higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

T910(**E**)(J31)T

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N3

(11040463)

31 July 2018 (X-Paper)
09:00–12:00

This question paper consists of 9 pages and 1 formula sheet.

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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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SECTION A

QUESTION 1

1.1 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 (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 The presence of the stuffing box or gland through which the shaft travels may cause a dynamic friction load, particularly if a viscous fluid is present, and is called …

A static friction.
B dynamic friction.
C friction load.
D pressure load.

1.1.2 If moving parts are in contact, static friction forces are set up tending to oppose any travel:

A Static friction
B Dynamic friction
C Friction load
D Pressure load

1.1.3 Instrument which measures resistance but is calibrated in temperature units:

A Pyrometer
B Thermistor
C Thermocouple
D Resistance thermometer

1.1.4 Made from metal oxides and has a negative temperature coefficient:

A Pyrometer
B Thermistor
C Thermocouple
D Resistance thermometer

1.1.5 Method to compensate for supply voltage variations:

A A regulator called a barretter lamp is used.
B The supply voltage must be stabilised.
C To compensate for this the resistance value of the receiver is made very high.
D To compensate for this the load resistance is made much larger than the potentiometer resistance.

(5 × 1) (5)

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1.2 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 The value of the load resistance does not affect the operation of an electrical telemetering system.

1.2.2 The lead wires between the receiver and the transmitter have an effect on the total resistance of the system.

1.2.3 A ratiometer instrument can be used to compensate for supply voltage variations.

1.2.4 Process lag concerns the capacity (tank of liquid) and the resistance (valves) of a process.

1.2.5 Proportional control is used to counteract the deviation or change in a process.

(5 × 1) (5)
[10]

ECS

QUESTION 2

Choose a term from COLUMN B that matches a 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	Action of a controller where the magnitude (size) of the output signal is dependent on the rate (speed) at which the measured deviation changes	A	integral action
2.2	Action of a controller where the output signal is changed at a rate (speed) depending on the magnitude (size) of the measured deviation	B	pneumatic telemetering
2.3	Action of a controller where the magnitude (size) of the output signal is equal to the (size) to the measured deviation	C	feedback element
2.4	Difference between the measured value and the set point	D	derivative action
2.5	Group of thermocouples connected in series	E	optical pyrometer
2.6	If valve possesses any unbalanced weight in the moving parts, this constitutes a load to be supported by the motor	F	total radiation pyrometer
2.7	Pyrometer which is nothing more than a photometer using monochromatic light	G	relay valve
2.8	Used when an electrical supply is not present	H	offset
2.9	Amplifies pressure	I	proportional action
2.10	Reduces vibration	J	thermopile
		K	pressure load
		L	weight load

(10 × 1) **[10]**

TOTAL SECTION A: 20

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SECTION B

QUESTION 3

3.1 A strain gauge is a device used to measure strain on an object.

3.1.1 Explain the principle upon which all strain gauges operate and give a basic formula that illustrates this principle. (5)

3.1.2 Explain the construction of non-bonded and a bonded strain gauge. (4)

3.1.3 Explain the term *gauge factor* as applicable to strain gauge. (1)

3.2 Show, with the aid of sketches, how one or more strain gauges can be used to do the following:

3.2.1 Measuring low pressures (5)

3.2.2 Measuring small differential pressures (5)
[20]

QUESTION 4

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

4.1.1 A platinum coil has a resistance of 38 Ω at 0 °C.

$\grave{\alpha} = 3,92 \times 10^{-3}$ and $\beta = -5,88 \times 10^{-7}$.

Calculate the resistance at 500 °C. (3)

4.1.2 The resistance of thermo-ohm is 150 Ω at 25 °C.

$\grave{\alpha} = 0,00392$ /°C.

Calculate the resistance at 0 °C. (2)

4.2 Give a definition for each of the following:

4.2.1 Seebeck effect (2)

4.2.2 Peltier effect (2)

4.3 In a potentiometer circuit used for temperature measurement, all resistances are manufactured from material of which resistance changes very little with temperature change, except for one resistance.

4.3.1 Name this resistor and explain why its value must change. (4)

4.3.2 One of the resistors has a variable resistance.

Explain what is adjusted with the aid of this resistance. (2)

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4.3.3 Another component in the circuit supplies a constant voltage.

Explain why this constant voltage is required. (3)

4.3.4 Another resistance is connected parallel with the slider wire.

Explain the reason for this arrangement. (2)
[20]

QUESTION 5

5.1 Pneumatic systems are characterised by the simplicity of the technology on which they are based and the relative ease with which they can be installed, operated and maintained. They are based on the use of a flapper-and-nozzle system in conjunction with a pneumatic relay to detect a very small relative movement.

5.1.1 Make a neat, labelled sketch of a flapper-and-nozzle system with feedback bellows and a relay valve. (5)

5.1.2 Discuss the principle of operation of the system in QUESTION 5.1.1. Clearly indicate the function of the feedback bellows and the relay valve. (5)

5.1.3 Name FOUR disadvantages of a flapper-and-nozzle system. (4)

5.2 State THREE factors which can adversely affect the operation of electrical telemetering systems, and explain how the effects of these factors can be counteracted. (6)
[20]

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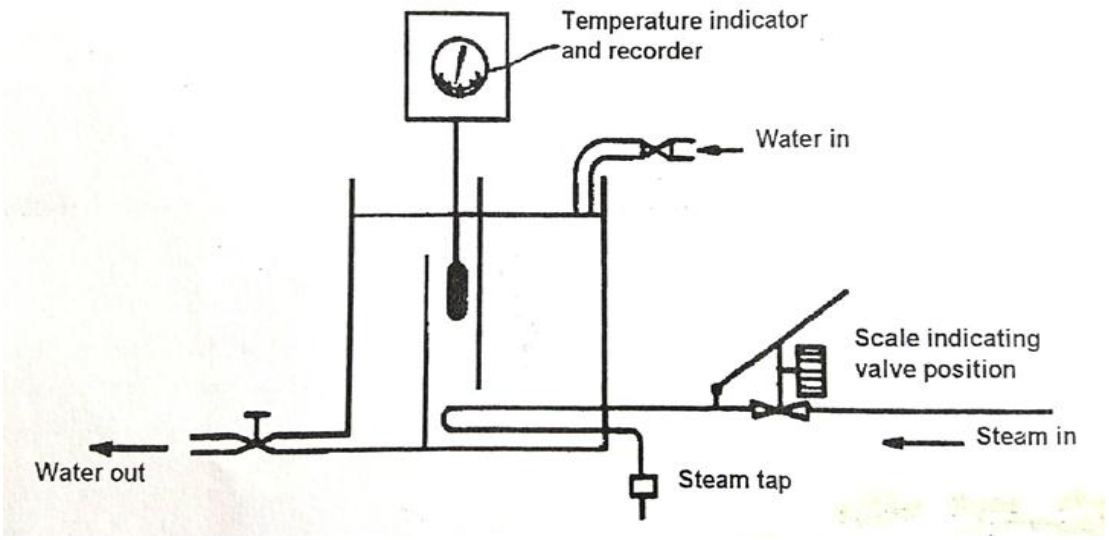
QUESTION 6

6.1 Give the names of the control actions and curves in the diagram below by writing the answer next to the letter (A–F) in the ANSWER BOOK.

INPUT / CONTROL ACTIONS	STEP:	PULSE:	RAMP:
A			
B			
C			
D			
E			
F			

(6)

6.2 An operator must control the temperature of water which is flowing at a constant rate through a tank as shown below. The water is heated by passing steam through a heating coil at the bottom of the tank. The operator varies the flow of steam by means of a valve and attempts to control the water at 80 °C.



6.2.1 What is the name of the control system he uses? Justify your answer. (2)

6.2.2 Suppose the steam flow control valve has two positions only.

- Position 1 is such that the valve is closed and no steam flows.
- Position 2 is such that the supply of steam is sufficient to maintain the temperature of the outgoing water at 80 °C.

Name the control action employed. (2)

6.2.3 Define the control action you have named in QUESTION 6.2.2. (2)

6.2.4 Make neat, labelled sketches showing how the temperature of water varies around the set point and also how the valve positions must be changed by the operator to control the water temperature at 80 °C. (4)

6.3 Make a neat, labelled diagram for the proportional position balance controller. (4)
[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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INSTRUMENT TRADE THEORY N3

FORMULA SHEET

$P_G = Pabs - Pa$

$P_1 - P_2 = h\Delta g$

$P_1 - P_2 = d\rho g\left(\frac{A_1}{A_2}+1\right)$ ***OR***

$P_1 - P_2 = d\rho g\left(\frac{A_2}{A_1}+1\right)$

$p = \frac{Mg}{A}$

$\frac{Q_1}{Q_2} = \frac{k\sqrt{h_1}}{k\sqrt{h_2}}$

$Dry\ calibration = \frac{P_1 - P_2}{\rho g}$

$Wet\ calibration = \frac{P_1 - P_2}{(\rho_2 - \rho_1)g}$

$W.C. = \left(\frac{\rho_2}{\rho_2 - \rho_1}\right) \times D.C.$

$D.C. = \left(\frac{\rho_2 - \rho_1}{\rho_2}\right) \times W.C.$

$H = \frac{\Delta P}{\rho g}$

$H = h\left(\frac{\rho_2}{\rho_1} - \frac{1}{2}\right)$

$H = \frac{\rho_2}{\rho_1}h - \frac{h}{2} - H = \left(\frac{P2}{P1} - \frac{1}{2}\right)h - H_1$

$t°C = \frac{9}{5}t + 32°F$

$t°C = (t + 273{,}15)\ kelvin$

$t°F = \frac{5}{9}(t - 32)\ °C$

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