higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T910**(E)**(A2)T

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N3

(11040463)

2 August 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
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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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SECTION A

QUESTION 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 (1.1–1.10) in the ANSWER BOOK.

1.1 A body that absorbs all the radiation falling upon it radiates energy at all wavelengths of the spectrum at maximum rate.

A Stefan Boltzmann's law
B Provost's theory of heat exchange
C Black body condition
D Pyrometry theory

1.2 A … is used in a flapper nozzle system to be able to control the output air effectively when sudden changes occur from the primary element.

A relay valve
B valve plug
C valve positioner
D positioner

1.3 … action is defined as the action of a controller where the output signal is changed at a rate depending on the size of the measured deviation.

A Proportional
B Derivative
C Integral
D ON-OFF control

1.4 A … is a device used for measuring an unknown voltage, by comparing it to a known voltage.

A thermistor
B pyrometer
C thermocouple
D potentiometer

1.5 Which type of pyrometer does not require an operator to balance the instrument in order to record the temperatures?

A Disappearing filament optical pyrometer
B Wedge-type disappearing filament optical pyrometer
C Photoelectric optical pyrometer
D Mirror-type pyrometer

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1.6 A … telemetering system is used when an electric supply is not present.

A pneumatic
B ratiometer
C conductance
D position

1.7 A … is a temperature sensitive resistor.

A strain gauge
B light-dependent resistor
C potentiometer
D thermistor

1.8 The … system is used to vary the pressure of the output signal which is proportional to the measured variable.

A flapper-and-nozzle
B continuous bleed
C non-bleed-type
D voltage telemetering

1.9 A capacitive transducer can be used to measure …

A displacement.
B force.
C weight.
D pressure.

1.10 A linear differential transformer can be used to measure …

A resistance.
B displacement.
C torque.
D temperature.

(10 × 1) **[10]**

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QUESTION 2

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

COLUMN A		COLUMN B	
2.1	The time it takes for the proportional action to repeat the derivative action	A	3–15 PSI
2.2	The resistance of a conductor is changed when an external stress is applied	B	pyrometer
2.3	An opposition to the generation of magnetic fields	C	integral action time
2.4	Resistor used to read the voltage in excess of the maximum voltage required by the slider wire	D	Zero resistor
2.5	It is used as a thermostat for temperature control in some electric appliances	E	ON-OFF control
2.6	When the controller controls between two extreme outputs	F	strain gauge
2.7	Feedback element	G	derivative action time
2.8	The standard output for a pneumatic system	H	bonded strain gauge
2.9	Measurements are relatively independent of the distance from the body of which the temperature has to be measured	I	proportional control
2.10	A dimensionless quantity that relates the mechanical properties to the electrical properties	J	reluctance
		K	upper resistor
		L	gauge factor
		M	bimetallic strip
		N	reduce vibrations

(10 × 1) **[10]**

TOTAL SECTION A: 20

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SECTION B

QUESTION 3

3.1 Load cells are commonly used to determine the level of solid substances or for the weighing of material in a storage bin or tanks.

3.1.1 What type of strain gauge is a load cell? (1)

3.1.2 Make a neat, labelled sketch to show how load cells are used to measure the mass of solid substances in storage tanks. (5)

3.1.3 Briefly discuss the principle of operation of load cells as shown in the sketch in QUESTION 3.1.2. (6)

3.2 Explain the term *piezo-electric effect*. (2)

3.3 Make a neat, labelled sketch of linear variable differential transformer. (6)
[20]

QUESTION 4

4.1 A resistance thermometer is an instrument which measures resistance but is calibrated in temperature units.

4.1.1 Make a neat, labelled sketch of this type of thermometer. (6)

4.1.2 Explain the principle of this type of thermometer. (4)

4.2 The resistance of a resistance thermometer is 33 Ω at 25 °C.

Calculate the resistance at 100 °C if $\propto$ = 0,004 Ω/Ω °C. (5)

4.3 Make a neat, labelled sketch of a thermocouple. (5)
[20]

QUESTION 5

5.1 What is the pneumatic standard output of the following in South Africa:

5.1.1 Zero

5.1.2 Full range

(2 × 1) (2)

5.2 Make a neat, labelled sketch of a flapper nozzle system with feedback bellows. (6)

5.3 Make a neat, labelled sketch of a current telemetering system and explain its principle of operation. (10)

5.4 State TWO defects of the system mentioned in QUESTION 5.2. (2)
[20]

QUESTION 6

6.1 A closed-loop system, also known as a feedback control system, uses the concept of an open-loop system as its forward path but has one or more feedback loops between its output and its input.

6.1.1 Draw a neat, labelled block diagram of a closed-loop system. (7)

6.1.2 Explain the principle of operation of the closed-loop system mentioned in QUESTION 6.1.1. (4)

6.2 Make a neat, labelled sketch of proportional force balance pneumatic controller. (7)

6.3 Name TWO actions that valve plugs are commonly designed for. (2)
[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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INSTRUMENT TRADE THEORY N3

FORMULA SHEET

1. $R_s = \frac{V_{sc}}{I_s}$

2. $R_z = \frac{V_{min}}{I_s} + R_{cj}$

3. $R_{sh} = \frac{R_{sw} \times R_t}{R_{sw} - R_t}$

4. $R_t = \frac{V_{max} - V_{min}}{I_s}$

5. $R_u = \frac{V_{sc} - V_{max}}{I_s}$

6. $I_s = \frac{1}{sensitivity}$

7. $R_{cj} = R_0 + \Delta R$

8. $\Delta R = \propto R_0 T$

9. $\Delta R = \frac{\Delta V}{I_s}$

10. $R_T = R_0[1 + \alpha T]$

11. $R_T = Ae^{\frac{B}{T}}$

12. $\mathrm{t}[^0\mathrm{C}] = \mathrm{T(K)} - 273{,}15$

13. $°\mathrm{F} = \frac{9}{5}°\mathrm{C} + 32$

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