

2507/205  
MEASUREMENTS TECHNOLOGY  
Oct./Nov. 2022  
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;*

*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.**

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1. (a) (i) State the **three** causes of instrument errors in measurements.
- (ii) The sensitivity of a voltmeter is  $20 \text{ k}\Omega/\text{V}$ . The voltmeter reads 200 V on its 1000 V scale when connected across an unknown resistor in series with a milli-ammeter. When the milli-ammeter reads 5 mA, determine the:
- (I) apparent resistance of the unknown resistor;
- (II) actual resistance of the unknown resistor;
- (III) percentage error in the measurement. (10 marks)
- (b) (i) State the functions of any three parts of an optical link.
- (ii) Describe **two** types of optic fibre sensors. (10 marks)
- 58 2. (a) (i) State **two** advantages of photoelectric over electromagnetic tachometer.
- (ii) With the aid of a labelled diagram, explain the operation of a photo electric tachometer. (11 marks)
- (b) (i) Draw a three-bit shaft encoder using straight binary.
- (ii) Draw the truth table for the encoder in (b) (i) above. (9 marks)
3. (a) Define the following terms as used in pressure measurements:
- (i) gauge pressure;
- (ii) atmospheric pressure. (2 marks)



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- (b) Figure 1 shows a schematic diagram of a cistern manometer. Derive the expression for the differential pressure. (6 marks)

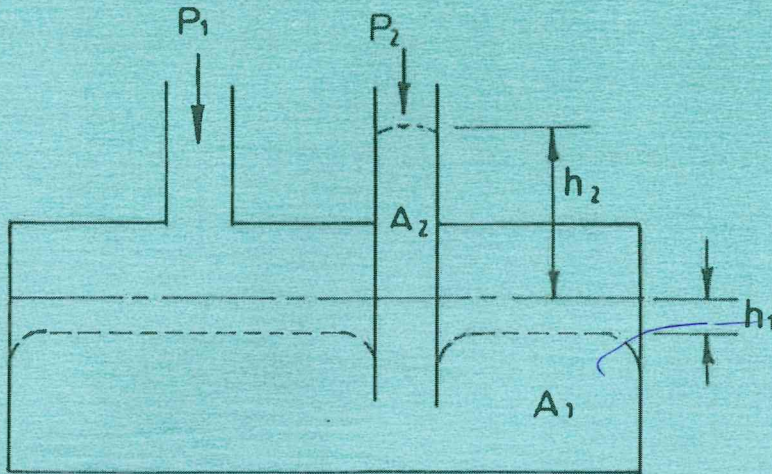


Fig.1

- (c) Draw a diagram of a U-tube manometer and explain how the reading is done on the manometer. (6 marks)
- (d) (i) State three factors that affect the accuracy of manometers.
- (ii) Figure 2 shows a pressure calibrating equipment. Explain how calibration is done on pressure gauge. (6 marks)

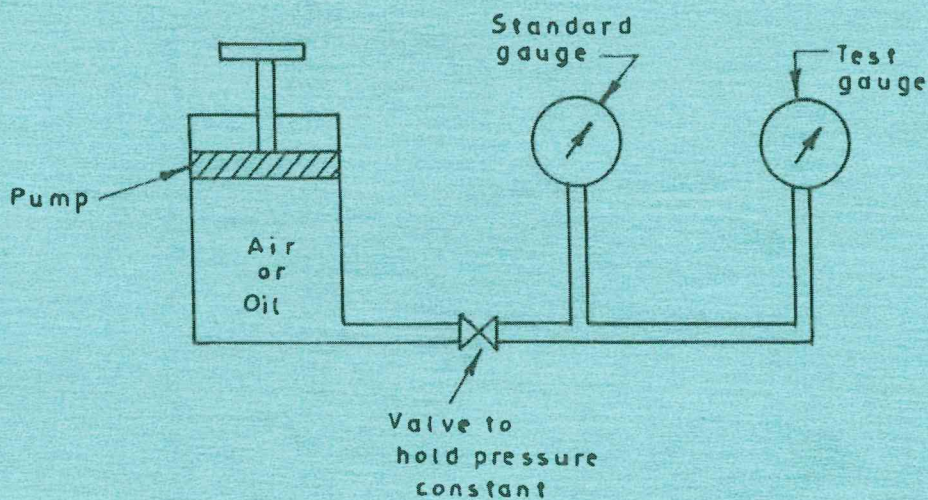


Fig.2

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4. (a) (i) State **three** requirements observed when using pressure gauge for level measurements.
- (ii) A liquid level is to be determined using pressure method. The height is 3.5 m and specific gravity is 2. Taking gravitational force as 9.81 N/Kg, determine the pressure generated by the liquid column. (5 marks)
- (b) With the aid of a diagram, explain the operation of a pressure gauge level indicator. (7 marks)
- (c) (i) State **two** principles of level measurement using capacitive methods.
- (ii) Draw a tank diagram using sight glass as level indicator.
- (iii) When using capacitive method for level measurement, the metal rod has a diameter of 10 mm and the insulation diameter is 15 mm. The capacitance is  $0.5 \mu F$  and the permittivity of insulation is 0.6. Determine the height of the liquid in metres. (8 marks)
5. (a) State **three** electrical principles on which temperature measurements are based. (3 marks)
- (b) A platinum thermometer has a resistance of  $150 \Omega$  at  $30^\circ C$ . Taking the temperature coefficient of resistance as  $0.00392/^\circ C$ , determine the:
- (i) resistance at  $70^\circ C$ ;
- (ii) temperature, if the thermometer has a resistance of  $200 \Omega$ . (5 marks)
- (c) Draw a labelled diagram of a spiral type bimetallic strip thermometer and describe its operation. (6 marks)
- (d) A bimetallic thermometer is made up of strips of nickel chromium alloy and invar bonded together at  $25^\circ C$ . Each strip has a thickness of 1 mm and a length of 50 mm. For nickel chromium alloy and invar, the modulus of elasticity are  $216 \text{ G N/m}^2$ ,  $147 \text{ GN/m}^2$  and coefficient of expansion are  $12.5 \times 10^{-6}/^\circ C$ ,  $1.7 \times 10^{-6}/^\circ C$  respectively. Determine the radius of curvature when the strip is subjected to a temperature of  $200^\circ C$ . (6 marks)

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6. (a) (i) State **three** desirable features of air used in pneumatic systems.
- (ii) With the aid of a labelled diagram, describe the operation of a pneumatic relay. (10 marks)
- (b) (i) State **two** factors to be considered when selecting an instrumentation circuit for measurement of strain.
- (ii) A load cell consists of a solid cylinder of steel 40 mm in diameter with four strain gauges bonded and connected to four arms of a voltage sensitive bridge. The bridge is supplied by 6 V source and a load of 1 kN is applied to the load cell. Taking the gauge resistance as  $100\ \Omega$ , poisson's ratio as 0.29, modulus of elasticity of steel as  $200\ \text{GN/m}^2$  and gauge factor as 2.1. Determine the:
- (I) stress;
- (II) strain;
- (III) per unit change in resistance;
- (IV) output voltage. (10 marks)
7. (a) (i) Draw a diagram of a pitot tube for measuring flow of liquid.
- (ii) Explain how flow is measured with the tube in (a) (i) above. (9 marks)
- (b) (i) State **two** components of energy experienced by a liquid in motion.
- (ii) A venturi tube of throat diameter of 60 mm is placed in a water pipe of diameter 100 mm to measure the volumetric flow. The venturi flow rate through the tube is  $0.08\ \text{m}^3/\text{s}$ , the liquid density is  $10\ \text{kg/m}^3$  and a viscosity of  $10^{-3}\ \text{N s/m}^2$ . Determine the:
- (I) Reynold's number for these conditions;
- (II) upstream- to - throat differential pressure when discharge coefficient is 0.99 and expansion factor  $B = 1$ . (11 marks)



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8. (a) State **three** applications of spectral measurements in atomic emission spectroscopy. (3 marks)
- (b) (i) State **three** properties of ultrasonic waves.  
(ii) Draw a labelled block diagram of an ultrasonic link. (8 marks)
- (c) With aid of a diagram, explain the operation of a photomultiplier tube. (9 marks)

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