higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N2

(11040452)

6 August 2021 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and 1 formula sheet.

211Q1G2106

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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 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 answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 On the … pressure scale, the zero point is at the atmospheric pressure line.

A gauge ■
B absolute
C vacuum
D atmospheric

1.2 A … error occurs when an observer measures a given position by means of a scale and a pointer.

A capillary
B hysteresis
C parallax
D zero

1.3 A … thermometer does NOT need to compensate for ambient temperature changes. ■

A vapour pressure expansion
B bimetallic expansion
C liquid expansion
D gas expansion

1.4 A/An … is a Bernoulli primary flow element used to measure the velocity of the stream at a point.

A pitot tube ■
B flow nozzle
C annubar
D orifice plate

1.5 … represents the error over the full range of the instrument.

■
A Span error
B Angularity error
C Zero error
D Hysteresis error

(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 The output EMF of a thermocouple is a function of the temperature to which the hot junction of the thermocouple is subjected.

2.2 Changing the incline angle in the inclined tube manometer changes the range of the instrument.

2.3 The orifice plate is used to create an abrupt change in the cross-sectional area of the pipe in which flow takes place.

2.4 The operation of the buoyancy type level gauge is based on the fact that the upthrust on an object is equal to the weight of the liquid the object displaces.

2.5 The density of a sealing liquid varies with its temperature.

(5 × 1) **[5]**

QUESTION 3

Give ONE term for each of the following descriptions by writing only the term next to the question number (3.1-3.5) on the ANSWER BOOK

3.1 A factor with which the maximum flow rate is multiplied to give the actual flow rate.

3.2 The device which depends on the EMF developed in a circuit in which the junctions of two dissimilar metals are at different temperatures.

3.3 Measurement devices which employ sound waves in the frequency range 20 kHz to 200 kHz for detection of liquid level.

3.4 A tube having multiple small openings facing the direction of the fluid; used to measure flow velocity.

3.5 If two dissimilar metals are joined, heat will be given off if the current flows in one direction and heat will be absorbed if the current flows in the opposite direction.

(5 × 2) **[10]**

TOTAL SECTION A: 20

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SECTION B

QUESTION 4: PRESSURE MEASUREMENT

4.1 Define the following:

4.1.1 Pressure

4.1.2 Density

(2 × 2) (4)

4.2 An inclined tube manometer uses mercury as sealing liquid.

Calculate the applied differential pressure if the following are known:

Angle of tube with the horizontal = 40°
Area of cistern = 0,03 m²
Area of tube = 0,00002 m²
Scale reading = 20 cm
Use g = 10 ms^{-2} (4)

4.3 Make a neat, fully labelled sketch of a single bell type differential pressure gauge. (4)

4.4 The McLeod gauge can be used to calibrate pressure gauges.

4.4.1 State Boyle's law as applicable to the McLeod gauge. (2)

4.4.2 Explain the working principle of the McLeod gauge. (6)

[20]

QUESTION 5: TEMPERATURE MEASUREMENT

5.1 Use a simple schematic circuit diagram to show how thermocouples can be connected to measure the difference between two temperatures. (4)

5.2 Make a neat, labelled sketch of a liquid-filled expansion thermometer. (6)

5.3 Convert 320 °F to Kelvin.

HINT: Convert to Celsius first. (5)

5.4 Make a neat sketch of a capillary compensation link as used for ambient temperature compensation by a mercury-filled liquid expansion thermometer. (5)

[20]

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QUESTION 6: FLOW MEASUREMENT

6.1 Draw a neat, graphical illustration of the difference between the scaling of a rotameter and an orifice plate. (5)

6.2 6.2.1 Make a neat, labelled sketch of a turbine flow meter. (4)

6.2.2 Briefly explain the working principle of the turbine flow meter. (4)

6.3 Answer the following questions on variable area flow meters:

6.3.1 What is the purpose of a variable area flow measurement instrument? (2)

6.3.2 Give THREE limitations of a variable area flow measurement instrument. (3)

6.3.3 Give TWO advantages of a variable area flow measurement instrument. (2)

[20]

QUESTION 7: LEVEL MEASUREMENT

7.1 A mercury-filled U tube manometer is used to measure the level in an open water tank. The zero mark is in line with the bottom of the tank.

Calculate the level in the tank if the mercury is 50 cm below the zero level. (4)

7.2 Make a neat, labeled sketch of a single-stand pipe purging system used for measuring the level in an open tank. (8)

7.3 Make a neat, labelled sketch of an ultrasonic level measuring detector. (4)

7.4 Explain the working principle of the ultrasonic level measuring detector. (4)

[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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INSTRUMENT TRADE THEORY N2

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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