higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

(8080216)

26 July 2019 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and 1 formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
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. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

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SECTION A

QUESTION 1: ANALYSERS

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 Device enabling the treatment of a mixture of liquid components in such a way that the components can be separated:

A Fractionating column
B Stripping column
C Boiler
D Distillation column

1.1.2 Action of a controller of which the output changes at a rate which is proportional to the measured deviation:

A Proportional
B Derivative
C Integral
D On-off control

1.1.3 When, in the absence of a controller, equilibrium is reached after a disturbance for any fixed set of conditions:

A Inherent regulation
B Automatic control loop
C Cascade control
D Open-loop control

1.1.4 Delay which occurs between change in process material at correcting element and arrival of changed material at detecting element:

A Process lag
B Transfer lag
C Measurement lag
D Distance/velocity lag

1.1.5 Subsection of class which determines specific material involved:

A Class
B Division
C Group
D Class III

(5 × 1) (5)

1.2 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–N) next to the question number (1.2.1–1.2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	Technique requiring the sample to be in solution form so that it may be directed into the flame in the form of a mist or spray	A	offset
1.2.2	Lines are sharply defined when looking at a diffraction pattern	B	low air flow interlock
1.2.3	Difference between point of process equilibrium and desired value	C	catalyst
1.2.4	When pressure within throat section of valve falls below vapour pressure of liquid, vapour bubbles form	D	boiler
1.2.5	Locations in which ignitable fibres may not be in sufficient quantities to produce explosive or ignitable mixtures	E	two-element control
1.2.6	Substance which facilitates chemical reaction between other substances but remain unchanged itself	F	cascade control
1.2.7	Water heater for generating steam	G	crystalline materials
1.2.8	Feed-water control system where two variables are used	H	flame excitation
1.2.9	Fuel is shut off upon loss of air flow and/or combustion air fan or blower	I	class iii
1.2.10	Quantity of water that passes through specific valve size at maximum valve lift and one psi pressure drop	J	deviation
		K	flashing
		L	valve coefficient
		M	potential value
		N	stoker

(10 × 1) (10)

1.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.3.1–1.3.5) in the ANSWER BOOK.

1.3.1 In optical emission spectrochemical analysis the wavelength of the atomic transitions reveals the concentration of the elements within the sample.

1.3.2 A diamagnetic gas has a negative volume susceptibility (k) value.

1.3.3 Division 1 location indicates that the hazardous material has a high probability of producing an explosive or ignitable mixture.

1.3.4 Single-element control uses one variable.

1.3.5 X-ray diffraction can determine whether a material is amorphous or crystalline.

(5 × 1) (5)
[20]

TOTAL SECTION A: 20

SECTION B

QUESTION 2: ANALYSERS

2.1 When atoms are bombarded with energetic electrons rays are emitted. This emission results from two separate effects.

Name and briefly describe these two effects. (7)

2.2 Make a neat, labelled sketch of a deflection-type paramagnetic oxygen analyser. (4)

2.3 Make a neat, labelled sketch of a mass spectrometer. (5)

2.4 Write down a formula for the radius of curvature of a magnetic-type mass spectrometer and name the units of each variable. (3)

2.5 Thermal-type detectors use temperature sensors which measure the infra-red energy emerging from the sample cells.

Name TWO types of these detectors. (2)
[21]

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QUESTION 3: AUTOMATIC CONTROL AND VALVES

3.1 Valve positioners are used on control valves to overcome problems resulting in time lag.

State FIVE problems that are resolved by the use of this device. (5)

3.2 Name THREE methods of adjusting controllers. (3)

3.3 Calculate the quantity of gas flow for the following:

- C_v of valve = 2,2
- SG of gas = 0,8
- Temperature of gas = 80 °C
- Upstream pressure = 22 bars
- Downstream pressure = 8 bars (5)

3.4 Sketch the characteristic curve of the following on the same axis:

- Quick opening valve
- Equal percentage valve
- Linear valve (4)

3.5 An automatic control loop comprises three parts.

Make a sketch of a typical loop and clearly label the parts. (4)

3.6 List THREE factors governing the rate at which heat is transferred to the bulb of a temperature detecting element. (3)

[24]

QUESTION 4: DISTILLATION COLUMN AND BOILERS

4.1 Explain the THREE basic functions of automatic combustion control systems for boilers. (4)

4.2 State THREE factors to be considered when selecting the method of control of a multiple fuel-fired boiler. (3)

4.3 Name THREE limiting actions which are introduced to boilers for safety purposes. (3)

4.4 Make a neat, labelled sketch illustrating overhead product withdrawal in a distillation column. (5)

4.5 List SIX variables that can be manipulated when controlling a distillation column. (6)

[21]

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QUESTION 5: INTRINSIC SAFETY

5.1 Define *purging* with respect to safety. (3)

5.2 State TWO disadvantages of barrier circuits. (2)

5.3 Define *non-incentive equipment.* (3)

5.4 Draw a type Z-purging installation. (3)

5.5 What is the nature of hazards encounter in class 1, Division 1 location? (2)

5.6 What is the approximate value in ohms of the ground resistor of a grounded busbar? (1)
[14]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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INDUSTRIAL INSTRUMENTS N6

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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