2507/205
MEASUREMENT TECHNOLOGY
June/July 2017
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;*
*Scientific calculator.*
*Answer any **FIVE** of the **EIGHT** questions in the answer booklet provided.*
*Maximum marks for each part of a question are as shown.*
***Candidates should answer the questions in English.***
***Take speed of light*** $= 3 \times 10^8$ m/s.

**This paper consists of 4 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 as used in measurement systems:

(i) reproducibility;

(ii) sensitivity. (2 marks)

(b) (i) State **three** causes of instrumental errors.

(ii) A voltmeter having a sensitivity of 1100 Ω/V reads 100 V on its 150 scale when connected across an unknown resistor in series with a milli-ammeter. If the milli-ammeter reads 5 mA, determine the:

(I) apparent resistance of unknown resistor;
(II) actual resistance of unknown resistor;
(III) error due to loading effect of the voltmeter. (11 marks)

(c) With the aid of a circuit diagram, explain angular speed measurement using a D.C. tachometer. (7 marks)

2. (a) (i) State **two** advantages of LVDT accelerometer over potentiometric accelerometer.

(ii) With the aid of a diagram, explain the operation of the LVDT accelerometer.

(iii) An LVDT accelerometer for seismic mass displacement measurement has a signal conditioning output of 0.31 mV/mm, a ±20 mm core displacement and a spring constant of 0.05 Kg. Determine the:

(I) natural frequency;
(II) maximum measurable acceleration;
(III) sensitivity of the accelerometer. (15 marks)

(b) With the aid of a labelled diagram, explain the operation of a bourdon tube pressure gauge. (5 marks)

3. (a) (i) With a labelled diagram, describe how a float is used to measure level in a tank.

(ii) With the aid of a diagram, describe how a dipstick is used to measure liquid level in a tank.

(iii) State **three** areas of application of the method in a (ii). (14 marks)

(b) With the aid of a labelled diagram, describe ultrasonic method of liquid level measurement. (6 marks)

4. (a) (i) With the aid of a labelled diagram, explain the operating principle of a bimetallic strip temperature sensor.

(ii) The emitted radiant energy from a piece of metal is measured and the temperature is 1065° C assuming a surface emissivity of 0.82. If the true emissivity is 0.75, determine the error in temperature measurement.

(11 marks)

(b) (i) State **two** requirements of conductor materials used in resistance temperature detectors (RTD).

(ii) A thermistor has a resistance of 4250 Ω at ice point and 940 Ω at 50° C. The resistance temperature relationship is given by: $R_T = a R_o \exp \frac{b}{T}$. Determine the:

(I) constants a and b;
(II) range of resistance for a temperature range of 40° to 100°.

(9 marks)

5. (a) (i) Distinguish between positive displacement and inferential flow meters.

(ii) With the aid of a circuit diagram, explain the principle of operation of a hot wire anemometer.

(9 marks)

(b) Figure 1 shows a diagram of a venturimeter with a contraction ranging from 10 mm diameter at A to 7 mm diameter at B. If the pipe is horizontal and the velocity of water is 4.5 m/s, determine the:

(i) velocity at B, $V_2$;

(ii) pressure drop difference $P_1 - P_2$.

(7 marks)

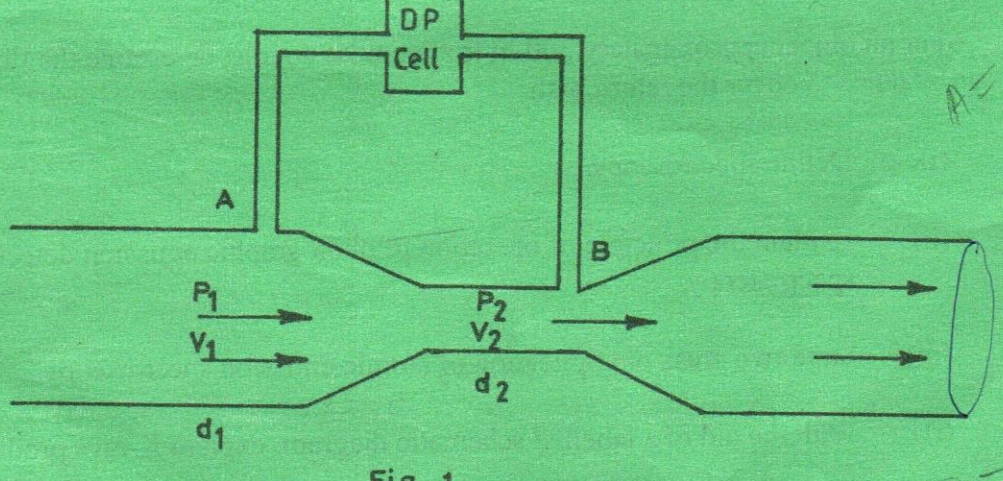


Fig. 1

(c) A conveyor belt moves coal at 100 m/min across a weighing platform 6 m in length. For a 120 Kg of coal on the platform, determine the coal delivery in Kg/hour. (4 marks)

6. (a) (i) State the **three** measurable quantities in a vibrating system.

(ii) With the aid of a diagram, explain the operation of a potentiometric accelerometer.

(iii) A seismic mass instrument having a mass of 6 Kg, a natural frequency of 4 Hz and a damping ratio of 0.66 is excited by a frequency of 6 Hz. Determine the:

(I) spring constant, K;
(II) error due to the proximity of the excited frequency. (14 marks)

(b) Draw a labelled diagram of a pneumatic relay and describe its operation. (6 marks)

7. (a) (i) Explain the principle of operation of a photoconductive detector.

(ii) A photovoltaic cell produces an open circuit voltage of 0.33 V when illuminated by 10 w/m$^2$ radiation intensity. A current of 2.2 mA is delivered into a 100 Ω load at that intensity. Determine the:

(I) internal resistance of the cell;
(II) open circuit voltage at 25 w/m$^2$. (9 marks)

(b) With the aid of a diagram, explain each of the following fibre optic cables:

(i) multimode step index;

(ii) multimode graded index. (8 marks)

(c) For an object approximately 300 m from a pulse source, determine the time taken by pulse to cover the return path. (3 marks)

8. (a) (i) Define spectroscopy.

(ii) Explain the principle of operation of photographic emission detector in spectroscopy.

(iii) State **two** areas of application of atomic emission spectroscopy. (8 marks)

(b) (i) With the aid of a labelled schematic diagram, explain X-rays production.

(ii) State **three** types of X-ray detectors. (12 marks)

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