higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

(8080194)

1 April 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators and drawing instruments may be used.

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

009Q1A2101

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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 section on a new page.
5. Sketches must be large, neat, fully labelled and may be done in pencil.
6. Use only a blue or black pen.
7. Write neatly and legibly.

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SECTION A

QUESTION 1

Complete the sentences by choosing an option from the list below. Write the answer next to the question number (1.1–1.5) in the ANSWER BOOK.

gauge; Kirchhoff's law; area; displacement; current; applied voltage; measured variable; inlet cone; distance; less than; electrical signal; pressure; dielectric; potential drops; the same as; velocity

1.1 The differential transformer is commonly used for (1.1.1) … measurements, which is directly proportional to the (1.1.2) … and is converted to a/an (1.1.3) … (3)

1.2 The Venturi tube consists of three parts, namely the (1.2.1) …, which reduces the area of the pipe, increasing the (1.2.2) … of the flow and decreasing the (1.2.3) … (3)

1.3 The capacitance of a capacitor is proportional to the (1.3.1) … of the smallest of the two plates and is inversely proportional to the (1.3.2) … or the (1.3.3) ... thickness between the two conductive plates. (3)

1.4 The principle of the potentiometer is based on (1.4.1) … which states that if a/an (1.4.2) … is flowing in a circuit, the sum of all the (1.4.3) … in the circuit are equal to the (1.4.4) ... (4)

1.5 (1.5.1) … pressure is measured with the atmospheric pressure as reference and is always (1.5.2) … the atmospheric pressure. (2)

[15]

QUESTION 2

Give ONE term for each of the descriptions by writing it next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 Transmission of measurements over long distances by electronic means for recording purposes

2.2 It consists of a continuous fine wire, wound between two sets of insulating pegs or frames, one stationary and the other free to move

2.3 It is defined as the action of a controller where the magnitude (size) of the output signal is equal to the (size) of the measured deviation.

2.4 The mass of a unit volume of a substance

2.5 The point after an orifice plate where the flow rate is at its maximum and the pressure at its minimum

(5 × 1) **[5]**

TOTAL SECTION A: 20

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SECTION B

QUESTION 3: ELECTRICAL AND NON-ELECTRICAL PRESSURE MEASUREMENT

3.1 The inclined-tube manometer is used to measure low pressure differences accurately.

Make a neat, labelled sketch of the inclined-tube manometer. (6)

3.2 Explain the difference between dry calibration and wet calibration. (2 × 2) (4)

3.3 Make a neat, labelled sketch to illustrate the construction of a bonded grid-type strain gauge. (5)

3.4 A load cell uses a strain gauge with a nominal resistance of 200 Ω and a sensitivity factor of 1,9. The load cell is subjected to a mass which results in a stress of 25 MPa. The modulus of deformation of the load cell is 90 GPa.

Calculate the change in resistance of the strain gauge. (5)
[20]

QUESTION 4: ELECTRICAL AND NON-ELECTRICAL TEMPERATURE MEASUREMENT

4.1 Explain the difference between the Celsius scale and the Kelvin scale of temperature measurement. (4)

4.2 Make a neat, labelled sketch of the self-balancing circuit of a resistance thermometer. (6)

4.3 Explain the term *radiation pyrometry*. (4)

4.4 Make a neat, labelled sketch of a disappearing-filament pyrometer. (6)
[20]

QUESTION 5: AUTOMATIC CONTROL AND TELEMETERING

5.1 Explain the terms used in automatic control:

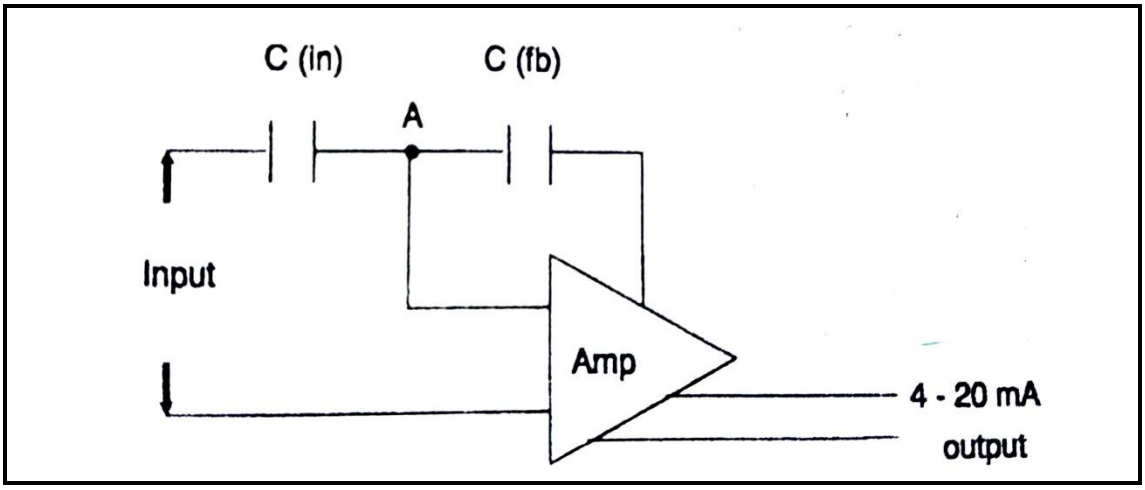
5.1.1 On-off control (3)

5.1.2 The proportional band of an automatic controller (2)

5.1.3 Valve positioner (2)

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5.2



5.2.1 Name the type of controller that is shown in the diagram. (1)

5.2.2 State TWO purposes of the two outputs from the amplifier. (2)

5.2.3 Explain the condition of this circuit with no input signal. (3)

5.3 Name THREE main parts that a telemetering system consists of. (3)

5.4 Make a neat, labelled sketch that shows how feedback bellows may be used to introduce proportional control in a simple flapper and nozzle system. (4)
[20]

QUESTION 6: FLOW AND LEVEL MEASUREMENT

6.1 Make a neat, labelled sketch to show the position of various pressure tappings relative to an orifice. (5)

6.2 Make a neat, labelled sketch of a reciprocating piston-type flowmeter. (5)

6.3 Make a neat, labelled sketch of a single stand pipe purge system used for measuring the level in an open tank. (6)

6.4 A single stand pipe gas purge system is used to measure the level of water in an open tank. The back pressure of a gas purge pressure gauge is 50 KPa when air is purged through the water.

Calculate the level in the tank if the open end of the tube is 5 cm above the bottom of the tank. (4)
[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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FORMULA SHEET

(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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