2507/205
MEASUREMENT TECHNOLOGY
June/July 2018
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;
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 shown.
Candidates should answer the questions in English.

Take: *speed of light* $C = 3 \times 10^8 \text{m/s}$
Planks Constant $h = 6.62 \times 10^{-34} J/s$
Electron charge $e = 1.6 \times 10^{-19} C$

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) (i) The regular periodic motion of a vibrating body is represented by

$$x(t) = x_0 \sin \omega t$$

Derive the expression for the:

(I) velocity;
(II) acceleration.

(ii) A water pipe vibrates at a frequency of 10 Hz with a displacement of 0.5 cm. Determine the peak acceleration in m/s^2. (6 marks)

(b) Explain the following types of electron emission:

(i) spontaneous emission;
(ii) stimulated emission.

(6 marks)

(c) (i) With the aid of a labelled diagram, explain the operation of a semi conductor photon detector.

(ii) Germinium has a band gap of $0.67_e V$. Determine the maximum wavelength for the photon needed to move an electron to the conduction band. (8 marks)

2. (a) Distinguish between lower critical velocity and upper critical velocity with reference to turbulent flow. (2 marks)

(b) (i) With the aid of a diagram, explain the principle of operation of a rectangular slit viscometer.

(ii) An oil of specific gravity 0.88 is made to flow from one tank to the other through a capillary tube of 40 mm diameter, 1.2 m long with a velocity of 0.2 m/S. Determine the head loss due to viscosity of oil if the viscosity of the oil is 0.15 poise.

(10 marks)

(c) (i) Figure 1 shows a capacitive pressure transducer. Describe its operation.

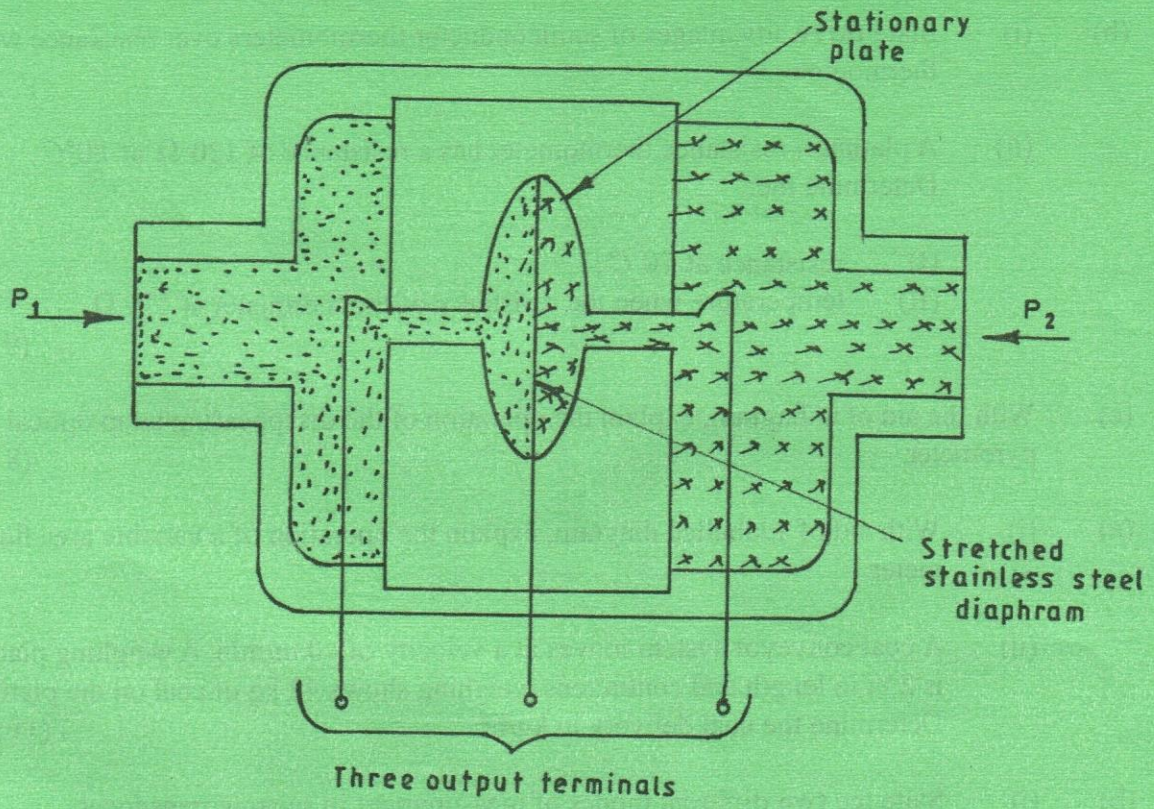

Fig. 1

(ii) State **two** drawbacks of capacitive transducers when used in pressure measurements.

(8 marks)

3. (a) (i) With a labelled diagram, explain the operation of a pneumatic differential pressure transducer.

(6 marks)

(ii) State **two** applications of pneumatic differential transmitters. (2 marks)

(b) A simple manometer containing mercury is used to measure the pressure of water flowing in a pipeline. The mercury level in the open tube is 60 mm higher than that of the closed tube. The height of water in the closed tube is 50 mm.

(i) draw the diagram of the manometer;

(ii) determine the pressure in the pipe in terms of head of water. Take relative density of mercury as 13.6.

(8 marks)

(c) Draw a labelled diagram of a hydraulic load cell. (4 marks)

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

(b) (i) State **three** advantages of semiconductor thermometers over resistance wire thermometers.

(ii) A platinum resistance thermometer has a resistance of 120 Ω at $30°C$. Determine the:

(I) resistance at $70°C$;
(II) temperature when the resistance of the thermistor is 170 Ω.

(9 marks)

(c) With the aid of a diagram, explain the operation of the disappearing lamp optical pyrometer. (8 marks)

5. (a) (i) With aid of a labelled diagram, explain the operation of a variable area flow meter.

(ii) A coal conveyor system moves at a velocity of 40 m/min. A weighing platform is 2 m in length and continuous weighing shows 42 kg of coal on the platform. Determine the coal delivery in kg/hr. (11 marks)

(b) (i) State the **two** different modes of measurement in seismic transducers.

(ii) A seismic instrument has a natural frequency of 6 Hz and a damping ratio of 0.7. If the system is excited by a frequency of 9 Hz, determine the error due to the proximity of excitation frequency with the natural frequency of the instrument. (9 marks)

6. (a) (i) State **two** requirements of radiation sources in absorption spectroscopy.

(ii) Draw a labelled diagram of the interference filter in absorption spectroscopy showing the path of light rays.

(5 marks)

(b) With the aid of schematic diagram of a flame emission spectrophotometer, explain how the flame emission spectrometry works. (7 marks)

(c) (i) An X-ray tube is operated at 50 kV. Determine the cut off wavelength of the emitted radiation.

(ii) Figure 2 shows the arrangement of non-dispersive X-ray absorptiometer. Explain its operation.

(8 marks)

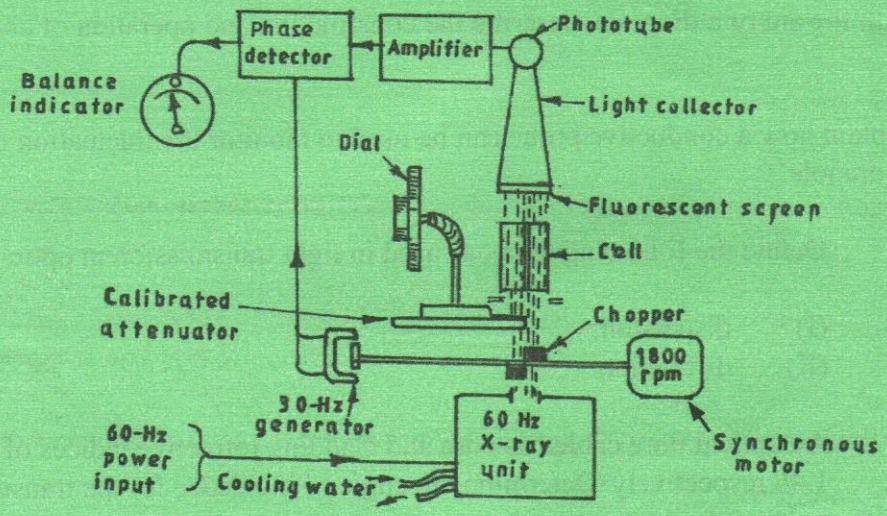

Fig. 2

7. (a) Define the following terms as used in measurements:

(i) measuring lag;
(ii) resolution;
(iii) dynamic error.

(3 marks)

(b) (i) State **three** types of errors in measurement systems.

(ii) The value of unknown resistor is determined by voltmeter-ammeter method. The voltmeter reads 110 V with a probable error of ±14 V and ammeter reads 12 A with a probable error of ± 3A. Determine the probable error in the computed value of unknown resistor.

(12 marks)

(c) With aid of a labelled diagram, describe the operation of a photoelectric tachometer.

(5 marks)

8. (a) Define the following in relation to pressure:

(i) international standard atmospheric (ISA);

(ii) vacuum pressure.

(2 marks)

(b) With the aid of a diagram, describe the construction and operation of aneroid barometer. (7 marks)

(c) Explain how a conductive probe can be used to monitor the fluctuation of water level in a borehole. (6 marks)

(d) (i) Define the following terms as used in light transmission in optic fibre cables:

(I) dispersion;
(II) diffraction.

(ii) An optical fibre cable has core and cladding refractive indices of 1.5 and 1.46 respectively. Determine the angle of incidence for the transmitted light. (5 marks)

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