higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N4

17 April 2020

This marking guideline consists of 7 pages.

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SECTION A

QUESTION 1

1.1 C
1.2 A
1.3 C
1.4 C
1.5 B
1.6 C
1.7 A
1.8 B
1.9 C
1.10 A

(10 × 1) **[10]**

QUESTION 2

2.1 True
2.2 True
2.3 True
2.4 False
2.5 True

(5 × 2) **[5]**

QUESTION 3

3.1 G
3.2 I
3.3 A
3.4 B
3.5 C

(5 × 1) **[5]**

TOTAL SECTION A: 20

SECTION B

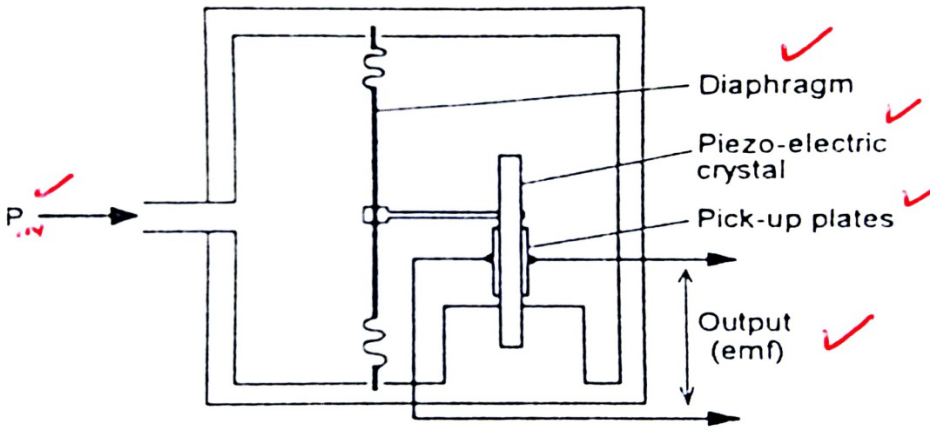
QUESTION 4

4.1
$$\Delta P = \rho g L \left[sin\theta + \frac{A_2}{A_1} \right]$$
$$\Delta P = 13600 \times 10 \times 0,15 \left[sin45^0 + \frac{0,00009}{0,039} \right] ✓✓$$
$$\Delta P = 20400 \times [0,7071 + 0,00231] ✓$$
$$\Delta P = 14,472 KPa ✓✓$$ (5)

4.2
$$A = \frac{\pi d^2}{4}$$
$$= \frac{\pi(0,001)^2}{4} ✓$$
$$= 0,0000007854\ m^2 ✓$$
$$R = \frac{\rho L}{A}$$
$$= \frac{8 \times 10^{-5} \times 50}{0,0000007854} ✓$$
$$= 5,092\ K\Omega ✓$$ (4)

4.3 Inductance is inversely proportional to reluctance. (1)

4.4 4.4.1



(5)

4.4.2 Some crystals such as rochelle salts and tourmaline generate an emf which is proportional to the pressure variations. (2)

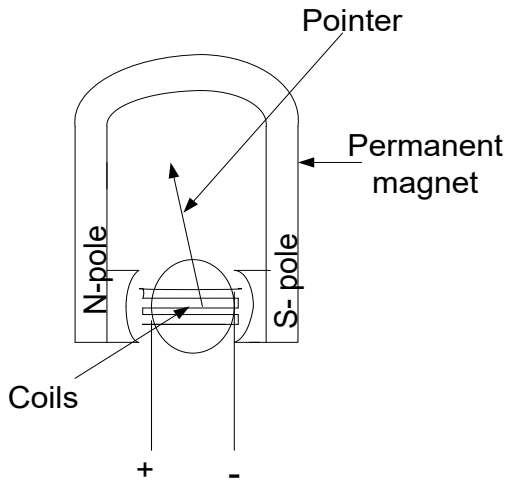
4.4.3
- Affected by temperature variations
- Requires shielding lead wires
- Long leads introducing errors
- Cannot measure static conditions

(Any 3 × 1) (3)

[20]

QUESTION 5

5.1 5.1.1



(5)

5.1.2
- If a voltage, like that of a thermocouple, is connected to the moving coil meter, a current flows through the coil.
- This current generates a magnetic field around the coil.
- The magnetic field of the coil interacts with the magnetic field of the permanent magnetic in such a way that a rotation force is placed upon the coil.
- The rotation force is proportional to the coil's magnetic field strength which in turn is proportional to the voltage or current flow through the coil. (4)

5.2 Invar is commonly used for the low expansion member✓ while brass or nickel alloys are used for the high expansion member. ✓ (2)

5.3 5.3.1 Four-lead null-balance Wheatstone bridge circuit (1)

5.3.2 $R_T = R_0(1+\propto T)$
$R_T = 10(1 + 0{,}004 \times 100)$ ✓
$R_T = 10(1{,}4)$ ✓
$R_T = 14\Omega$✓ (3)

5.3.3 $\frac{R_1}{R_2} = \frac{R_3 + 2r}{R_{TH} + 2r}$✓

$\Rightarrow \frac{R_1}{R_2} = \frac{R_3}{R_{TH}}$✓ Since r = same in all lead wires

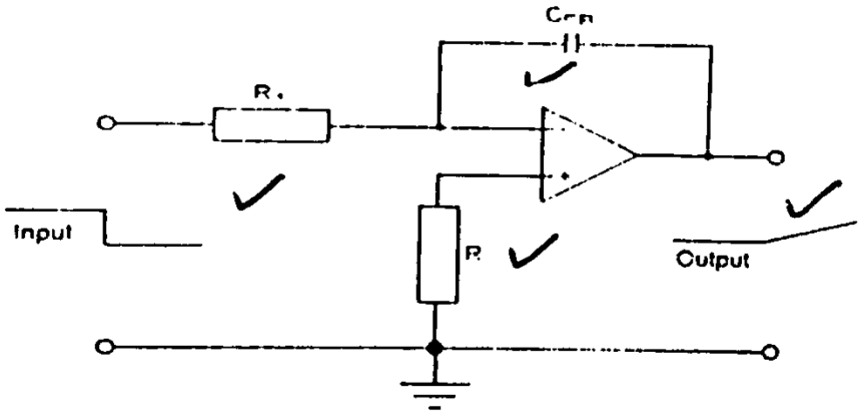
$\therefore R_1 = R_2$ ✓ and $R_3 = R_{TH}$✓ (4)

5.3.4 $R_3 = R_{TH} = 14\Omega$ (1)

[20]

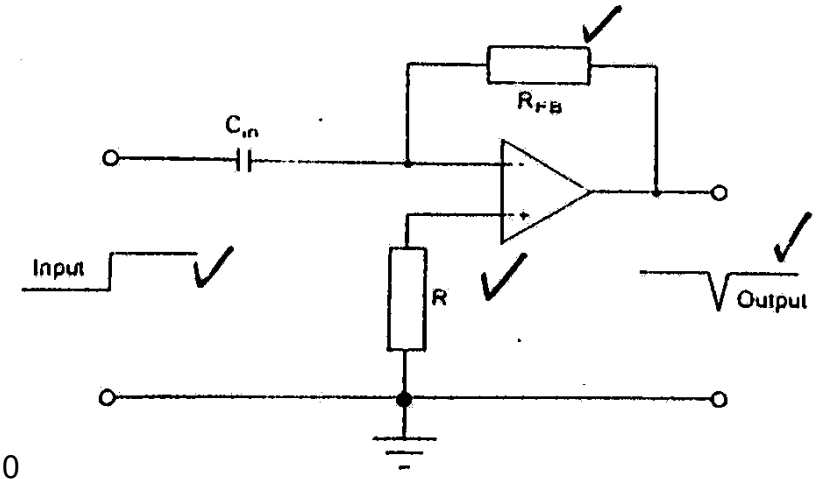
QUESTION 6

6.1 6.1.1



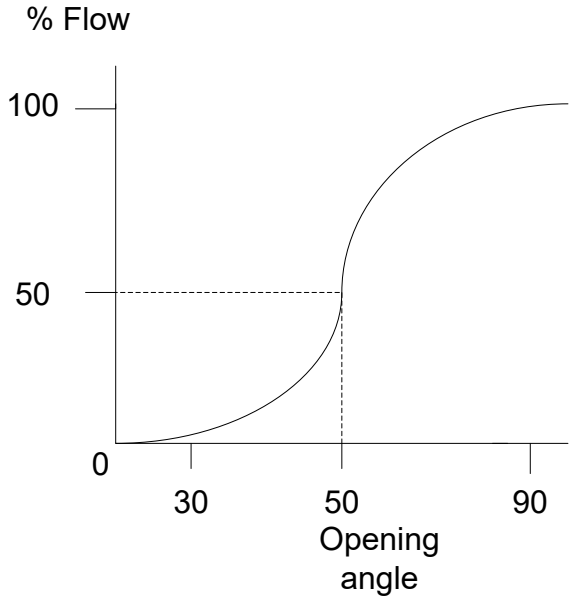
(4)

6.1.2



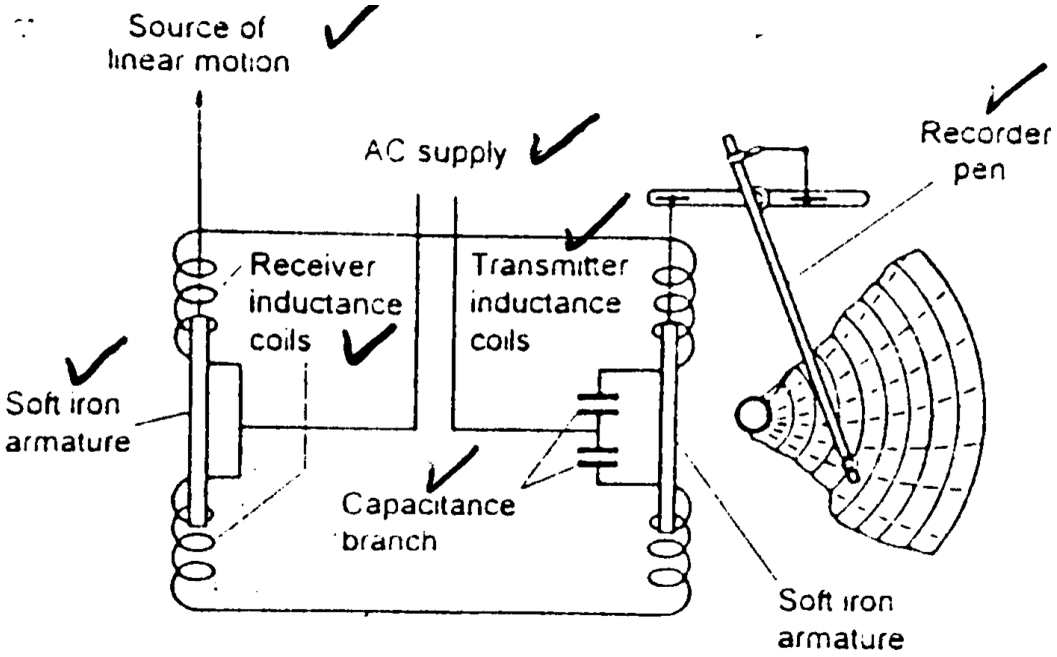
0 (4)

6.2



(2)

6.3



(7)

6.4
- Accurate calibration
- Linear relationship between measured variable and output
- Reduced vibrations

(3)
[20]

QUESTION 7

7.1

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

$$\frac{80}{Q_2} = \sqrt{\frac{50}{100}}$$

$$\Rightarrow Q_2 = 80\sqrt{2}$$

$$= 113{,}137\ m^3/h$$

(3)

7.2

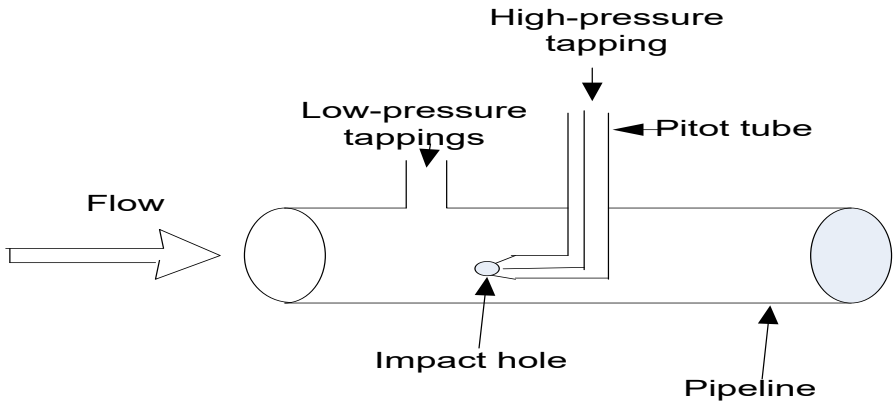


Diagram = 5 marks

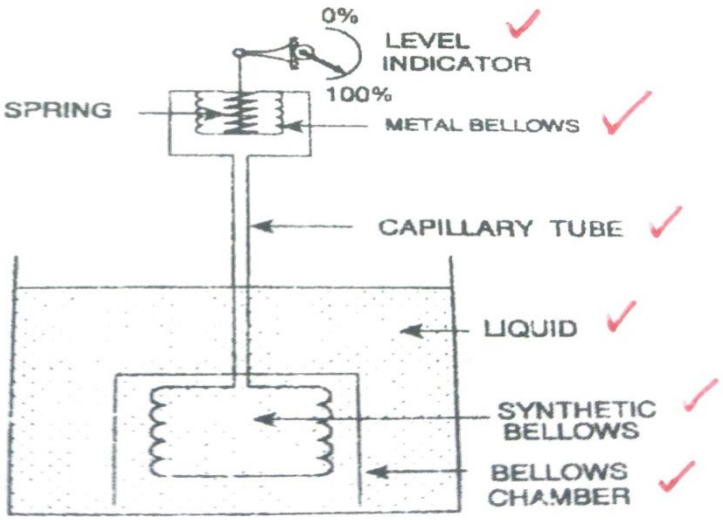
- A pitot tube consists of a small tube inserted into a pipe with the inserted end bent so that it faces the fluid stream.
- A small sample of the fluid impinges on this end of the tube and is brought to rest.
- The kinetic energy is converted into potential energy in the form of static head.
- The static head is the static pressure plus the impact pressure measured by the inserted end of the tube.
- The velocity of the fluid is related to the impact pressure, which is the difference between the static head and the static pressure:

$$\frac{1}{2}mv^2 = mgh$$
$$V = \sqrt{2gh}$$

where v = average velocity of the fluid
g = acceleration due to gravity
h = pressure head

Discussion = 6 marks (11)

7.3



(6)
[20]

TOTAL SECTION B: 80
GRAND TOTAL: 100

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