higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

(8080194)

23 July 2021 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS N4
TIME: 3 HOURS
MARKS: 100

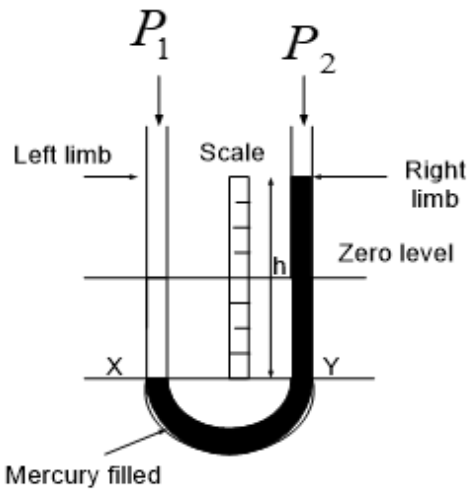
INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Start each question on a new page.
5. Only use a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1: ELECTRICAL AND NON-ELECTRICAL PRESSURE MEASUREMENT

1.1 Study the FIGURE below and prove that the pressure difference is given by: $\Delta P = P_1 - P_2 = \rho g h$



(3)

FIGURE

1.2 The difference between the sealing liquid levels in a mercury-filled equal-legged U-tube manometer is 30 cm.

Calculate the appropriate pressure difference. (2)

1.3 Calculate the distance on the scale of an inclined tube manometer filled with water. The applied differential pressure is 0, 15 kPa. The range tube is inclined at an angle of 45° with the horizontal. The area of the cistern is 100 mm² and that of the range tube is 10 mm². (4)

1.4 The conductor material used in a strain gauge must comply with certain conditions.

Name FOUR such conditions. (4)

1.5 Make a neat sketch to illustrate the construction of a nonbonded type of strain gauge. (5)

1.6 Name THREE factors on which the capacitance of a capacitor depends. (3)

1.7 Explain the working principle of the variable capacitance transducer. (4)

[25]

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QUESTION 2: ELECTRICAL AND NONELECTRICAL TEMPERATURE MEASUREMENT

2.1 A resistance thermometer is an instrument which measures resistance but is calibrated in temperature units.

2.1.1 A platinum coil has a resistance of 38 Ω at 0 °C.

$\alpha = 3{,}92 \times 10^{-3}$ and $\beta = -5{,}88 \times 10^{-7}$.

Calculate the resistance at 500 °C.

2.1.2 The resistance of thermo-ohm is 150 Ω at 25 °C.

$\alpha = 0{,}00392/°C$.

Calculate the resistance at 0 °C.

(2 × 3) (6)

2.2 A potentiometer circuit is used for temperature measurement. All resistors, except one, were manufactured from material whose resistance changes very little with temperature change.

2.2.1 Name this resistor and explain why it must be changed. (4)

2.2.2 Another component in the circuit supplies a constant voltage.

Explain why this constant voltage is required. (3)

2.3 Draw the performance curve of temperature to resistance for a thermistor with a negative temperature coefficient. (2)

2.4 State TWO applications of a thermistor. (2)

2.5 State Stefan Boltzmann's law. (4)

2.6 Distinguish between *optical pyrometers* and *total radiation pyrometers* by referring to the different wavelengths on which each one is used (numbers are not necessary). (4)

[25]

QUESTION 3: AUTOMATIC CONTROL AND TELEMETERING

3.1 Draw sketches to illustrate the response of the following control actions when a process variable deviates from a set point:

- Proportional action
- Proportional plus integral action
- Proportional plus integral plus derivative action (6)

3.2 The measuring unit is one of the units of an automatic control system.

Fully explain the function of this unit. (5)

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3.3 Make a neat, labelled sketch of a flapper nozzle system and fully explain its operation. (8)

3.4 State the functions of each of the following components of a pneumatic telemetering system:

3.4.1 The feedback element

3.4.2 The relay

(2 × 3) (6)
[25]

QUESTION 4: FLOW AND LEVEL MEASUREMENT

4.1 Name and explain the THREE energies present in a liquid flow line. (3 × 2) (6)

4.2 Write down an expression to define *square law effect*.

Clearly explain the symbols in the expression. (4)

4.3 Name FOUR installation requirements which must be met by an orifice plate. (4)

4.4 Make a neat, labelled sketch of a torque tube displacer level detector. (5)

4.5 The back pressure of a purge level system is 37 kPa and the liquid density is 800 kg/m^3.

Calculate the depth of the purge point of the tube below the surface of the liquid. (3)

4.6 Name any THREE examples of electrical level measuring instruments. (3)
[25]

TOTAL: 100

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FORMULA SHEET

INDUSTRIAL INSTRUMENTS N4

(1) $\Delta P = \rho gh$

(2) $\Delta P = \rho gh\left[\frac{A_2}{A_1} + 1\right]$

(3) $\Delta P = \rho gL\left[\sin\theta + \frac{A_2}{A_1}\right]$

(4) $P_1 - P_2 = \frac{r_2 Mg\sin\theta}{Ar_1}$

(5) $P_1 - P_2 = \frac{Mgr\sin\theta}{AL}$

(6) $F = ma$

(7) $P = \frac{F}{A}$

(8) $A = \frac{\pi d^2}{4}$

(9) $°F = \frac{9}{5}°C + 32$

(10) $R_T = R_0(1+\propto T)$

(11) $R_T = R_0(1+\propto T + \beta T^2)$

(12) $Q = k\sqrt{h}$

(13) $H_L = \left[\frac{\rho_m}{\rho_L}\right] \times h - \frac{h}{2}$

(14) $H_L = \left[\frac{\rho_m}{\rho_L}\right] \times h - H_1 - \frac{h}{2}$

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