higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PROCESS CONTROL
NQF LEVEL 3

(6050403)

20 November 2024 (Y-paper)
13:00–16:00

This question paper consists of 7 pages.

335Q1N2420

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
PROCESS CONTROL
NQF LEVEL 3
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.

Copyright reserved

SECTION A

QUESTION 1

Give ONE term for each of the following descriptions by writing it next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 Continuous level-measuring instrument that consists of a glass tube connected above and below the liquid level in a tank and that allows the liquid level to be observed visually

1.2 Device that records the output of a measurement device

1.3 Area of a signal range where no signal changes or signal responses occur

1.4 System with many input signals and/or output signals

1.5 System that is configured to operate under an open condition when the system shuts down completely

(5 × 1) **[5]**

QUESTION 2

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–H) next to the question number (2.1–2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Measure of how many measurable units of information a system can process in a given amount of time	A	control limits
2.2	Consistently meeting standards appropriate for a specific product	B	normal control limit
2.3	Horizontal lines above and below the centre line that are used to judge whether a process is out of control	C	throughput
2.4	SI unit of temperature measurement	D	kelvin
2.5	Measure of the internal energy of a system	E	quality
		F	temperature
		G	pascal
		H	ratio

(5 × 1) **[5]**

Copyright reserved

QUESTION 3

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.1–3.10) in the ANSWER BOOK.

3.1 Proportional action ensures that the control effort is proportional to the error in the system.

3.2 Absolute pressure is the desired value of the process variable.

3.3 A direct level-measuring instrument determines the level by measuring physical changes that are proportionally related to the liquid level.

3.4 Feedback control maintains a certain process condition by measuring, comparing and correcting the error between the process condition and set point.

3.5 When one material has a greater coefficient of thermal expansion than the other material, the difference in expansion can be used as a measure of temperature by direct reading or by connection to a mechanical linkage.

3.6 Cascade control is a control strategy where a primary controller, which controls the ultimate measurement, adjusts the set point of a secondary controller.

3.7 Materials supplied to machines are called feed.

3.8 The bubbler tube method is a level-measuring technique that utilises hydrostatic pressure to determine the level of liquid in a container.

3.9 An exothermic reaction is a chemical reaction that releases energy by heat.

3.10 A positive-displacement flowmeter admits fluid into a chamber of known volume and then discharges it.

(10 × 1) **[10]**

TOTAL SECTION A: 20

SECTION B

QUESTION 4

4.1 List THREE common signal transfer methods used in plants. (3)

4.2 What does each of the following SI units stand for?

4.2.1 m^3/h

4.2.2 psi

(2 × 1) (2)

4.3 Give ONE advantage and ONE disadvantage of radio signal transfer. (1 + 1) (2)

4.4 Electric transmission was developed to eliminate the problems and distance limitations of pneumatic transmission and to allow the use of higher-level of technology.

4.4.1 Define the term *transmission signal*. (2)

4.4.2 Name FOUR methods of electric transmission. (4)

4.5 Differentiate between *accuracy* and *precision* as it relates to instrument readings. (2)

[15]

QUESTION 5

5.1 A liquid-in-glass thermometer is a thermal expansion thermometer consisting of a sealed, narrow-bore glass tube with a bulb at the bottom filled with a liquid.

5.1.1 Explain the basic operation of this type of thermometer. (4)

5.1.2 Name TWO of the most common substances used in filled thermometers. (2)

5.1.3 One substance was commonly used in filled thermometers in the past, however its use is now discouraged.

Explain why. (2)

5.2 Explain the functioning of each of the following positive-displacement meters:

5.2.1 Oval gear

5.2.2 Rotary vane

5.2.3 Nutating disc

(3 × 2) (6)

Copyright reserved

5.3 A bubbler is an indirect level-measuring instrument consisting of a tube extending to the bottom of a vessel, a pressure gauge and a pressure regulator.

5.3.1 Make a neat, labelled sketch of this type of level gauge. (6)

5.3.2 Explain the basic working principle of the bubbler level gauge. (6)

5.4 Define each of the following terms:

5.4.1 Linear expansion coefficient

5.4.2 Thermal potential difference

5.4.3 Turbulent flow

5.4.4 Velocity head

(4 × 1) (4)
[30]

QUESTION 6

6.1 Give the meaning of each of the following assigned instrument letters and standard instrument symbols:

6.1.1 DP

6.1.2 R

6.1.3 TIR

6.1.4 LC

6.1.5 ZI

(5 × 1) (5)

6.2 Make a neat sketch of each of the following equipment symbols:

6.2.1 Conveyor

6.2.2 Pneumatic actuated valve

6.2.3 Screw conveyor

(3 × 2) (6)

6.3 Explain the operation of an open fail-safe system. (4)
[15]

Copyright reserved

QUESTION 7

7.1 Define each of the following terms:

7.1.1 Derivative action

7.1.2 Proportional action

7.1.3 Integral action

(3 × 2) (6)

7.2 Draw a neat, labelled sketch showing a distillation column reflux and distillate system comprising each of the following components:

- Distillation column
- Condenser
- Accumulator
- Pump
- Valve
- Connecting lines (8)

7.3 Name THREE types of water-boiler drum-level control systems. (3 × 2) (6)

[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

Copyright reserved