higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

(8080216)

15 November 2022 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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INDUSTRIAL INSTRUMENTS N6
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. Use only a blue or black pen.
5. A pencil may be used to neatly draw the diagrams and graphs, clearly showing all the relevant detail.
6. Write neatly and legibly.

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QUESTION 1: ANALYSERS

1.1 Define the following terms:

1.1.1 Volume susceptibility

1.1.2 Diamagnetic substance

(2 × 2) (4)

1.2 Give THREE examples of broad-emission sources of UV energy and ONE example of a discrete-line UV energy source. (4)

1.3 In process chromatography, all the operating parameters are controlled and events are on a cyclic and repetitive basis.

1.3.1 Draw a neat, labelled basic diagram of a chromatograph. (6)

1.3.2 An analyser was part of the diagram of a chromatograph that you drew for QUESTION 1.3.1.

State FIVE points to explain the working principle of this analyser. (5)

1.3.3 Name the operating parameters which must be controlled for the successful operation of the chromatograph. (5)

1.4 Draw a neat, labelled diagram of a methanometer which uses the principle of the heat of the reaction to measure the percentage of methane in the air. (4)

[28]

QUESTION 2: AUTOMATIC CONTROL AND VALVES

2.1 Define the following terms:

2.1.1 Feedback control (3)

2.1.2 Multi-element control (2)

2.2 Draw a diagram of the cascade control of a heat-exchange process. (6)

2.3 A control valve is used to control the flow of a gas in a pipeline. The specific density of the gas is 0,8 at a temperature of 80 °C. The upstream pressure is 13,79 bar and the downstream pressure is 3,4475 bar. The CV value of the valve is 1,5 and the atmospheric pressure is 101,35 kPa (1,0135 bar).

Determine the gas flow capacity of the valve in cubic metres per hour. (4)

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2.4 In an air-operated controlled process, after the temperature had been balanced at 120 °C under manual control, the manual pressure regulator is changed suddenly at time zero to increase the pressure on the valve so that the valve opening increases from 25% to 45% of full-valve stem travel.

The following temperature change in a 100 °C to 200 °C scale is noted:

Time (min)	0	1	2	3	4	5	6	7
Temp (°C)	120	120,5	122,5	125,5	131	135,5	137	137,5

2.4.1 Draw the reaction curve. (3)

2.4.2 Calculate the optimal settings for a proportional and integral controller. (14)

[32]

QUESTION 3: DISTILLATION COLUMN AND BOILERS

3.1 Name THREE types of trays found in a distillation column. (3)

3.2 Draw a diagram of improved column feed temperature control. (6)

3.3 What is the function of a condenser in a distillation column? (2)

3.4 Define *boiler load.* (2)

3.5 Explain how the following fans are used to operate a furnace or burner:

3.5.1 Natural-draft fans

3.5.2 Forced-draft fans

3.5.3 Induced-draft fans

3.5.4 Balanced-draft fans

(4 × 2) (8)

3.6 The water level in a steam drum is affected by a phenomenon known as 'drum swell'.

Explain the cause of this and how it affects the level of water in the steam drum.

(4)

[25]

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QUESTION 4: INTRINSIC SAFETY

4.1 Draw a block diagram showing a flow chart of techniques used to prevent the ignition of explosive hazards. (6)



4.2 Explain what is meant by *isolation by potting*. (3)

4.3 Explain what is meant by *non-incentive equipment* and *wiring*. (3)

4.4 Name THREE types of barriers with respect to intrinsically safe transmitters. (3)



[15]

TOTAL: 100

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FORMULA SHEET

1. $$C_v = 1.16Q\sqrt{\frac{G_f}{\Delta P}}$$

2. $$C_v = \frac{1.16W}{\sqrt{G_f \Delta P}}$$

3. $$C_v = \frac{Q}{295}\sqrt{\frac{G.T}{\Delta P(P_1 + P_2)}}$$

4. $$C_v = \frac{47{,}2W}{\sqrt{\Delta P(P_1 + P_2)}}$$

5. $$C_v = \frac{72{,}4W}{\sqrt{\Delta P(P_1 + P_2)}}$$

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