higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 4

(6060474)

27 February 2018 (Y-Paper)
13:00–16:00

This question paper consists of 6 pages.

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TIME: 3 HOURS
MARKS: 150

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. ALL drawings must be neat and well balanced.
5. ALL work you do NOT want to be marked must be clearly crossed out.
6. Start each section on a NEW page.
7. Write neatly and legibly.

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SECTION A

QUESTION 1

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.1–1.15) in the ANSWER BOOK.

1.1 When interpreting instrument labels, the second letter inside the circle indicates a measured variable.

1.2 The acronym FRC stands for flow recorder controller.

1.3 In an open-loop control system there is no feedback signal connected to a controller to compare the process variable with the set point of the process.

1.4 Ultrasonic detectors are suitable for applications where contact with process liquid is desirable.

1.5 Particle size is not a limitation in a scatter turbidity analyser.

1.6 Microwaves are electromagnetic energy and require air molecules to be transmitted.

1.7 Density is the ratio of mass per unit volume of a substance.

1.8 The memory on a PLC is usually backed up by a battery in case of total power failure.

1.9 A solution with a pH value of seven is said to be acidic.

1.10 pH changes may affect the reflection properties of the particles in the scatter effect suspended solid and turbidity analysers.

1.11 A flanged DP transmitter should be used for liquids with a high viscosity.

1.12 An RTD is a resistance-based temperature measuring device.

1.13 A low-level supply interlock is used to shut off the supply of fuel upon loss of flame in the furnace.

1.14 The acronym LIC stands for level indicating controller.

1.15 The operating frequency range of ultrasonic instruments is around 20 kHz.

(15 × 1) (15)

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QUESTION 2

Choose a description from COLUMN B that matches a term in COLUMN A. Write only the letter (A–J) next to the question number (2.1–2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Hydrostatic head	A	supervisory control and data acquisition system
2.2	Ultrasonic or sonar	B	on or off signals: 1 or 0 respectively
2.3	Turbidity	C	device used to help prevent a machine from harming its operator or damaging itself by stopping the machine when tripping
2.4	Process flow diagram	D	measurement of time flight divided by the speed of light
2.5	pH meter	E	force or weight produced by the height of the liquid
2.6	SCADA system	F	materials to be measured reflect or affect, in a detectable manner, high-frequency sound signals generated at appropriate locations near measured materials
2.7	Programmable logic controller	G	cloudiness or haziness of a fluid caused by individual particles or suspended solids that are generally invisible to the naked eye
2.8	Discrete signals	H	electronic instrument used for measuring the acidity or alkalinity of a solution
2.9	Interlocks	I	diagram commonly used in engineering to indicate the general flow of plant processes and equipment
2.10	Time domain reflectometry	J	digital computer used for automation of electromechanical processes, such as control of machinery or factory assembly lines

(10 × 2) (20)

TOTAL SECTION A: 35

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SECTION B

QUESTION 3

3.1 Explain the basic working principle of a hydrostatic level-measuring instrument. (4)

3.2 Name and explain THREE system configurations for open-tank level measurements. (3 × 2) (6)

3.3 3.3.1 Draw a simple, labelled sketch of an ultrasonic level detector. (5)

3.3.2 Explain the working principle of the ultrasonic level detector that you have sketched in QUESTION 3.3.1 (5)

3.4 Describe the purpose and application of microwave level-measuring instruments. (4)

3.5 Distinguish between *point* and *continuous nucleonic level measurement*. (2 × 3) (6)

[30]

QUESTION 4

4.1 Briefly describe how the idea of mass measurement came about in relation to volume measurement. (6)

4.2 List FOUR factors affecting the calibration of a mass meter employing the vibrating tube technique. (4)

4.3 List THREE criteria according to which load cells are classified and give ONE example of each criteria. (3 × 2) (6)

4.4 Name FIVE major subsystems of a typical distributed control system. (5)

4.5 Define each of the following terms:

4.5.1 Mass

4.5.2 Density

(2 × 2) (4)

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QUESTION 5

5.1 Name FOUR ways to measure suspended solids in the fluid or turbidity. (4)

5.2 Draw a simple labelled sketch of an absorption suspended solid analyser. (5)

5.3 Explain the working principle of a piezoelectric humidity analyser. (5)

5.4 5.4.1 Draw a simple, labelled sketch showing the major components of a typical pH analyser. (5)

5.4.2 Explain the working principle of the typical pH analyser that you have sketched in QUESTION 5.4.1 (5)

5.5 Describe the maintenance requirements of load cells. (6)

5.6 List FIVE limitations of scattered reflection turbidity analysers. (5 × 2) (10)

[40]

QUESTION 6

6.1 6.1.1 Draw a fully labelled sketch of a cascade control loop. (6)

6.1.2 Explain the operation of the cascade control loop that you have sketched in QUESTION 6.1. (4)

6.2 Explain the difference between an *open-loop* and *closed-loop* control system. (2 × 3) (6)

6.3 Name FOUR major components of a PLC. (4)

[20]

TOTAL SECTION B: 115

GRAND TOTAL: 150

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