higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

INSTRUMENTATION TECHNOLOGY
NQF LEVEL 4

(6060474)

8 November 2018 (Y-Paper)
09:00–12:00

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

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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. Clearly cross out ALL the work you do not want to be marked.
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 (1.1–1.10) in the ANSWER BOOK.

1.1 The Doppler method is one of the techniques used in microwave level measurement.

1.2 The pH of a solution is the measurement of the hydrogen ion concentration in a liquid solution.

1.3 Torque effect suspended solid analysers operate on the principle of shear stress produced on the stationary blade placed inside the process flow.

1.4 Ultrasonic type detectors are used in applications where contact of the measuring instrument with the liquid in process is desirable.

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

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

1.7 The pressure exerted by a liquid is independent of volume and shape.

1.8 Errors in hydrostatic level measurement can be caused as a result of temperature.

1.9 Level conductivity meters can easily be used in the oil milling industry.

1.10 Static alignment of a DP cell must be done when the zero output is not stable.

(10 × 1) **[10]**

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QUESTION 2

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (2.1–2.10) in the ANSWER BOOK.

2.1 Methods used for ultrasonic level measurement include the …

A sonar method.
B frequency difference method.
C pressure difference method.
D hot-wire method.

2.2 Increasing the temperature of a process liquid, decreases it's …

A conductivity.
B number of ions.
C viscosity.
D cell constant.

2.3 Which ONE of the following PH values indicates a basic solution?

A 0
B 4
C 7
D 11

2.4 Which ONE of the following meters is NOT an example of a humidity (dew point) analyser?

A Hair hygrometer
B Electrolytic hygrometer
C Thermal electrical dew point hygrometer
D Handheld hydrometer

2.5 Humidity is defined as …

A mass per unit volume of a substance.
B force per unit area of a substance.
C amount of water vapour present in a sample.
D resistance to flow of a liquid.

2.6 Which ONE of the following transmitters is suitable to be used for level measurement of liquids with a low viscosity?

A Standard DP transmitter
B Flanged DP transmitter
C Remote seal transmitter
D Analytic transmitter

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2.7 The acronym FRC on a process loop drawing refers to …

A temperature-indicating controller.
B flow recorder.
C level-indicating controller.
D flow recorder controller.

2.8 According to ISA standards - Instrumentation symbols and identification - Instrument labels are indicated inside a circle. The second letter inside the circle indicates the:

A measured variable
B function of the instrument
C controlled variable
D set point

2.9 Which ONE of the following statements describes an advantage of the ultrasonic level measurement device:

A Non-contact type.
B Work in areas involving high pressure conditions.
C Not affected by heavy vapours, foams and powder.
D Low accuracy measurement.

2.10 A … is a diagram commonly used in engineering to indicate the general flow of plant processes and equipment.

A PID
B PFD
C PLC
D DCS

(10 × 2) **[20]**

TOTAL SECTION A: 30

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SECTION B

QUESTION 3

3.1 Briefly explain what you understand by the term *level measurement*. (4)

3.2 Name THREE major components of a nucleonic level measuring instrument. (3)

3.3 List THREE disadvantages of an ultrasonic level measurement. (3)

3.4 Explain the principle of operation of a torque or shear effect turbidity analyser. Also mention the limitations of the torque effect. (5)

3.5 3.5.1 Draw any suitable arrangement for point sensing in a continuous nuclear level measurement. (5)

3.5.2 Briefly describe the measuring principle for the arrangement drawn in QUESTION 3.5.1. (5)

[25]

QUESTION 4

4.1 Explain the following methods for mass measurement and give an example where possible.

4.1.1 Inferred mass measurement

4.1.2 Direct mass measurement

(2 × 3) (6)

4.2 Convert 10 g/cm³ to kg/m³. (6)

4.3 4.3.1 Draw a simple labelled sketch illustrating the construction of a load cell. (4)

4.3.2 Explain the basic working principle of the load cell drawn in QUESTION 4.3.1. (5)

4.4 Describe the maintenance requirement of load cells. (4 × 1) (4)

[25]

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QUESTION 5

5.1 Name FIVE energy sources that are used in the absorption effect turbidity analyser. (10)

5.2 Briefly explain the functions of the following components of a PH meter:

5.2.1 A measuring electrode. (3)

5.2.2 A reference electrode. (4)

5.3 List SIX installation practices regarding turbidity analysers. (6)

5.4 Name THREE factors that can affect the accuracy of in-line pH analysers. (3)

5.5 Metallic electrodes are subject to poisoning by traces of quantities of impurities in electrolytic solution.

Discuss the maintenance requirements of these electrodes. (4)

5.6 Name and explain FIVE common problems associated with in-line humidity analysers. (5 × 2) (10)

5.7 Explain with the aid of a simple labelled sketch the principle of operation of a scattered effect suspended solid turbidity analyser. (6 + 4) (10)

[50]

QUESTION 6

6.1 What is the purpose of SCADA? (3)

6.2 Name the THREE main elements of SCADA. (3)

6.3 Explain the following interlock configurations as used in boilers in control systems.

6.3.1 Purge interlock

6.3.2 Low airflow interlock (2 × 2) (4)

6.4 Explain in detail the function of the transmitter in a process control system. (3)

6.5 Define the following terms as applicable to control systems:

6.5.1 Deviation (2)

6.5.2 Set point (2)

6.5.3 Split range (3)

[20]

TOTAL SECTION B: 120
GRAND TOTAL: 150

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INSTRUMENTATION TECHNOLOGY L4

FORMULA SHEET

(1) $°F = \frac{9}{5}K - 459.67$

(2) $K = \frac{5}{9}[°F + 459.67]$

(3) $K = °C + 273.15$

(4) $\text{Volume} = \text{area} \times \text{base}$

(5) $\Delta P = \rho g h$

(6) $\text{Percentage} = \frac{\text{Measured variable}}{\text{Total output}} \times 100$

(7) $A = \frac{\pi d^2}{4}$

(8) $P = \frac{F}{A}$

(9) $F = mg$

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