2507/205
MEASUREMENT TECHNOLOGY
March/April 2024
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 5 printed pages.

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

Turn over

1. (a) (i) State **two** categories of systematic errors.

(ii) A voltmeter of sensitivity 1010 Ω/V reads 50 V on its 150 V scale when connected across an unknown resistor in series with a milliammeter. When the milliammeter reads 800 mA, determine the:

(I) apparent resistance of the unknown resistor;
(II) actual resistance of unknown resistor;
(III) error due to the loading effect of voltmeter.

(10 marks)

(b) (i) State **three** requirements for purge fluid used to protect pressure instruments.

(ii) With the aid of a diagram, explain the operation of the slack diaphragm type pressure gauge.

(10 marks)

2. (a) State **three** direct methods of liquid level measurements. (3 marks)

(b) The following parameters were obtained when measuring liquid level in a tank.

Height = 10 m; pressure = 125 N/m^2.

Determine the density of the liquid. Take g = 9.81 m/s^2. (3 marks)

(c) (i) **Figure 1** shows a closed diaphragm box for level measurement. Describe its operation.

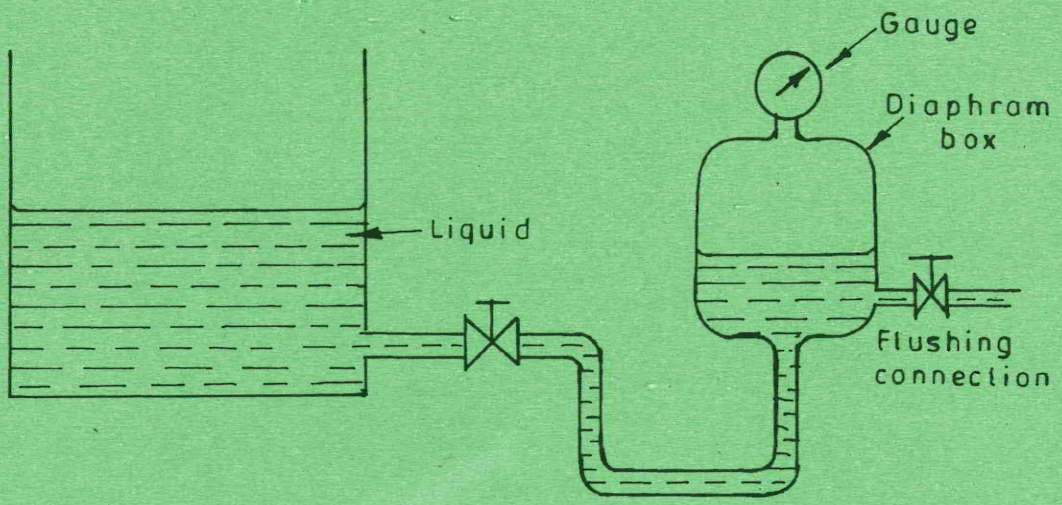

Fig. 1

(ii) List **four** consideration to be observed when using a diaphragm box for level measurements. (8 marks)

(d) With the aid of a labelled diagram, explain the operation of a chain-float level measurement. (6 marks)

3. (a) State **three** causes of errors when using fluid filled thermometers in temperature measurements. (3 marks)

(b) (i) With the aid of a labelled diagram, explain the working principle of a disappearing filament pyrometer.

(ii) The lens of an optical pyrometer has a transmission factor of 0.8. The instrument indicates a temperature of 1480 °C. Determine the actual value of temperature.

(iii) State **two** merits of thermistors when used in temperature measurement. (11 marks)

(c) List **three** factors that affect the accuracy of a manometer. (3 marks)

(d) A glass vessel is filled with 200 cm^3 of water at 10 °C and heated to 60 °C. If the coefficient of expansion of water is 0.0003/°C, determine the new volume of water at this temperature. (3 marks)

4. (a) State **three** applications of pneumatic relays. (3 marks)

(b) With the aid of a diagram, describe the operation of a motion balance differential pressure transmitter. (8 marks)

(c) (i) State **three** advantages of venturi over nozzle flow meters.

(ii) A horizontal venturi meter measures flow of oil of specific gravity 0.9 in a 75 mm diameter pipe. If the differential pressure between the throat and the pipe is 34.5 kN/m^2 and the area ratio; M is 4, determine the flow rate when discharge coefficient Cd is 0.97. (9 marks)

5. (a) State **three** types of layers. (3 marks)

(b) (i) With aid of a diagram, explain the working principle of X-ray fluorescence spectrometry.

(ii) An X-ray tube is operated at 50 KV. Assuming that the speed of light is 3×10^8 m/s, determine the short wave length cut off of the system. (10 marks)

(c) (i) A photocell has a dark resistance of 100 KΩ and a resistance of 30 KΩ in a day light beam. It has a time constant of 72 ms. Determine the resistance of the cell after 10 ms of application of the beam.

(ii) With the aid of a labelled diagram, explain the operation of a photoemissive cell. (7 marks)

6. (a) (i) State **three** advantages of using a stroboscope over tacho-generator in speed measurements.

(ii) A disc mounted on the shaft of a machine has 12 pattern points. The number of flashes projected by a stroboscope in a minute is 6,000. Determine the:

(I) speed of machine if the disc appears stationery and has single image of 12 points.

(II) speed of the disc when the disc appears to move forward at 10 rpm.

(7 marks)

(b) With the aid of a diagram, describe the operation of a toothed rotor variable reluctance tachometer. (7 marks)

(c) An accelerometer has a seismic mass of 0.05 kg and a spring constant of 3×10^3 N/m. Maximum mass displacement is ± 0.02 m. Determine the:

(i) natural frequency;

(ii) maximum acceleration;

(iii) frequency in hertz.

(6 marks)

7. (a) (i) State the operational difference between positive displacement and inference flowmeters.

(ii) With the aid of a diagram, explain the operation of deflecting plane flow meter.

(9 marks)

(b) State **three** parameters to be considered when selecting flowmeters. (3 marks)

(c) A float of diameter 1 cm and height 1 cm is used in a rotameter which is tapered at 5 °C from the bottom inlet. For a flow rate of 25 cm^3/sec, the bob reaches a height of 2.5 cm from the reference level. The flat density is 4 times fluid density. Determine the:

(i) metering ratio;

(ii) volume of float;

(iii) discharge coefficient, Cd;

(iv) coefficient of flow for water.

(8 marks)

8. (a) Define the following with respect to viscosity measurements:

(i) fluidity;

(ii) relative viscosity.

(2 marks)

(b) (i) Distinguish between Newtonian and non Newtonian fluids.

(ii) With the aid of a labelled diagram, explain the operation of a falling ball viscometer.

(10 marks)

(c) A load cell consists of a solid cylinder of steel, 40 mm in diameter. Four strain gauges of 100 Ω each are bonded on it to form a voltage sensitive bridge. The poison's ratio is 0.29, gauge factor 2.1 and modulus of elasticity is 200 GN/m^2. The bridge is supplied with 6 V. Determine the:

(i) stress;

(ii) strain;

(iii) per unit change in resistance due to strain;

(iv) change in output voltage.

(8 marks)

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