higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

(8080194)

1 December 2022 (X-paper)
09:00–12:00

Drawing instruments may be used.

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

306Q1E2201

Copyright reserved

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. Take gravitational acceleration as 9,8 m/s^2.
5. Use 3,142 as the value of π.
6. Write neatly and legibly.

Copyright reserved

QUESTION 1: PRESSURE MEASUREMENT

1.1 Make a neat, labelled sketch of an inclined-tube manometer. (4)

1.2 What is the manometer in QUESTION 1.1 being used for? (2)

1.3 The height between the sealed liquid levels in a mercury filled, equal-legged U-tube manometer is 35 cm.

Calculate the appropriate pressure difference if the following details are known:

- h = 35 cm
- g = 9,8 m/s^2
- ρ = 13 600 kg/m^3 (Mercury)

$P_1 - P_2 = ?$ (5)

1.4 Explain how a McLeod vacuum gauge operates. (3)

1.5 Make a neat, labelled sketch of a foil-type strain gauge. (3)

1.6 Make a neat, labelled sketch of a Pirani vacuum meter, and explain its operation. (8)

[25]

QUESTION 2: LEVEL MEASUREMENT

2.1 Make neat sketches of the following level-measuring devices:

2.1.1 Static diaphragm boxes (4)

2.1.2 Gas-purging unit in an OPEN tank (4)

2.2 Name TWO advantages of a *buoyancy type level gauge* that makes use of a torque tube. (2)

[10]

QUESTION 3: FLOW MEASUREMENT

3.1 Name FOUR requirements that must be met when installing an orifice plate. (4)

3.2 Name FOUR methods of tapping around an orifice plate to measure differential pressure. (4)

3.3 Name TWO advantages of the *Venturi tube*. (2)

Copyright reserved

3.4 Explain the working principle of the *Pitot tube*. (4)

3.5 Name the THREE energies that exist in a liquid flow line. (3)

3.6 Name the THREE advantages of a *turbine flowmeter*. (3)

[20]

QUESTION 4: TEMPERATURE AND TELEMETERING

4.1 The resistance of a platinum resistance thermometer is 25,5 Ω at 0 °C. Calculate the resistance of the thermometer at 500 °C if the platinum's temperature resistance coefficients are:

$\alpha = 3{,}958 \times 10^{-3}$ Ω/Ω °C and
$\beta = 5{,}83 \times 10^{-7}$ Ω/Ω °C (3)

4.2 Make a neat, fully labelled sketch of a continuous direct-acting bleed-type pneumatic relay. (6)

4.3 What is the function of a pneumatic relay? (3)

4.4 Make a neat, fully labelled sketch of a voltage-current telemetering system. (5)

4.5 It is known that optical pyrometers are not suitable for recording or controlling temperatures, but are very useful for checking and calibrating total-radiation pyrometers.

Distinguish between an *optical pyrometer* and a *total-radiation pyrometer* by referring to the different wavelengths on which each one is being used. (3)

[20]

QUESTION 5: AUTO CONTROL

5.1 Define the term *automatic control* in a process-controlled environment. (2)

5.2 What is meant by the term *load change*? (2)

5.3 Name ONE type of process lag that is known to you. (1)

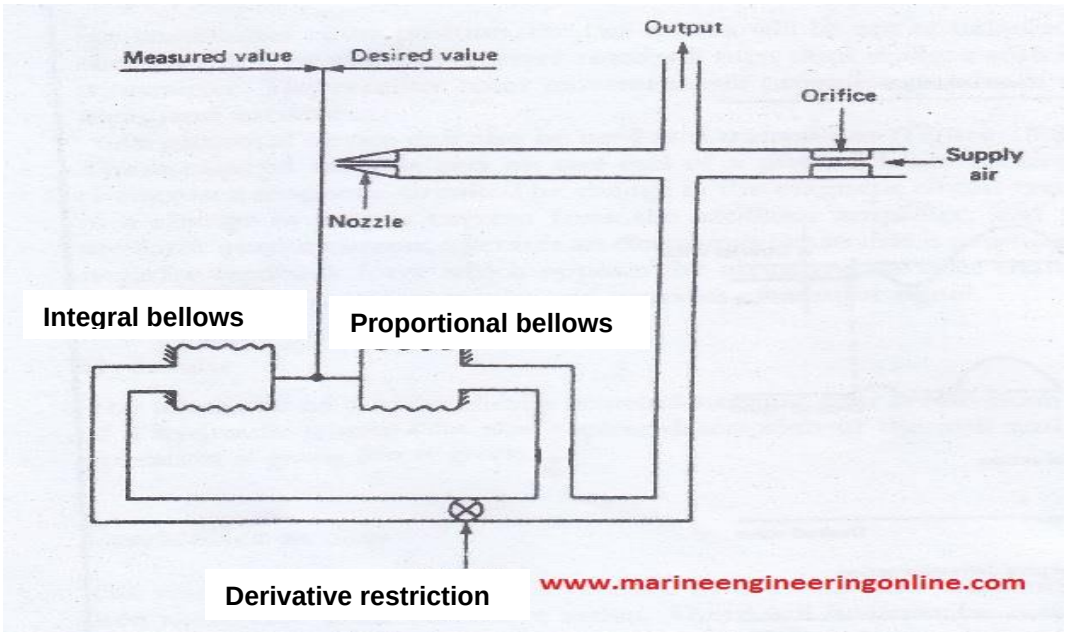
5.4 Make a neat, labelled sketch of a motion-balance valve positioner that incorporates the following:

- A receiver
- Feedback spring
- A relay
- A flapper and nozzle
- Valve motor
- Valve stem

(6)

5.5 Sketch and describe the basic operation of a *proportional electronic controller* making use of capacitors and an OP-AMP. (8)

5.6 Refer to the drawing below and answer the following questions:



5.6.1 Name the drawing above. (2)

5.6.2 Describe the operation of the diagram above. (4)

[25]

TOTAL: 100

Copyright reserved

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

Copyright reserved