



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T910(E)(A4)T

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N3

(11040463)

4 April 2019 (X-Paper)

09:00–12:00

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

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
INSTRUMENT TRADE THEORY N3
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. Write neatly and legibly.
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QUESTION 1

Various options are given as possible answers to the following questions. Choose the answer and write only (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 A ... is a transducer that does not require a power supply.

- A thermistor
- B thermocouple
- C strain gauge
- D potentiometer



1.2 A/An ... error is considered an error in temperature measurement when thermocouples are used.

- A parallax
- B installation
- C zero
- D capillary

1.3 The ... is NOT a factor to be considered when choosing a valve.

- A type of plug
- B valve size
- C valve curve
- D valve positioner



1.4 ... is a frictional load that is found in a pneumatic control valve.

- A Weight and inertia
- B Dynamic and inertia
- C Inertia and static
- D Dynamic and static

1.5 The following statement explains the ... effect: When two wires of different materials are joined together, an EMF is generated in the circuit, if one junction is heated and the other is kept at a constant temperature.

- A Petier
- B Thompson
- C Bernoulli
- D Seebeck



1.6 The theory of the application of control in the regulation of a process without direct human intervention is referred to as ... control.

- A manual
- B cascade
- C automatic
- D fuzzy



1.7 An advantage of a piezo-electric transducer is ...

- A temperature variations.
- B a signal conditioning system.
- C that it can generate EMF.
- D long leads.

1.8 A group of thermocouples connected in series is called a ...

- A thermopile.
- B pyrometer.
- C thermostat.
- D thermistor.



1.9 A/an ... is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit.

- A Wien bridge
- B Wheatstone bridge
- C capacitive bridge
- D inductive bridge

1.10 A valve ... is a device that compares a control signal to a valve actuator and moves the actuator stem in accordance with the value of the input signal.

- A plug
- B positioner
- C actuator
- D stem



(10 × 1) [10]

QUESTION 2

Choose a/an item/word/description from COLUMN B that matches a/an item /description in COLUMN A. Write only the letter (A–L) next to the question number (2.1–2.10) in the answer book.



COLUMN A		COLUMN B
2.1	It is used to standardize the current flow in a potentiometer circuit	A control point
2.2	The mathematical expression or formula for a gauge factor	B compensating gauge
2.3	An instrument that measures resistance but is calibrated in temperature units	C relay valve
2.4	A strain gauge that consists of a wire which is wound around cores and structures	D measured variable
2.5	It is used as a thermostat for temperature control in some electric appliances	E $K = \frac{\Delta R/R}{\Delta L/L}$
2.6	Function to be controlled, for example flow, temperature, level or pressure	F bonded strain gauge
2.7	A strain gauge which is connected to the unstressed part of the object of which the strain has to be monitored	G standard cell
2.8	The point at which the controller actually regulates the process	H off-set
2.9	It is used to minimize time lag in pneumatic telemetering systems	I non-bonded strain gauge
2.10	The difference between the value of the measured signal and the set point	J resistance thermometer
		K active gauge
		L bimetallic strip



(10 × 1)

[10]

QUESTION 3

- 3.1  A transducer works on the following principle: The electrical resistance of a conductor will change when tension or pressure is applied to it.
- 3.1.1 What type of transducer is referred to in the statement above? (2)
- 3.1.2 Give the mathematical expression or formula for the transducer you mentioned in QUESTION 3.1.1. Also explain the symbols and give their SI-units. (5)
- 3.1.3 Explain TWO things that will happen simultaneously to a wire (conductor) when tension is applied to it. (3)
- 3.1.4 Name FOUR areas of application for the transducer you mentioned in QUESTION 3.1.1. (4)
- 3.2 An inductance-type transducer can be used to measure pressure.
- Show, with the aid of a diagram, how this can be done.  (6)
- [20]**

QUESTION 4

- 4.1 Convert 300 °C into its equivalent temperatures in:
- 4.1.1 Kelvin scale (2)
- 4.1.2 Fahrenheit scale (3)
- 4.2 Explain in your own words, how the calibration of a total-radiation pyrometer is done.  (5)
- 4.3 Temperature can be measured with the aid of a thermistor.
- Name FIVE characteristics of a thermistor. (5)
- 4.4 Make a neat, labelled sketch of a potentiometer circuit with automatic cold-junction compensation. Use the correct names of the resistors in the circuit. (5)
- [20]**

QUESTION 5

- 5.1 Make a sketch of a continuous bleed, reverse-acting pneumatic relay valve. (6)
- 5.2 Explain the operation for the sketch you made in QUESTION 5.1.  (4)
- 5.3 A variation of the supply voltage is one of the disadvantages of electrical telemetering. Readings will vary as the supply varies. The supply must therefore be stabilized.
- 5.3.1 State THREE methods of counteracting the effects of a supply voltage variation. (3)
- 5.3.2 Make a sketch of a conductive-type telemetering system for transmission and measuring signals which represent a differential pressure.  (7)
- [20]**

QUESTION 6

- 6.1 Draw a block diagram of butterfly valves in the open position. (4)
- 6.2 Make a neat, labelled sketch of an ON–OFF electronic controller. (10)
- 6.3 What is a controller? (2)
- 6.4 Briefly describe how a controller works  (2)
- 6.5 Define 'Integral Action' as applied in control systems (2)
- [20]**

TOTAL: 100

INSTRUMENT TRADE THEORY N3

FORMULA SHEET

$$(1) \quad R_s = \frac{V_{sc}}{I_s}$$

$$(2) \quad R_z = \frac{V_{min}}{I_s} + R_{cj}$$

$$(3) \quad R_{sh} = \frac{R_{sw} \times R_t}{R_{sw} - R_t}$$

$$(4) \quad R_t = \frac{V_{max} - V_{min}}{I_s}$$

$$(5) \quad R_u = \frac{V_{sc} - V_{max}}{I_s}$$

$$(6) \quad I_s = \frac{1}{sensitivity}$$

$$(7) \quad R_{cj} = R_0 + \Delta R$$

$$(8) \quad \Delta R = \propto R_0 T$$

$$(9) \quad \Delta R = \frac{\Delta V}{I_s}$$

$$(10) \quad t[^{\circ}\text{C}] = T(\text{K}) - 273,15$$

$$(11) \quad ^{\circ}\text{F} = \frac{9}{5}^{\circ}\text{C} + 32$$