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INSTRUMENT TRADE THEORY N3

(11040463)

7 April 2020 (X-paper)
09:00–12:00

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

136Q1A2007

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. Use only a black or a blue pen.
 5. Sketches must be large, neat and fully labelled.
 6. Write neatly and legibly.
-

QUESTION 1

- 1.1 State the principle upon which the strain gauge works. (2)
- 1.2 Make drawings of differential transformers and show the following conditions:
 - 1.2.1 When both EMF's are equal (2)
 - 1.2.2 When one EMF is greater than the other (2 x 3) (6)
- 1.3 A rare-earth pressure transducer is used to measure blood pressure variations.
 - 1.3.1 Make a drawing of the rare-earth transducer. (4)
 - 1.3.2 State FIVE advantages of a rare-earth transducer. (5)
- 1.4 A transducer is shown in FIGURE 1.

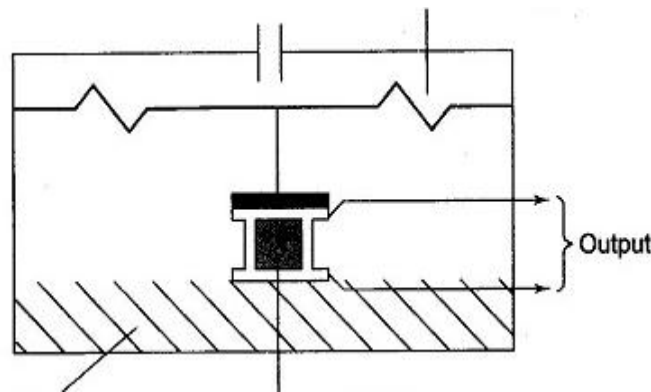



FIGURE 1

- 1.4.1 Name the transducer shown in FIGURE 1. (1)
- 1.4.2 Explain the principle of operation of the transducer in FIGURE 1. (4)
- 1.4.3 State THREE disadvantages of the transducer shown in FIGURE 1. (3)

[25]


QUESTION 2

2.1 Various options are given as possible answers to the following questions. Choose the answer and write only (A–C) next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

2.1.1 The law of ... states that an electrical current cannot be maintained in a single homogeneous metal by means of heat alone. 

- A homogenous metals
- B intermediate metals
- C immediate temperatures

2.1.2 A type T-thermocouple consists of the following two types of metals:

-  A Copper and constantan
- B Iron and constantan
- C Chromel and alumel

2.1.3 A ... has a negative temperature coefficient.

- A thermistor
- B resistance thermometer
- C pyrometer

2.1.4 Thermometry deals with the measurement of ...

- A temperature.
- B resistance.
- C expanded material.

2.1.5 An advantage of a ... is that direct contact with the heated body is not necessary.

- A pyrometer 
- B thermistor
- C resistance thermometer (detector) (RTD)

(5 × 1)

(5)

2.2 Study the sketch in FIGURE 2 and answer the questions.

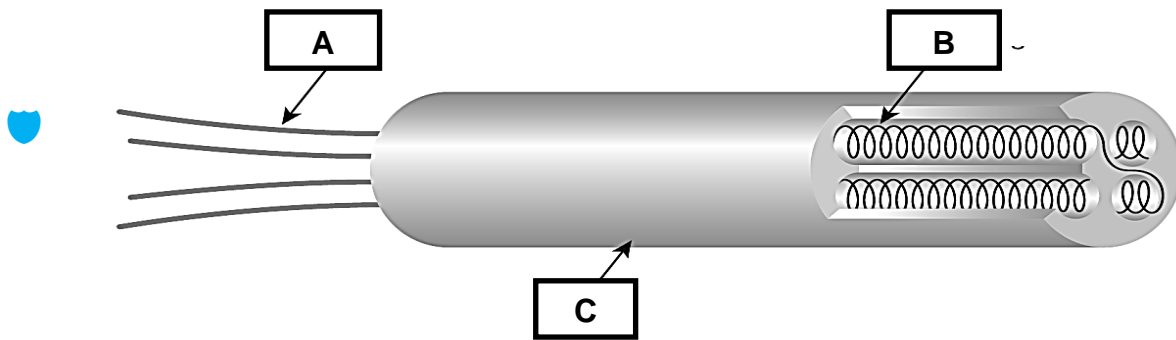


FIGURE 2

- 2.2.1 Name the parts indicated on the sketch in FIGURE 2 by writing only the answer next to the letter (A–C) in the ANSWER BOOK. (3)
- 2.2.2 What is the function of the powder that surrounds B in FIGURE 2? (2)
- 2.2.3 Discuss the basic working principle of a platinum resistance thermometer (detector) (RTD). (5)

2.3 Design a potentiometer for temperature measurements which has automatic cold junction compensation and supply voltage standardisation.

The following is supplied:

Temperature range $0\text{ }^{\circ}\text{C}$ to $600\text{ }^{\circ}\text{C}$

An EMF of $24,9\text{ mV}$ is supplied by a thermocouple with a hot junction of $600\text{ }^{\circ}\text{C}$ and a cold junction of $0\text{ }^{\circ}\text{C}$.

Supply voltage $1,5\text{ V}$

Standard cell voltage $1,018\text{ V}$

Room temperature $20\text{ }^{\circ}\text{C}$

Slide wire resistance $25\ \Omega$

Resistance of cold junction compensator $3\ \Omega$

Assume that both branch currents are 2 mA .

(10)
[25]

QUESTION 3

3.1 Telemetering is the reproduction at a convenient location, of measurement made at a remote point.

3.1.1 Draw a neat, labelled diagram of a voltage telemetering system. (5)

3.1.2 Explain how voltage telemetering takes place. (4)

3.1.3 Make a neat, labelled sketch of a ratio telemetering system that uses a copper sleeve. (6)




3.2 Choose the description from COLUMN B that matches an item in COLUMN A. Write only the letter (A–J) next to the question number (3.2.1–3.2.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.2.1	A regulator, called a barrater lamp is used	A	science of measuring data at a remote location by using electrical or pneumatic methods
3.2.2	Lead wires	B	with only the supply pressure on the relay, no air will bleed to the atmosphere
3.2.3	Telemetry	C	continuous bleed
3.2.4	Function of the feedback element	D	factor which affects the operation of electrical telemetering systems
3.2.5	Nonbleed-type relay	E	disadvantage of a flapper and nozzle system
3.2.6	Leakages	F	function of the relay
3.2.7	Variations in supply pressure	G	used to vary the pressure of the output signal which is proportional to the measured variable
3.2.8	Amplifies the pressure	H	linear relationship between measured variable and output
3.2.9	Disadvantage of a pneumatic system	I	disadvantage of a pneumatic system
3.2.10	Flapper and nozzle system	J	method to compensate for supply voltage variations

(10 × 1)

(10)
[25]

QUESTION 4

- 4.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (4.1.1–4.1.5) in the ANSWER BOOK.
- 4.1.1 The valve plug is that movable part of a valve body assembly which provides a variable restriction to flow. 
- 4.1.2 Valve plugs are normally designed for two-position control or for throttling.
- 4.1.3 A positioner is a device installed between the valve plug and the valve actuator.
- 4.1.4 A positioner is used in order to overcome friction in the valve and to increase process lines.
- 4.1.5  A valve positioner is a device used to increase or decrease the air load pressure driving the actuator of a control valve until the valve's stem reaches a position balanced to the output signal from the process variable instrument controller. (5 × 1) (5)
- 4.2 Make neat, labelled graphs of the following characteristic curves for valves:
- 4.2.1 Linear
- 4.2.2 Equal percentage
- 4.2.3 Quick opening
- 4.2.4 Butterfly  (4 × 2) (8)
- 4.3 Make a neat, fully labelled sketch of a proportional and integral pneumatic position balance controller and explain its working principle. (12) [25]
- TOTAL: 100**

INSTRUMENT TRADE THEORY N3

FORMULA SHEET

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

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

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

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

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

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

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

$$(8) \Delta R = \alpha R_0 T$$

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

$$(10) R_u = \frac{V_{std\ cell} - V_{max}}{I_s}$$