higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T850(**E**)(A7)T

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N5

(8080205)

7 August 2018 (X-Paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 2 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS N5
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. Write neatly and legibly.

SECTION A: FLOW MEASUREMENTS

QUESTION 1

1.1 A pitot tube is used to measure fluid velocity by converting the kinetic energy of the flowing fluid into potential energy. The fluid is stationary as it hits the end of the tube, and its velocity at this point is zero. The potential energy created is transmitted through the tube to a measuring device.

1.1.1 Prove from first principles that the velocity of flowable liquid as measured by using a pitot tube adheres to the flowing equation below.

$V = C\sqrt{2gh}$ (7)

1.1.2 Make ONE sketch to indicate the position of various pressure tappings relative to an orifice. (6)

1.1.3 State TWO advantages and TWO disadvantages of a pitot tube. (2 + 2) (4)

1.2 State THREE precautions when annubar is being used. (3)

1.3 Give THREE factors affecting flow rate. (3)
[23]

QUESTION 2

2.1 Discuss the construction and principle of operation of a variable area flow-meter. (5)

2.2 How is the float of the rotameter kept clean in the case of sticky fluids? (3)

2.3 Density variations affect the calibration of the variable area flowmeter.

What can be done to compensate for the changes in density? (2)

2.4 Name the factors on which the type of flow in a pipe depends. (4)
[14]

TOTAL SECTION A: 37

SECTION B: DENSITY, HUMIDITY AND VISCOSITY MEASUREMENT

QUESTION 3

3.1 Sketch a differential head hydrometer and describe its working principle. (10)

3.2 Make a neat, labelled sketch of an infrared type absorption hygrometer. (7)

3.3 Viscosity can be measured by different viscometers.

3.3.1 Define *viscosity*. (2)

3.3.2 Name FOUR types of viscometers. (4)

3.3.3 Which unit is used to measure dynamic viscosity? (1)
[24]

TOTAL SECTION B: 24

SECTION C: pH MEASUREMENT

QUESTION 4

4.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (4.1.1–4.1.3) in the ANSWER BOOK.

4.1.1 The pH of a liquid solution is a measure of hydrogen ion activity.

4.1.2 A pH value less than 7,0 means that the solution is alkaline.

4.1.3 Buffer solutions are used with pH probes for the purpose of calibration.

(3 × 1) (3)

4.2 Describe the process involved in the cleaning of PH electrodes. (6)

4.3 All materials that come into contact with the process liquid must be chemically resistant at all measurement temperatures.

State FOUR requirements of an ideal housing material for electrodes. (4)

4.4 What is the main purpose of a reference electrode? (3)
[16]

TOTAL SECTION C: 16

SECTION D: AUTOMATIC CONTROL

QUESTION 5

5.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–E) next to the question number (5.1.1–5.1.7) in the ANSWER BOOK.

5.1.1 Derivative control action is used when controlling ..., but rarely used when controlling ...

A temperature, flow
B flow, level
C pH, level
D level, temperature
E level, flow

5.1.2 A/An … process always require some degree of … control action to achieve set point.

A integrating, derivative
B integrating, feed forward
C self-regulating, proportional
D runaway, linear
E self-regulating, integral

5.1.3 The reciprocal of proportional band is called …

A reset.
B percent.
C minutes per repeat.
D rate.
E gain.

5.1.4 Reset control action is often expressed in units of …

A percentage.
B second per rate.
C minutes.
D time constant ration.
E repeats per minutes.

5.1.5 A proportional band setting of 175% is equivalent to a gain setting of …

A 175.
B 0,756.
C 1,32.
D 0,571.
E 1,75.

1.5.6 Cascade control is characterised by …

A a special relay or function block to compensate for nonlinear process gain.
B one controller providing a set point for another controller.
C the presence of dead time relay or function block.
D two controllers of which the outputs are selected either by high or low value.
E the presence of a lead/lag relay or function block.

5.1.7 In a feedback control system the controller gets its input from the …

A load variable.
B manipulated variable.
C inferred variable.
D controlled variable.
E dynamic variable.

(7 × 2) (14)

5.2 Sketch a neat, labelled block diagram of a feedback controller. (9)
[23]

TOTAL SECTION D: 23
GRAND TOTAL: 100

INDUSTRIAL INSTRUMENTS N5

FORMULA SHEET

$W = 359{\cdot}2\, C\, Z \in E d^{2} \sqrt{(h\rho)}\quad \rho \qquad R_d = W/158\, \mu d$

$Q = 359{\cdot}2\, C\, Z \in E d^{2} \sqrt{(h\rho)}\quad \rho \qquad R_d = Q\rho/158\, \mu d$

$Q_g = 2238\, CZEd^{2} \sqrt{(h/\rho)} \qquad R_d = Q_g\rho/98{\cdot}6\, \mu d$

$m = (d/D)^2 \qquad E = 1/\sqrt{(1-m^2)}$

$$N = \frac{W}{359{\cdot}2\, D^2\sqrt{(h)}} = \frac{Q\sqrt{(\rho)}}{359{\cdot}2\, D^2\sqrt{(h)}} = \frac{Q_g\sqrt{(\rho)}}{2238\, D^2\sqrt{(h)}}$$

$mE = N/CZ\in$

$CmE = N/Z\in \qquad mE = CmE/C$

$$R_d = \frac{W}{158\mu D\sqrt{(m)}} = \frac{Q\rho}{158\,\mu D\sqrt{(m)}} = \frac{Q_g\rho}{986\mu D\sqrt{(m)}}$$

$d/D = [(mE)^2/1 + (mE)^2]^{\frac{1}{4}}$

$W = 1890\, Ud^2\sqrt{(\rho P)}$ *vir kritieke vloei/for critical flow*

$d = [W/1890U\sqrt{(\rho P)}]^{\frac{1}{2}}$ *vir kritieke vloei/for critical flow*

$W = 001252\, CZ\in Ed^2\sqrt{(h\rho)} \qquad R_d = 3{\cdot}54\, W/\mu d$

$Q = 001252\, CZ\in Ed^2\sqrt{(h/\rho)} \qquad R_d = 354\, Qd/\mu d$

$m = (d/D)^2 \qquad E = 1/\sqrt{(1-m^2)}$

$$N = \frac{W}{0{\cdot}01252\, D^2\sqrt{(h\rho)}} = \frac{Q\sqrt{(\rho)}}{0{\cdot}01252\, D^2\sqrt{(h)}}$$

$mE = N/CZ\in$

$CmE = N/Z\in \qquad mE = CmE/C$

$$R_d = \frac{3{\cdot}54W}{\mu D\sqrt{(m)}} = \frac{3{\cdot}54Q\rho}{\mu D\sqrt{(m)}}$$

$d/D = [(mE)^2/1 + (mE)^2]^{\frac{1}{4}}$

$W = 1{\cdot}252\, Ud^2\sqrt{(\rho P)}$ *vir kritieke vloei/ for critical flow*

$d = [W/1{\cdot}252\, U\sqrt{(\rho P)}]^{\frac{1}{2}}$ *vir kritieke vloei/ for critical flow*

1 kPa = 102 mmWD = 102 mmWC

1 lb/ft^3 *= 16,0183 kg/m*^{3}

Atmosferiese druk/Atmospheric pressure = 101,325 kPa

Gravitasieversnelling/Gravitation acceleration = 9,81 m/s^2

For/ Vir $D + \frac{D}{2}$ *-tappe/tappings en/and flenstappe/flange tappings* $\frac{h}{Pa} \times 27,2 = \frac{kPa}{kPa} \times 27,2$

$$Q = \frac{8}{15} \quad Tan\,\frac{\theta}{2}\sqrt{2g.H^5}$$

$$Q = \frac{2}{3} \quad B\sqrt{2g..H^3}$$