higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N3

26 November 2024

This marking guideline consists of 6 pages.

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QUESTION 1

1.1 1.1.1 False
1.1.2 True
1.1.3 True
1.1.4 True
1.1.5 False

(5 × 1) (5)

1.2
- It is used in a weighbridge to determine the load carried by trucks.
- It measures strain directly, which can be used to indirectly determine stress, torque, pressure, deflection of beams and building weight tanks and vessel levels.
- A strain gauge can be used to give a clearer idea of how a material is behaving under load in any design or build, where physical stress analysis is an important factor.
- It is often used in medical instruments such as kidney dialysis machines and syringe pumps to help monitor the fluid flow rate. (Any 2 × 1)

(marker to use discretion) (2)

1.3
- Grid-type strain gauge
- Rosette-type strain gauge
- Spiral-type strain gauge
- Helical-type strain gauge (Any 3 × 1) (3)

1.4 1.4.1 The sketch demonstrates the use of a strain gauge to measure low pressure. (1)

A Strain gauge
B Temperature-compensating gauge
C Flexible beam
D Bellows
E Pressure (5)

1.4.3
- The resistance of active strain gauges is affected by the surrounding temperature,✓
- therefore it causes incorrect readings of the strain.✓
- A compensating strain is connected closer to the active strain gauge✓
- to cancel the resistance change in the active gauge due to temperature changes in the circuit.✓ (4)

1.5
- When some mechanical pressure is applied across faces of a quartz crystal,✓
- a voltage proportional to the applied mechanical pressure appears across the crystal.✓
- Conversely, when voltage is applied across the crystal's surfaces,✓
- the crystal is distorted by an amount proportional to the applied voltage.✓

This phenomenon is known as the piezoelectric effect. (4)

[24]

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QUESTION 2

2.1 $I_s = \frac{1}{sensitivity} = \frac{1}{220} = 0{,}00455\ A$✓

$\Delta R = \frac{\Delta V}{I_s} = \frac{0{,}001}{0{,}004545} = 0{,}219\ \Omega$✓

$R_0 = \frac{\Delta R}{\alpha T} = \frac{0{,}219}{0{,}0043 \times 25} = 2{,}037\ \Omega$✓

$R_{cj} = R_0 + \Delta R = 2{,}037 + 0{,}219 = 2{,}256\ \Omega$✓✓

$R_s = \frac{V_{sc}}{I_s} = \frac{1{,}02}{0{,}00452} = 224{,}176\ \Omega$ ✓

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

$R_z = \frac{0{,}008}{0{,}00455} + 2{,}256$ ✓

$= 4{,}014\ \Omega$ ✓

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

$R_t = \frac{41 \times 10^{-3} - 0{,}008}{0{,}00454}$ ✓

$= 7{,}253\ \Omega$✓

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

$R_{sh} = \frac{25 \times 7{,}253}{25 - 7{,}253}$ ✓

$= \frac{181{,}319}{17{,}747}$✓

$= 10{,}217\ \Omega$ ✓

$R_u = \frac{V_{std\ cell} - V_{max}}{I_s}$

$R_u = \frac{1{,}02 - 41 \times 10^{-3}}{0{,}00454}$ ✓

$= 215{,}165\ \Omega$✓ (15)

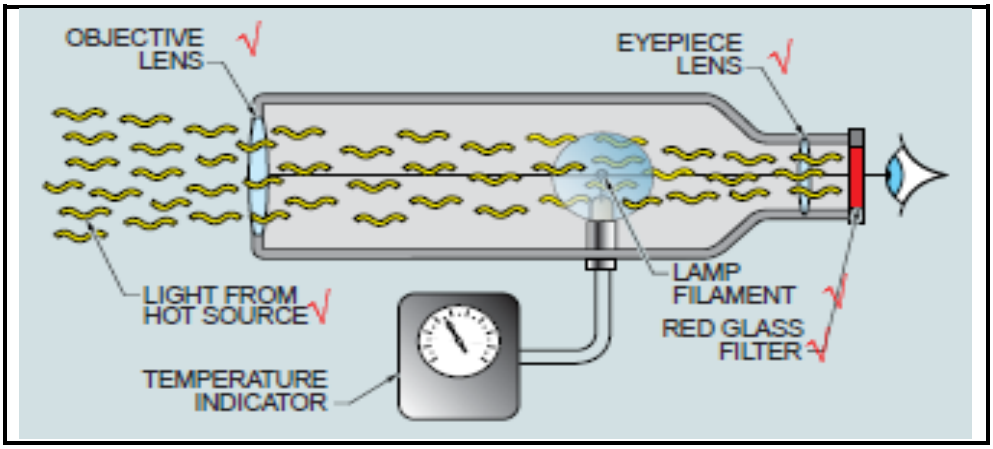
2.2
- Thermistors are made of metal oxides.✓
- The oxides used are that of cobalt, iron, tin and zinc.✓
- The oxides in powder form are pressed into a shape✓
- and then heated forming a ceramic body.✓
- Two terminals are also added before the heating process.✓
- There are a few shapes such as beads, rods, discs and washers.

(Any 5 × 1) (5)

2.3 2.3.1
- An optical pyrometer is a photometer using monochromatic light✓
- which compares the intensity of the radiation✓ from a standard source
- with the intensity of radiation emitted✓
- by the body of which the temperature is to be measured.✓ (4)

2.3.2
- There is no need for contact with the body of which temperature is to be measured, i.e. temperatures can be measured remotely.
- The body of which the temperature is being monitored can be stationary or moving.
- The measurements are independent of the distance between the body and the pyrometer. (Any 1 × 1) (1)

2.3.3



(5)

(marker to use discretion) **[30]**

QUESTION 3

3.1
3.1.1 F
3.1.2 A
3.1.3 D
3.1.4 E
3.1.5 B

(5 × 1) (5)

3.2 3.2.1

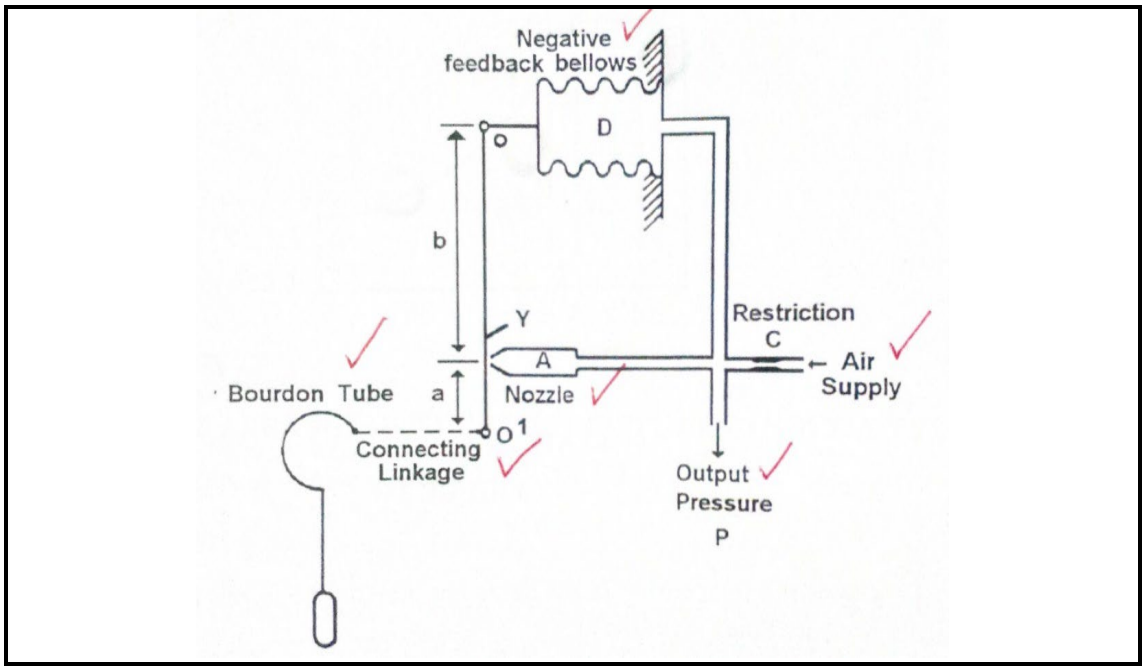
- Accurate calibration
- Reduces vibration
- Linear relationship between measured variable and output

3.2.2

- Provides a greater volume of air
- Amplifies the pressure
- Higher speed

(2 × 2) (4)

3.3



(1 mark each for 6 labels) (6 × 1) (2 marks for the sketch) (8)

3.4 3.4.1

- In a reverse-acting actuator an increase in the pneumatic pressure applied to the diaphragm lifts the valve stem, opening the valve✓
- and the output pressure increases✓
- and a decrease in the applied pressure closes the valve decreasing the output pressure.✓

3.4.2

- In a direct-acting actuator, an increase in the pneumatic pressure applied to the diaphragm extends the valve stem,✓
- this will close the valve, decreasing the output pressure.✓
- A decrease in the applied pressure will increase the output pressure.✓

(2 × 3) (6)

[23]

QUESTION 4

4.1	4.1.1	Closed-loop control system	(1)
	4.1.2	Level	(1)
	4.1.3	• D/P stands for differential pressure.✓ • PV stands for process variable.✓ • SP stands for set point.✓	(3)
	4.1.4	• The level set point is at 50%.✓ • If the liquid is pumped out and the level drops below 50%,✓ • the controller will compare the process variable signal with the set point and generate an error signal.✓ • This error signal is sent to the pneumatic valve to open and refill the tank.✓ • As the level in the tank rises ,the error is reduced until it is zero.✓	(5)
4.2	4.2.1	Proportional✓ plus integral✓ plus derivative✓ electronic controller	(3)
	4.2.2	• When an error signal appears at the input, the capacitor C (in) charges✓ • and a voltage is obtained at point A which is also an input to the amplifier.✓ • A feedback voltage is now produced✓ • and appears at the C(fb) to counteract the error signal✓ • and the voltage at point A returns to zero.✓	(5)
	4.2.3	• The integral potentiometer provides a discharge path for C (in) which creates a potential at point A.✓✓ • This action where the capacitors are discharged and the input to the amplifier is zero✓ • will result in a condition where the output has recovered before an input signal appears at the amplifier.✓	(4)
4.3	Proportional band		(1)
			[23]
		TOTAL:	**100**

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