higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T820**(E)**(A13)T

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N5

(8080205)

13 August 2019 (X-Paper)
09:00–12:00

This question paper consists of 5 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. Sketches must be neat, large and fully labelled.
5. Write neatly and legibly.

QUESTION 1: FLOW MEASUREMENT

1.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–I) next to the question number (1.1.1–1.1.6) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1	Velocity-sensitive device that measures the volumetric flow of gases and liquids	A	primary flow element
1.1.2	Instrument that measures the total volume of flow in a certain time	B	square root problem
1.1.3	Device that creates a difference in pressure in a flowing fluid	C	process control
1.1.4	Device that controls the amount of flow of substance	D	control valve
1.1.5	Rough and irregular movement of fluid	E	integrator
1.1.6	Obstruction placed in an open channel at a right angle to direction of flow to create a pressure head	F	laminar flow
		G	weir
		H	swirl flowmeter
		I	turbulent flow

(6 × 1) (6)

1.2 Make a neat, labelled sketch of a drag-body flowmeter. (7)

1.3 Give THREE advantages and TWO disadvantages of a drag-body flowmeter. (3 + 2) (5)

1.4 Explain, with the aid of a neat, labelled sketch, the working principle of a nutating-disc flowmeter. (4 + 7) (11)

[29]

QUESTION 2: DENSITY, HUMIDITY AND VISCOSITY MEASUREMENT

2.1 Make a neat, labelled sketch of a hand-held hydrometer. (4)

2.2 Explain the working principle of a hand-held hydrometer. (6)

2.3 Make a neat, labelled sketch of a piezoelectric hygrometer sampling system. (14 × ½) (7)

2.4 Explain the working principle of a vibrating-reed viscometer. (11)

[28]

QUESTION 3: pH MEASUREMENT

3.1 Define the term *conductivity of a substance*. (2)

3.2 Name THREE factors affecting measurement with potential-measuring instruments. (3)

3.3 Name SIX types of measuring electrodes used with a reference electrode. (6)

3.4 Calculate the pH value of a solution having a hydrogen-ion concentration of $2{,}3 \times 10^{-11}$. Comment on the acidity or alkalinity of the solution. (4)

3.5 Indicate whether the following statement is TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (3.5) in the ANSWER BOOK.

A positive electrode produces a change in voltage proportional to the hydrogen-ion concentration. (1)

[16]

QUESTION 4: AUTOMATIC CONTROL

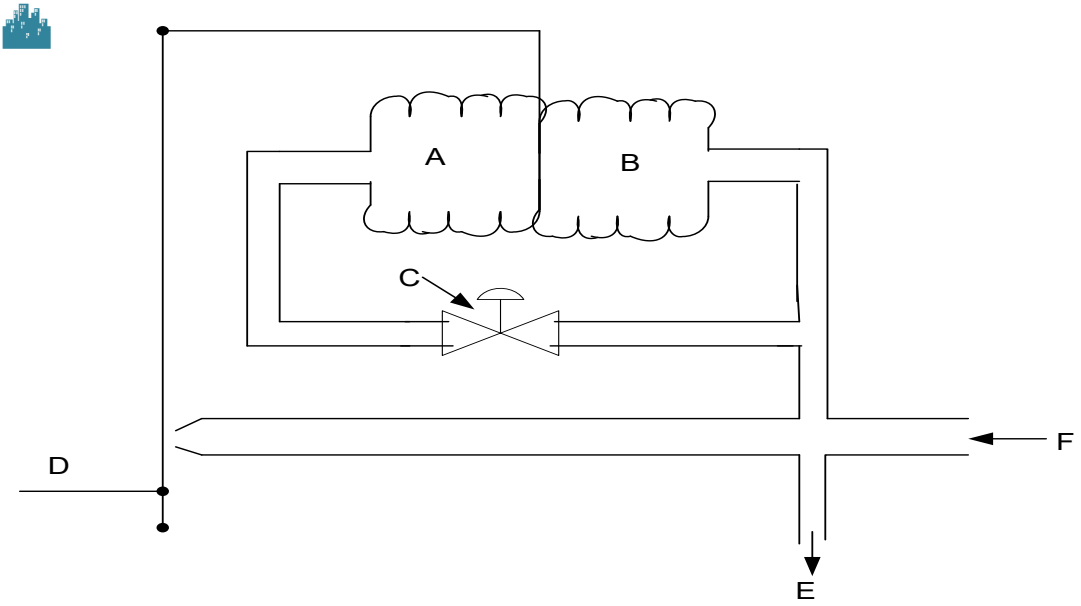
4.1 Complete the following paragraph describing the operation principle of an electronic proportional controller by using the words in the list below. Write only the missing word or words next to the question number (4.1.1–4.1.9) in the ANSWER BOOK.

voltage; current signal; zero; voltage signal; amplifier; counteract; feedback voltage; error signal; 20 mA signal; feedback

There are two outputs from the amplifier. One comprises a (4.1.1) … for control purposes and the other one is a (4.1.2) … of ±4 V for (4.1.3) … purposes. With no input signal the feedback voltage is (4.1.4) ... and the potential at point A, reference to earth, is zero. If an (4.1.5) … appears at the input, the input capacitor is charged and a (4.1.6…) appears at point A, forming an input signal to the (4.1.7 …). A (4.1.8 ...) is generated to CFB to (4.1.9 …) the error signal and the potential at A returns to zero. (9 × 1) (9)

4.2 Make a neat, labelled block diagram of a closed-loop system showing only the FOUR main parts. (4)

4.3 Study the sketch below and answer the questions.



4.3.1 Which type of controller mode is represented by the diagram? (2)

4.3.2 Label the components in the diagram by writing only the answer next to the letter (A–F) in the ANSWER BOOK. (6 × 1) (6)

4.3.3 Explain the working principle of the controller mode shown in the given diagram. (6)

[27]

TOTAL: 100

FORMULA SHEET

W = 359≅2 CZ,Ed2 $\sqrt{(h\rho)}$ Rd = W/15≅8 µd

Q = 359≅2 CZ,Ed2 $\sqrt{(h/\rho)}$ Rd = QΔ/15≅8 µd

W = 0≅01252 CZ,Ed2 $\sqrt{(h\rho)}$ Rd = 3≅54 W/µd

Q = 0≅01252 CZ,Ed2 $\sqrt{(h/\rho)}$ Rd = 3≅54 QΔ/µd

Qg = 2 238 CZEd2 $\sqrt{(h/\rho)}$ Rd = QgΔ/98≅6 µd

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

$$N = \frac{W}{0\cdot01252\,D^2\sqrt{(h\rho)}} = \frac{Q\sqrt{(\rho)}}{0\cdot01\,252\,D^2\sqrt{(h)}}$$

mE = N/CZ, CmE = N/Z, mE = CmE/C

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

$$R_d = \frac{W}{15\cdot8\,\mu D\sqrt{(m)}} = \frac{Q\rho}{15\cdot8\,\mu D\sqrt{(m)}} = \frac{Q_g\rho}{98\cdot6\,\mu D\sqrt{(m)}}$$

$$N = \frac{W}{359\cdot2\,D^2\sqrt{(h)}} = \frac{Q\sqrt{(\rho)}}{359\cdot2\,D^2\sqrt{(h)}} = \frac{Q_g\sqrt{(\rho)}}{2\,238\,D^2\sqrt{(h)}}$$

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

W = 1 890 Ud2 $\sqrt{(\rho P)}$ for critical flow

CmE = N/Z, mE = CmE/C

$d = [W/1\,890U\sqrt{(\rho P)}]^{\frac{1}{2}}$ for critical flow

$$R_d = \frac{3\cdot54W}{\mu D\sqrt{(m)}} = \frac{3\cdot54Q\rho}{\mu D\sqrt{(m)}}$$ $d/D = [(mE)^2/1 + (mE)^2]^{\frac{1}{4}}$

$W = 1\cdot252\,Ud^2\sqrt{(\rho P)}$ for critical flow

$d = [W/1\cdot252\,U\sqrt{(\rho P)}]^{\frac{1}{2}}$ for critical flow

1 kPa = 102 mmWD = 102 mmWG

1 lb/ft3 = 16,0183 kg/m3

Atmospheric pressure = 101,325 kPa

Gravitation acceleration = 9,81 m/s^2

For D + D/2 tappings and flange tappings:

$$\frac{h}{Pa} \times 27{,}2 = \frac{kPa}{kPa} \times 27{,}2$$

$$Q = \frac{8}{15} \quad Tan \frac{\theta}{2} \sqrt{2g.H^5} \qquad Q = \frac{2}{3} \quad B \sqrt{2g.H^3}$$