higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N5

(8080205)

7 December 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and 1 formula sheet.

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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. 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: FLOW MEASUREMENTS

QUESTION 1

1.1 Nutating-disc meters are used extensively for residential water service measurement, but can be used in many industrial applications.

1.1.1 Make a neat labelled sketch of nutating-disc flow meter. (4)

1.1.2 State THREE advantages and THREE disadvantages of nutating-disc flow meters. (6)

1.2 Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (1.2.1–1.2.6) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	This system will generate a signal to the process flow control valve to rectify the fault	A	primary instrument
1.2.2	This will measure the flow rate over a certain period	B	square root problem
1.2.3	This instrument generates a differential pressure of the flow	C	process control
1.2.4	This valve controls the amount of flow of a substance	D	process flow control valve
1.2.5	This controls the process for an output for an instrument and if an error occurs, to the feedback	E	integration
1.2.6	The flow rate is the square root of the differential pressure	F	feedback

(6 × 1) (6)

[16]

QUESTION 2: FLOW MEASUREMENTS

2.1 Sketch and describe the working of a drag-body flow meter. (6)

2.2 State FIVE advantages and TWO disadvantages of a drag-body flow meter. (7)

[13]

TOTAL SECTION A: 29

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SECTION B: DENSITY, HUMIDITY AND VISCOSITY

QUESTION 3

3.1 State THREE factors that affect the specific gravity of a liquid. (3)

3.2 Describe the working principle of a common hand held hydrometer (6)

3.3 Discuss a Piezoelectric hygrometer under the following headings:

3.3.1 Sampling system (4)

3.3.2 Limitations (3)

3.4 Make a neat labelled sketch of coaxial-cylinder viscometer. (10)

3.5 Make a neat labelled sketch of a thermal electrical dew point hygrometer. (7)
[33]

QUESTION 4: pH AND CONDUCTIVITY MEASUREMENT

4.1 State SIX general requirements that should be met when a pH electrode is used. (6)

4.2 Name THREE factors that affect measurement with potential measuring instruments. (3)

4.3 Make a neat, labelled sketch of an electrodeless conductivity system. (8)
[17]

QUESTION 5: AUTOMATIC CONTROL

5.1 Which of the following tasks is associated with process control applications? (Select THREE options that apply)

- Measurement
- Comparison
- Quality analysis
- Adjustment
- Calculation (3)

5.2 The most commonly used circuitry or discrimination between reference and error levels is the operational amplifier.

5.2.1 Make a neat, labelled sketch of a differential amplifier or comparator. (4)

5.2.2 Name TWO forms of discrimination other than the one mentioned in QUESTION 5.2. (2)

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5.3 Match each term below to the correct description. Write only the alphabet letter next to the number in the ANSWER BOOK.

1) Closed-loop automatic control.
2) Closed-loop manual control
3) Open-loop automatic control

A An operator turns off the heater coil when the temperature transmitter delivers a certain reading.
B A controller turns off the heater coil at set intervals, regardless of the process temperature.
C A temperature sensor measures process temperature, sends the results to a controller to compare to the set point, and the controller turns off the heater. (6)

5.4 A description of the operation of a proportional controller is given below. Complete the sentences by using the words provided in the list below. Write only the word or words next to the question number (5.4.1–5.4.12) in the ANSWER BOOK.

proportional control; current signal; halfway; amplifier; voltage signal; counteract; potential; feedback voltage; proportional band; error; original; outputs.

The capacitors are equal in value. There are two (5.4.1 …) from the amplifier. One comprises a (5.4.2 …) ranging from 4 to 20 mA for control purposes. The other is a (5.4.3 …) of ± 4V for feedback purposes. With no input signal, Efb, the feedback voltage is zero and the potential relative to earth is zero. There will be an output signal, however, and this could conveniently be 12 mA the (5.4.4 …) value between 4 and 20 mA. If an (5.4.5 …) signal is impressed on the input capacitor, C is charged and a (5.4.6 …) appears at point A, forming in input signal to the (5.4.7 …).A feedback voltage is generated to Cfb to (5.4.8 …) this and the potential at A returns to zero. This is, of course, the same condition as we had for the (5.4.9 …) output signal of 12mA. But as long as there is a sustained input signal to the amplifier, there is an equally sustained (5.4.10 ...) generated and if this changes, so does the output current in proportion. The (5.4.11 …) can be adjusted to change the gain of the controller. This is done by adjusting the amount of feedback voltage to Cfb. Thus a form of (5.4.12 ...) has been established.

(12 × ½) (6)
[21]

TOTAL SECTION B: 71
GRAND TOTAL: 100

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FORMULA SHEET

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

$$Q = \frac{2}{3} \; B\,C\sqrt{2g.H^3}$$

$$Q = \frac{2}{3} \; CB\sqrt{2g.H^3}$$

pH = -log[H^+]

pOH = -log [OH^-]

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