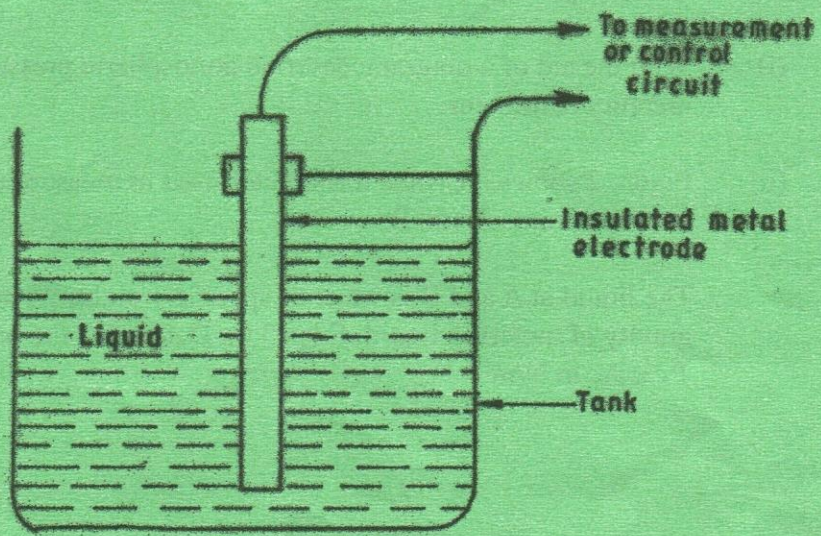


Fig. 3

(ii) With the aid of a labelled diagram, describe the conductivity probe method of liquid level measurement. (10 marks)

6. (a) Define the following with respect to humidity measurement:
- (i) absolute humidity;
 - (ii) relative humidity;
 - (iii) dew point. (3 marks)
- (b) With the aid of a diagram, explain the principle of operation of a resistive hygrometer. (7 marks)
- (c) (i) Distinguish between batch and continuous weighing.
- (ii) With the aid of a schematic diagram, explain the operation of a pneumatic load cell. (10 marks)
7. (a) (i) State **three** properties of laser light.
- (ii) An He-Ne laser source having power of 7.5 mW transmits to a detector 150 m away. The detector has an area of 5 cm², determine the power of the laser light to which the detector must respond. (7 marks)
- (b) (i) With the aid of diagram, explain the principle of operation of a photovoltaic detector.
- (ii) (I) Explain the working principle of an LED.
- (II) A silicon LED is connected to a supply voltage of 5 V. The voltage drop across the diode is 1.6 V. For a current of 16 mA, determine the series resistor required for proper circuit operation. (13 marks)
8. (a) (i) State **three** factors that influence the choice of excitation source in spectroscopy.
- (ii) With the aid of a labelled diagram, explain how grating dispersion is done in spectroscopy. (10 marks)
- (b) (i) State **three** major components of atomic emission spectroscopy (AES) instrumentation.
- (ii) Describe the Direct-current arc as an emission source in spectroscopy. (6 marks)

- (c) Figure 4 shows a diagram of a scintillation counter x-ray detector. Name the parts labelled W, X, Y and Z. (4 marks)

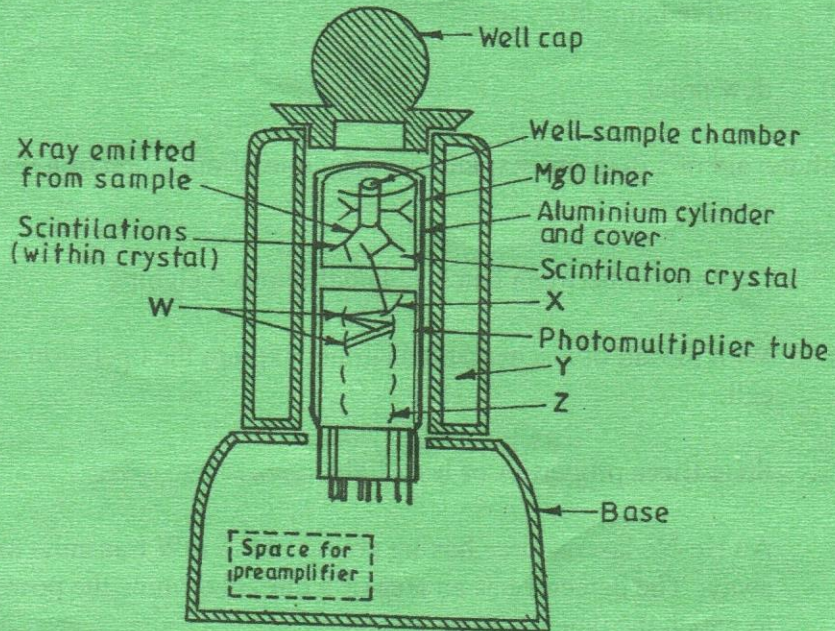


Fig. 4

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