higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T810**(E)**(M28)T

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

(8080194)

28 March 2019 (X-Paper)
09:00–12:00

Calculators may be used.
Candidates will require drawing instruments.

This question paper consists of 7 pages and 1 formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 A … is used to accurately position the flapper pneumatic telemetering system.

A relay valve
B feedback bellows
C positioner
D Bourdon tube

1.1.2 The theory of the application of control in the regulation of a process without direct human intervention is referred to as … control.

A manual
B cascade
C automatic
D fuzzy

1.1.3 A … flowmeter is NOT an example of an inferential flowmeter.

A turbine
B vortex
C nutating disc
D deflecting type

1.1.4 A group of thermocouples connected in series is called a …

A thermopile.
B pyrometer.
C thermostat.
D thermistor.

1.1.5 A … is used in a flapper nozzle system to control the output air effectively when sudden changes occur from the primary element.

A relay valve
B valve plug
C valve positioner
D control valve

(5 × 1) (5)

1.2 Choose a/an item/word from COLUMN B that matches a description in COLUMN A. Write only the letter (A–O) next to the question number (1.2.1–1.2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	The action of a controller where the output is proportional to the rate at which the measured deviation changes	A	Bourdon tube
1.2.2	A device for measuring voltage which is unknown, by comparing it against a known voltage	B	black body condition
1.2.3	The point where the velocity of the flow reaches a maximum value and the pressure is at its lowest after passing through a restriction	C	positioner
1.2.4	Error in indication over the full range of the instrument	D	viscosity
1.2.5	A body that absorbs all the radiation falling upon it and thus radiates energy at all wavelengths of the spectrum at the maximum rate	E	zero error
1.2.6	An opposition to the generation of magnetic fields	F	thermocouple
1.2.7	When two dissimilar metal wires are joined together at one end, a voltage is produced at the other end proportional to the temperature difference between the junctions	G	reluctance
1.2.8	A device which is installed between the controller and the valve actuator	H	vena contracta
1.2.9	The resistance of a liquid to flow	I	magnetic flowmeter
1.2.10	The flowmeter which uses Faradays' law	J	turbine flowmeter
		K	potentiometer
		L	derivative action
		M	turbine flowmeter
		N	Seebeck effect
		O	range error

(10 × 1) (10)

1.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.3.1–1.3.5) in the ANSWER BOOK.

1.3.1 Piezo-electric pressure transducers are affected by temperature variations.

1.3.2 In a flapper and nozzle system, the feedback bellows is used for the accurate positioning of the flapper.

1.3.3 Offset comes about when only proportional action is used to control a process.

1.3.4 Derivative action is used to increase the recovery time of the process control.

1.3.5 Integral action is used to eliminate offset.

(5 × 1) (5)
[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2: PRESSURE MEASUREMENT

2.1 Name FOUR types of calibration faults or errors in Bourdon tube devices. (4)

2.2 An inclined tube manometer is used to measure the difference between two air pressures.

Calculate the applied differential pressure if the following is known:

- Angle of the tube to horizontal = 50^{o}
- Area of the cistern = 2×10^{-2} m²
- Area of the tube = 8×10^{-5} m²
- Scale reading = 20 cm (5)

2.3 Explain the term *gauge factor* as applicable to strain gauges and give a formula to enhance your explanation. (4)

2.4 Make a neat, labelled sketch of a variable capacitance transducer. (4)

2.5 Explain what is meant by the term *bonded strain gauge*. (3)
[20]

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QUESTION 3: TEMPERATURE MEASUREMENT

3.1 Distinguish between the following measuring methods as applicable to the Wheatstone bridge:

3.1.1 Null-balance method

3.1.2 Out-of-balance method

(2 × 3) (6)

3.2 Explain and make a simple sketch to show the principle of a bimetal thermometer. (8)

3.3 Make a neat, labelled sketch of a resistance thermometer. (6)

[20]

QUESTION 4: AUTOMATIC CONTROL AND TELEMETERING SYSTEMS

4.1 Define the following terms:

4.1.1 Telemetering (2)

4.1.2 Direct-acting in continuous-bleed relay valves (3)

4.2 Make a neat, labelled sketch of a pneumatic, three-term position balance controller. (8)

4.3 Sketch a position-balance type of valve positioner that incorporates the following:

- A receiving bellows
- A feedback spring
- A relay
- A flapper and nozzle
- A valve motor (5)

4.4 Name any TWO factors to keep in mind when choosing a control valve. (2)

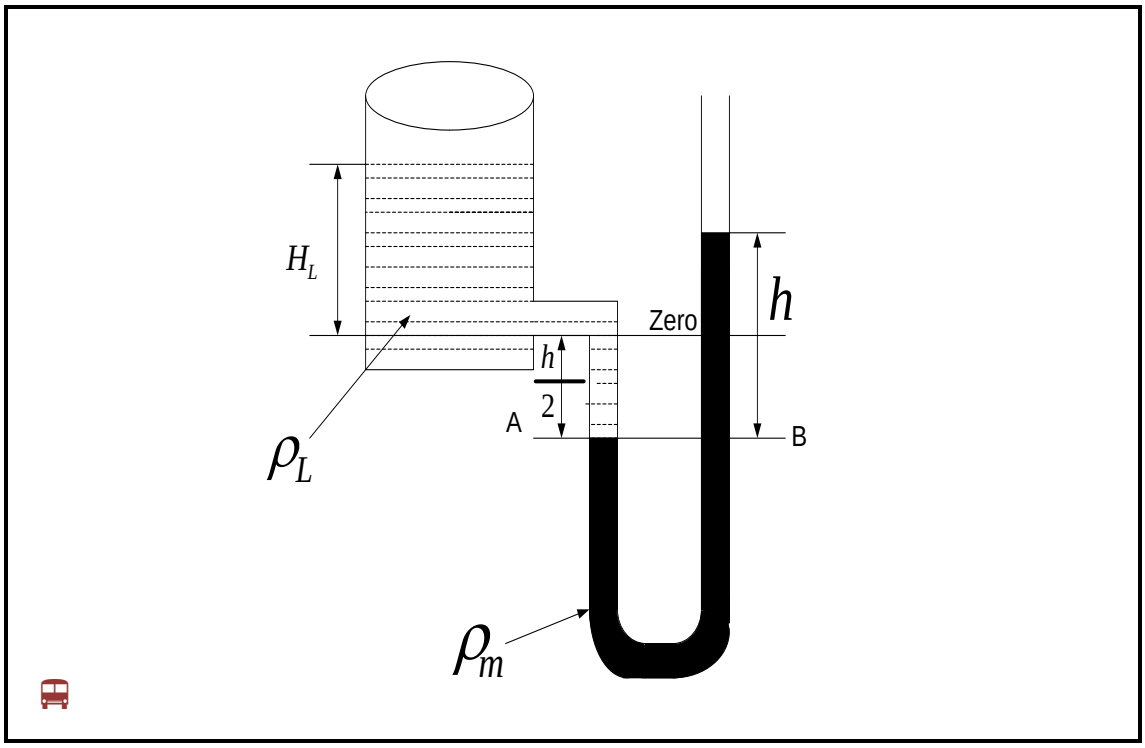
[20]

QUESTION 5: FLOW AND LEVEL MEASUREMENT

5.1 What is meant by *the wet calibration of a mercury-type flowmeter*? (2)

5.2 Study the sketch below and prove that:

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



(4)

5.3 5.3.1 Briefly explain the principle of operation of positive displacement flowmeters.

5.3.2 Name the most common types of the meter.

(2 × 2) (4)

5.4 Name and sketch THREE types of orifice plates. (6)

5.5 Sketch a curve showing the variation of static pressure across an orifice plate when flow occurs. (4)

[20]

TOTALSECTION B: 80
GRAND TOTAL: 100

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INDUSTRIAL INSTRUMENTS N4

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. $°F = \frac{9}{5}℃ + 32$

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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