higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

INSTRUMENT TRADE THEORY N3

(11040463)

22 November 2022 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 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. Use only a blue or black pen.
5. Sketches, graphs, and diagrams should be neat and in good proportion and may be done in pencil.
6. Write neatly and legibly.

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QUESTION 1

1.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1.1	Type of bonded strain gauge	A	piezoelectric crystal
1.1.2	Type of non-bonded strain gauge	B	helical type
1.1.3	Used in record players and ceramic microphones	C	magnetic transducers
1.1.4	Inductance and reluctance type	D	differential transformers
1.1.5	Commonly used for displacement measurements	E	on-off controller
		F	load cell

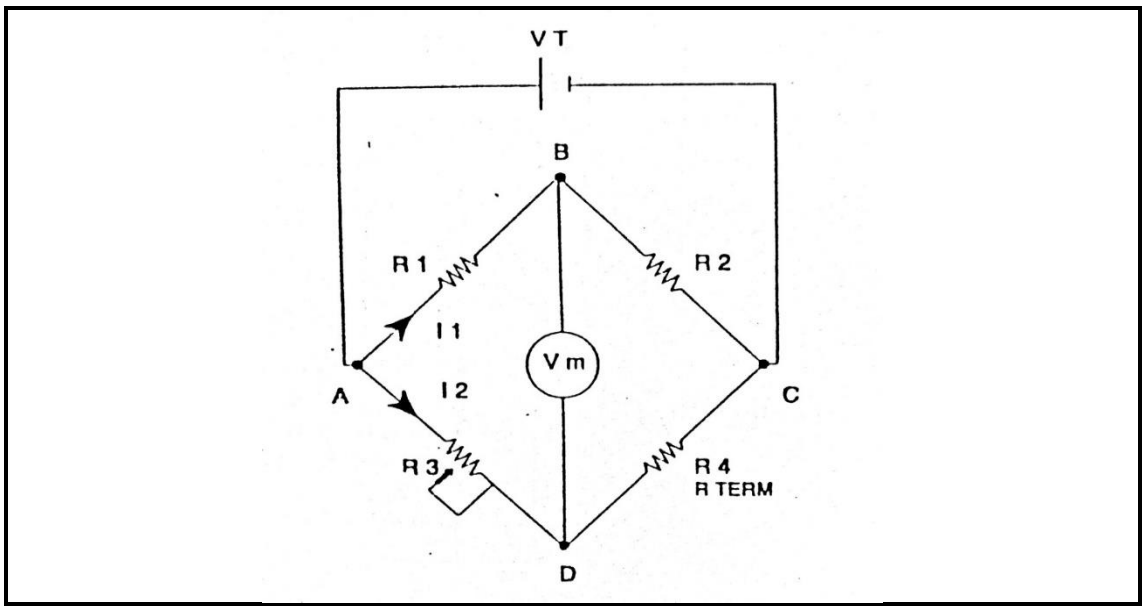
(5 × 1) (5)

1.2 A strain gauge is used together with a Wheatstone bridge circuit to measure mass. Strain gauges are affected by ambient temperature changes.

Explain how one can compensate for a change of ambient temperature and length of lead wires. (5)

1.3 Make TWO neat, labelled sketches that show how strain gauges are used to measure mass. Show the reaction of strain gauges when there is no load and when there is full load. (5)

1.4



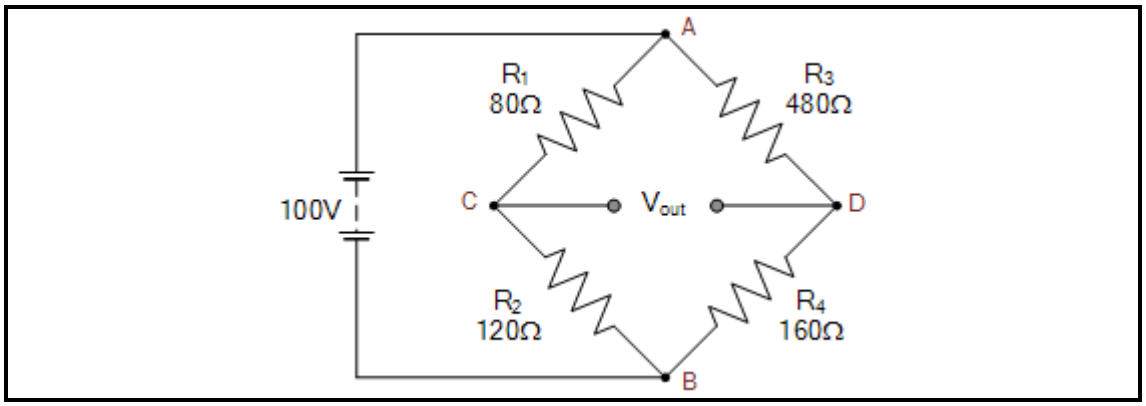
Use the figure above to prove that $R_4 = \frac{R2 \div R3}{R1}$ (6)

1.5 Name FOUR pressure transducers that you know. (4)

[25]

QUESTION 2

2.1 Study the figure below and answer the questions.



2.1.1 Calculate the voltage V_{out} in the gauge. (9)

2.1.2 State TWO main disadvantages of the unbalanced two-lead Wheatstone bridge. (2)

2.2 What is a *potentiometer*? (2)

2.3 State the following law:

2.3.1 Provost's theory of exchanging

2.3.2 Stefan Boltzmann's law

(2 × 3) (6)

2.4 Make a neat, labelled sketch of a photoelectric optical pyrometer. (6)

[25]

QUESTION 3

3.1 Make a neat, labelled sketch of a resonant-impedance telemetering system and explain its working principle. (2 × 6) (12)

3.2 Draw a neat, approximated, labelled graph of the following control valve characteristics:

- Linear
- Equal percentage
- Quick opening (4)

3.3 Make a neat, labelled sketch of a direct-acting continuous bleed relay valve. (5)

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3.4 Answer the following questions on telemetry

3.4.1 What is *telemetry*?

3.4.2 Give TWO applications of telemetry. (2 × 2) (4)

[25]

QUESTION 4

4.1 Define the following terms:

4.1.1 A load change

4.1.2 Control point

4.1.3 Control point off-set

4.1.4 Deviation

4.1.5 Measured variable (5 × 2) (10)

4.2 Make a neat, labelled sketch of a proportional, integral and derivative position balance controller. (6)

4.3 Name FIVE forces acting on a pneumatic control valve. (5)

4.4 What is the difference between the following:

4.4.1 Valve plug

4.4.2 Valve positioner (2 × 2) (4)

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

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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