higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T810**(E)**(J24)T

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

(8080194)

24 July 2018 (X-Paper)
09:00–12:00

Calculators and drawing instruments may be used.

This question paper consists of 5 pages and a formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
INDUSTRIAL INSTRUMENTS N4
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. ALL drawings must be neat and well balanced.
5. Take g = 9,8 m/s².
6. Write neatly and legibly.

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QUESTION 1: PRESSURE MEASUREMENT

1.1 A ring balance meter is used to measure the difference between two air pressures.

1.1.1 Make a neat, labelled sketch of a ring balance meter. (6)

1.1.2 Prove that the mathematical expression for differential pressure of a ring balance meter is given as: $P_1 - P_2 = \frac{r_2 M g \sin\theta}{A r_2}$. (4)

1.2 Determine the angular deflection of a ring balance meter if the applied pressure difference is 1 000 Pa, the mass of the counterweight 0,8 kg, the average radius of the ring 30 cm, the average radius of the counterweight 40 cm and the cross-sectional area of the ring 0,00785 m². (5)

1.3 Define the term *transducer*. (2)

1.4 What will the resistance of a conductor be if it has a specific resistance of 70 μΩ.m, a length of 20 m and a diameter of 1 mm? (4)

1.5 Make a neat sketch to illustrate the construction of a bonded-grid strain gauge. (4)

[25]

QUESTION 2: TEMPERATURE MEASUREMENT

2.1 Make a neat, labelled sketch of a helical bimetallic strip thermometer. (7)

2.2 Explain the principle of a thermocouple with reference to the Seebeck effect. (4)

2.3 Explain *cold junction compensation* as it applies to thermocouples. (2)

2.4 Briefly explain how thermistors are manufactured and give TWO examples of materials used to manufacture these devices. (6)

2.5 A potentiometer has a sensitivity of 200 ohms per volt and a thermocouple has an output of 0, 65 mV at 25 °C.

Calculate the value of the cold junction compensator at 25 °C if the resistance temperature coefficient (∝) of the resistance wire is 0,0058/°C. (6)

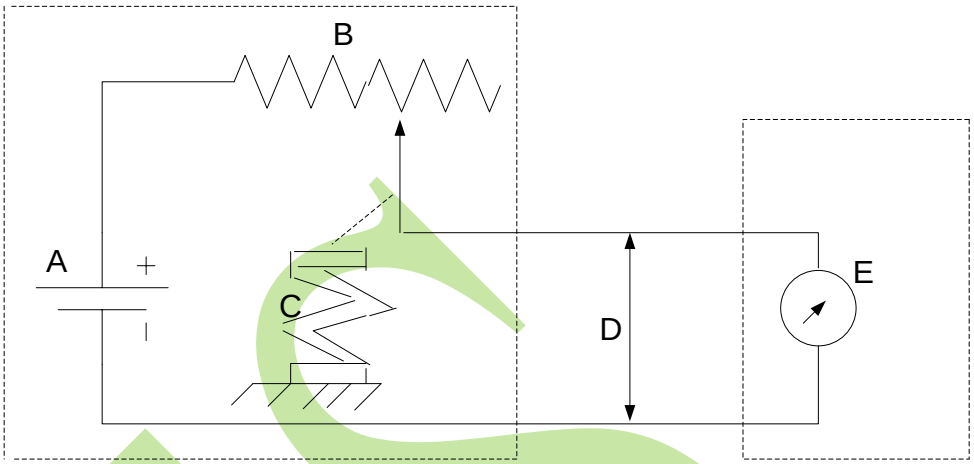
[25]

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QUESTION 3: AUTOMATIC CONTROL AND TELEMETERING

3.1 Define the term *telemetering.* (2)

3.2



3.2.1 Which type of telemetering system is represented by the diagram? (2)

3.2.2 Name the components marked A, B, C, D and E. (5)

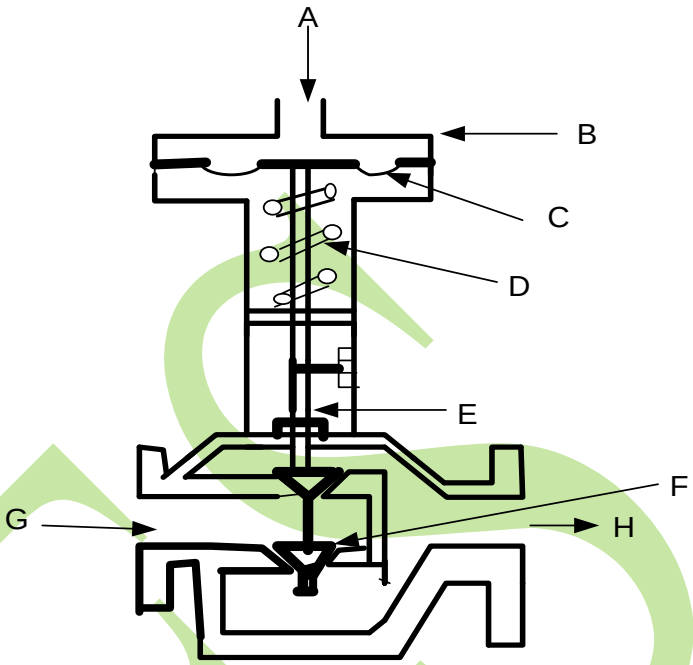
3.2.3 Give TWO disadvantages of the system. (2)

3.3 Study the figure below and sketch the resulting graphs of the control modes given for step, pulse and ramp inputs in the numbered boxes (1–6) in the ANSWER BOOK. Do NOT redraw the given sketches.

Inputs / Control modes	Step	Pulse	Ramp
Proportional mode		(1)	(2)
Integral mode	(3)		(4)
Derivative mode	(5)	(6)	

(6)

3.4 Label the components in the sketch below by writing only the answer next to the letter (A–H) in the ANSWER BOOK.



(8)
[25]

QUESTION 4: FLOW AND LEVEL MEASUREMENT

4.1 Briefly explain the principle of all Bernoulli-type primary-flow elements. (4)

4.2 A flowmeter is calibrated for a pressure difference of 150 mm water at a flow rate of 1 000 m³/h. The pressure difference changes to 200 mm water.

Calculate the new flow rate. (4)

4.3 Show, by using vectors, the forces acting on the vane of a deflecting vane-type flowmeter. (4)

4.4 A single-standpipe gas-purge system is used to measure the level in an open tank. The back pressure of a gas-purge pressure gauge is 85 KPa when air is purged through a liquid which has a density of 3 000 kg/m³.

Calculate the level in the tank if the open end of the tube is 4 cm above the bottom of the tank. (4)

4.5 Make a neat, labelled sketch of a float buoyancy level-measuring instrument using torque tube transmission. (5)

4.6 Name FOUR advantages of a buoyancy-type level gauge that uses a torque tube. (4)
[25]

TOTAL: 100

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FORMULA SHEET

1. $\Delta P = \rho gh$

2. $\Delta P = \rho gh\left[\frac{A_2}{A_1} + 1\right]$

3. $\Delta P = \rho gL\left[\sin\theta + \frac{A_2}{A_1}\right]$

4. $P_1 - P_2 = \frac{r_2 Mg\sin\theta}{Ar_1}$

5. $P_1 - P_2 = \frac{Mgr\sin\theta}{AL}$

6. $F = ma$

7. $P = \frac{F}{A}$

8. $A = \frac{\pi d^2}{4}$

9. $R = \frac{\rho L}{A}$

10. $°F = \frac{9}{5}°C + 32$

11. $R_T = R_0(1+\propto T)$

12. $R_T = R_0(1+\propto T + \beta T^2)$

13. $Q = k\sqrt{h}$

14. $H_L = \left[\frac{\rho_m}{\rho_L}\right] \times h - \frac{h}{2}$

15. $H_L = \left[\frac{\rho_m}{\rho_L}\right] \times h - H_1 - \frac{h}{2}$

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

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

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

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

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

21. $I_s = \frac{1}{\text{sensitivity}}$

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

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

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

25. $t°C = T(K) - 273{,}15$

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