higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N3

(11040463)

25 August 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.

140Q1G2102

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
INSTRUMENT TRADE THEORY N3
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.

QUESTION 1

1.1 Name the TWO types of magnetic transducers. (2)

1.2 Explain the operating principle of each of the magnetic transducer types named in QUESTION 1.1. (2 + 2) (4)

1.3 Make a neat, labelled sketch to show how bonded strain gauges are cemented to measure low differential pressure and explain how the pressure is measured. (6)

1.4

1.4.1 Which type of a strain gauge is shown in the figure? (1)

1.4.2 Explain the difference between the strain gauge shown in the figure and a normal grid-type gauge. (2)

1.4.3 Give FIVE advantages of the strain gauge shown in the figure. (5)

1.5 Explain the operating principle of a strain gauge transducer and give its formula. (5)
[25]

QUESTION 2

2.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

2.1.1 Thermistors are cheap, can respond quickly and are accurate.

2.1.2 Pyrometers mostly use the infrared part of the spectrum to measure temperature.

2.1.3 A thermopile is a type of sensor used in a pyrometer.

2.1.4 A disappearing filament pyrometer is an example of an optical pyrometer.

2.1.5 Pyrometers are used for extremely low temperatures.

(5 × 1) (5)

2.2 2.2.1 Name THREE contact type, temperature sensors. (3)

2.2.2 A thermistor has a characteristic temperature of 3 000 K.

If the thermistor has a resistance of 100 kΩ at 300 K, what will the resistance at 900 K be? (4)

2.3 A resistance thermometer is connected to a Wheatstone bridge. Four-wire compensation is used. Each lead of the thermometer has a resistance of 4 Ω. The circuit consist of three resistances of 15 Ω each and a 3 V battery.

2.3.1 Sketch the circuit. (5)

2.3.2 Determine the total resistance of the branch of which the resistance stays constant. (3)

2.3.3 Prove that this circuit will compensate at any ambient temperature. (5)

[25]

QUESTION 3

3.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–G) next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1.1	Mechanism that measures the value of a process variable and operates to limit the deviation of that variable from a desired value	A	pneumatic relay
3.1.2	Duct of changing cross section, usually converging shaped, in which fluid velocity is increased	B	magslip systems
3.1.3	Electronic telemetering system consisting of two H-shaped iron cores with rotors excited from a common AC supply and stator windings interconnected phase for phase	C	position-balance pneumatic transmitter
3.1.4	Increasing the power or energy gain to operate the feedback bellows and the receiver of a flapper and nozzle system	D	force-balance pneumatic transmitter
3.1.5	Operating principle based on balancing an unknown force represented by the input by a known force	E	feedback bellows
		F	nozzle
		G	automatic controller

(5 × 1) (5)

3.2 3.2.1 What is *telemetry*? (2)

3.2.2 Give TWO applications of frequency telemetering. (2)

3.2.3 Make a neat, labelled sketch of a frequency telemetering system. (8)

3.2.4 Give FIVE advantages of an electrical telemetering system. (5)

3.2.5 List THREE factors that can affect the operation of an electrical telemetering system. (3)

[25]

QUESTION 4

4.1	Define each of the following terms:			
	4.1.1	Open-loop control		
	4.1.2	Closed-loop control		
	4.1.3	Offset		
	4.1.4	Valve plug		
	4.1.5	Deviation	(5 × 1)	(5)
4.2	4.2.1	What is the purpose of a positioner?		(3)
	4.2.2	What is meant by the term *air-to-open*?		(2)
	4.2.3	Give FIVE advantages of positioners.		(5)
	4.2.4	Draw a cam-equipped force-balance positioner.		(10)
				[25]
			TOTAL:	**100**

INSTRUMENT TRADE THEORY N3

FORMULA SHEET

1. $R_s = \frac{V_{sc}}{I_s}$

2. $R_z = \frac{V_{min}}{I_s} + R_{cj}$

3. $R_{sh} = \frac{R_{sw} \times R_t}{R_{sw} - R_t}$

4. $R_t = \frac{V_{max} - V_{min}}{I_s}$

5. $R_u = \frac{V_{sc} - V_{max}}{I_s}$

6. $I_s = \frac{1}{sensitivity}$

7. $R_{cj} = R_0 + \Delta R$

8. $\Delta R = \propto R_0 T$

9. $\Delta R = \frac{\Delta V}{I_s}$

10. $R_T = R_0[1 + \alpha T]$

11. $R_T = Ae^{\frac{B}{T}}$

12. $\mathrm{t}[^0\mathrm{C}] = \mathrm{T(K)} - 273{,}15$

13. $°\mathrm{F} = \frac{9}{5}°\mathrm{C} + 32$