higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N2

(11040452)

16 April 2021 (X-paper)
09:00–12:00

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INSTRUMENT TRADE THEORY N2
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. Use only a black or blue pen.
6. Write neatly and legibly.

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SECTION A

QUESTION 1

Various options are given as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 … is the act or process of adjusting a scale so that the readings of an instrument conform to an accepted and certified standard.

A Precision
B Accuracy
C Calibration
D Sensitivity

1.2 A/An … is a mechanism that can be set to operate at definite temperatures and can convert the expansion of heated metal or fluid into sufficient movement and power to operate small devices or control electric circuits.

A thermometer
B telemetry
C thermostat
D pyrometer

1.3 RTDs in industrial applications are rarely used above … °C.

A 100
B 660
C 300
D 1 000

1.4 A/An … flow, which occurs at low flow velocities, is characterised by individual fluid particles travelling in a straight path.

A turbulent
B laminar
C ideal
D transitional

1.5 Which ONE of the following level-measuring instruments is classified as a direct-level measurement?

A Nucleonic gauges
B Ultrasonic systems
C Sight glass
D Gas-purge systems

(5 × 1) **[5]**

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QUESTION 2

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.1–2.5) in the ANSWER BOOK.

2.1 Hysteresis error is caused by residual offset and inertia lag.

2.2 When a sample of fluid impinges on the end of a pitot tube, the potential energy is converted into kinetic energy.

2.3 Ultrasonic level meter blanking distance refers to the shortest possible distance that the transducer can measure.

2.4 Fundamental interval is the difference in resistance of a thermometer between 100 °C and 0 °C.

2.5 *C*apsules are two diaphragms joined back to back.

(5 × 1) **[5]**

QUESTION 3

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–L) next to the question number (3.1–3.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.1	Short tube of varying cross section usually cone-shaped with a convergent-divergent shape	A	temperature
3.2	Dimensionless quantity that is the ratio of the inertial force to the viscous force	B	hydrostatic head
3.3	Two dissimilar metals joined together to form junctions	C	vena contracta
3.4	Position where velocity of flow is the highest and pressure is the lowest after passing through a constriction	D	bourdon tube
3.5	Relative hotness or coldness of a body as determined by the ability of the body to transfer heat to its surroundings	E	venturi tube
3.6	Pressure exerted by a liquid in an open or nonpressurised container	F	square law effect
3.7	Flattened hollow metal tube bended in a certain shape and sealed at one end	G	Reynolds number
3.8	Using air as calibration medium, while considering the density of the measuring liquid	H	dry calibration
3.9	Level-measuring device following the Archimedes principle	I	wet calibration
3.10	Differential pressure set up by the primary flow element is not directly linear with the flow rate but varies at the square of the flow	J	torque tube displacer
		K	capsule
		L	thermocouple

(10 × 1) **[10]**

TOTAL SECTION A: 20

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SECTION B

QUESTION 4: PRESSURE MEASUREMENT

4.1 Explain the term *specific gravity*. (2)

4.2 Make a neat, labelled sketch of a C-type bourdon-tube gauge. (7)

4.3 Name and explain the THREE most common types of pressure measurement. (3 × 2) (6)

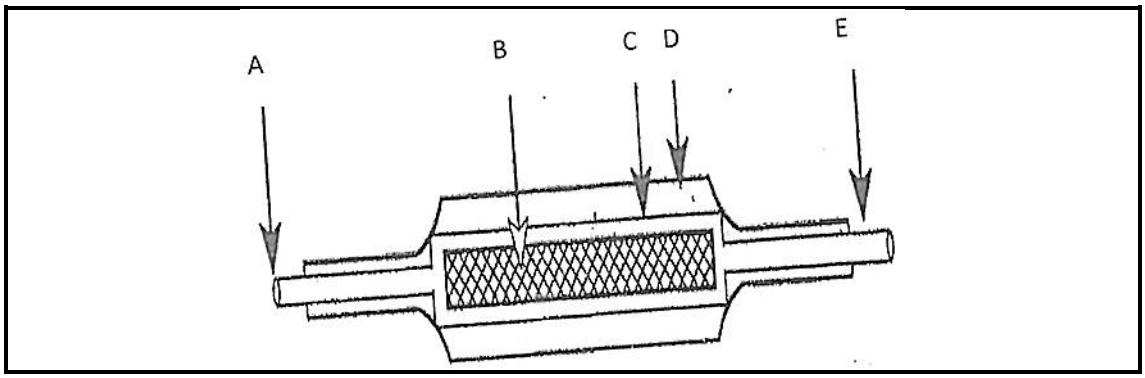
4.4 A well-type manometer is used to measure the difference between two air pressures. The height to which the mercury sealing liquid rises is 10 mm. The well has a rectangular section of 5 m by 4 m and the diameter of the thin limb is 1 mm.

Calculate the differential pressure. Use g=10 ms^{-2} (5)
[20]

QUESTION 5: TEMPERATURE MEASUREMENT

5.1 Explain the difference between *null balance* and the *out-of-balance method* as applicable to a Wheatstone bridge. (2 + 2) (4)

5.2



5.2.1 Label the parts of the link by writing only the answer next to the letter (A–E) in the ANSWER BOOK. (5 × 1) (5)

5.2.2 Explain how the link compensates for ambient temperature changes. (3)

5.2.3 Name TWO other links used to compensate for temperature. (2)

5.3 Use single-line thermocouple drawings to explain the law of intermediate temperatures as applicable to thermocouples. (3)

5.4 The resistance of a platinum resistance thermometer is 27,2 Ω at 0 °C.

Calculate the resistance at 490 °C if the coefficients of resistance of platinum are $\propto = 4 \times 10^{-3}\Omega/\Omega°C$ and $\beta = 5{,}6 \times 10^{-7}\Omega/\Omega°C$. (3)
[20]

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QUESTION 6: FLOW MEASUREMENT

6.1 Make a neat, labelled sketch of a magnetic flowmeter and name the operating principle. (6)

6.2 Briefly explain the operating principle of all positive displacement-type flowmeters. (4)

6.3 Show the difference between *laminar flow* and *turbulent flow* by making drawings. (3 + 3) (6)

6.4 Explain how a pitot tube is used to measure liquid flow in a pipeline. (4)

[20]

QUESTION 7: LEVEL MEASUREMENT

7.1 Explain the basic operating principle of a capacitive level-measuring instrument. (4)

7.2 Calculate the height of a volatile liquid in a closed tank fitted with a manometer if the following is known:

$\mathrm{h} = 0{,}08\ \mathrm{m}$
$\mathrm{H} = 4\ \mathrm{m}$
$\rho_L = 0{,}7 \times 10^3\ \mathrm{kg/m^3}$
$\rho_m = 14 \times 10^3\ \mathrm{kg/m^3}$

Vapour condensed in the right limb of the manometer forms a column of liquid above the mercury. (4)

7.3 A single standpipe gas-purge system is used to measure the level in an open tank. The back pressure of a gas-purge pressure gauge is 85 kPa when air is purged through a liquid with a density of 3 000 kg/m³. Use g = 9,8 $\mathrm{ms^{-2}}$.

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

7.4 Make a neat, labelled sketch of a bellow-type level-measuring device that consists of a transmitter bellow in the tank and a receiver bellow at the pressure gauge. (8)

[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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FORMULA SHEET

(1) $\Delta P = \rho g h$

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

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

(4) $P_1 - P_2 = \frac{r_2 M g \sin\theta}{A r_1}$

(5) $P_1 - P_2 = \frac{M g r \sin\theta}{A L}$

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

(15) $H_L = H + h\left[1 - \frac{\rho_m}{\rho_L}\right]$

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