higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

INDUSTRIAL INSTRUMENTS N6

1 April 2021

This marking guideline consists of 6 pages.

SECTION A

QUESTION 1

1.1 reset
1.2 proportional
1.3 Division
1.4 joule
1.5 condenser

(5 × 1) **[5]**

QUESTION 2

2.1 quick-opening characteristic
2.2 control valve
2.3 low airflow interlock
2.4 cascade control loop
2.5 cavitation

(5 × 1) **[5]**

QUESTION 3

3.1 False – Screwed connections are used for small-sized valves and flanges for large-sized valves. (2)

3.2 False – For crystalline materials, the lines are sharply defined. (2)

3.3 True (1)

3.4 True (1)

3.5 False – An increase in air pressure on the diaphragm causes the valve to open, which will result in an increase in flow through the valve. (2)

3.6 False – Override control occurs when two or more control loops are connected to a common valve in such a way that, under normal conditions, the normal control loop is in command of the valve. (2)

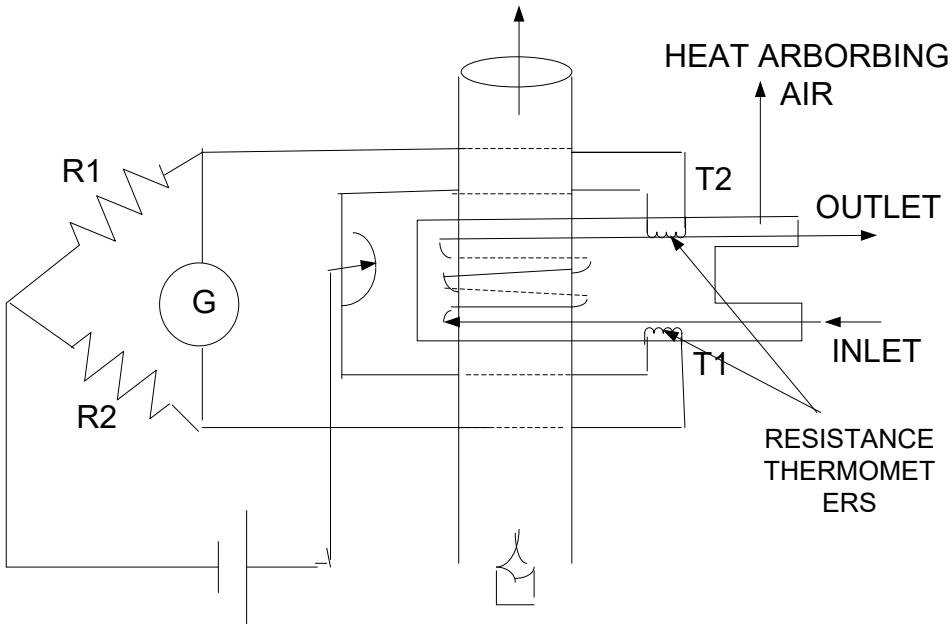
[10]

TOTAL SECTION A: 20

SECTION B

QUESTION 4: ANALYSERS

4.1



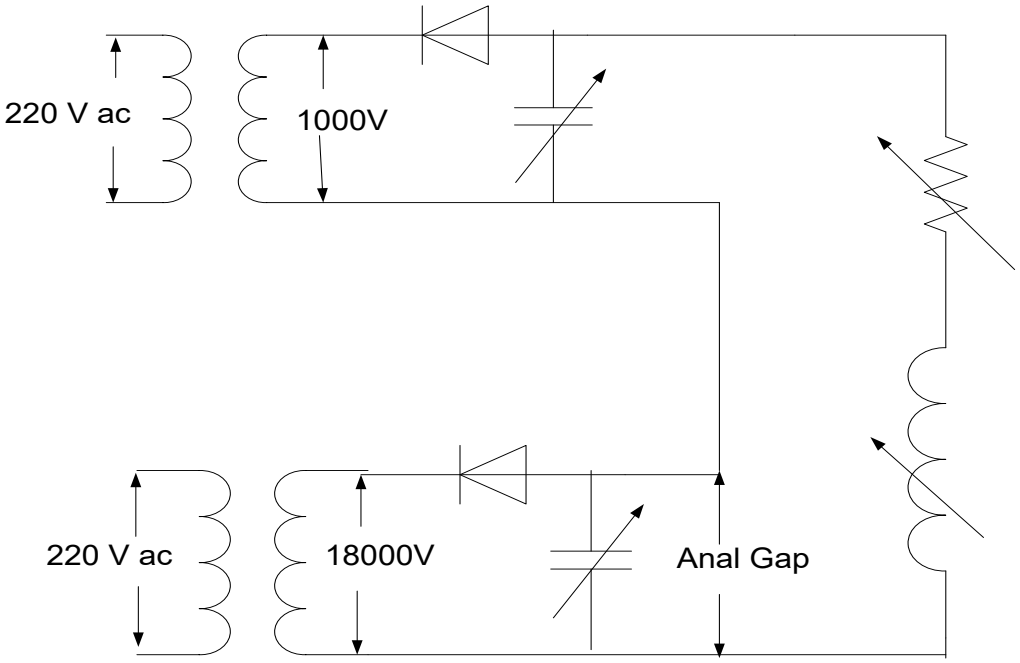
- Metered quantities of gas and air are introduced to a burner and the tank is heated.
- When air is introduced to the air chamber, it absorbs the heat from the tank.
- The temperature rise of the air is measured by resistance thermometers to provide a measure of the heating value.
- Since both thermometers sense the same temperature, the bridge is in balance.
- When the cooling medium (air) is introduced through the capillary tubing, resistance thermometer T_1 will be cooled and resistance thermometer T_2 will be heated up as a result of heat exchange between the tank and the capillary tube.
- The bridge goes out of balance and this out-of-balance signal is proportional to the heat developed by the burning gas mixture.

(6 × 1 diagram and 6 × 1 explanation) (12)

4.2

- Flame excitation: The sample must be in solution form so that it may be sprayed into the flame.
- Arc excitation: It is usually used for analyses where a minute amount of the element is present.
- Spark excitation: The spark discharge is the most reproducible of the sources but it has a low sensitivity. (3 × 2) (6)

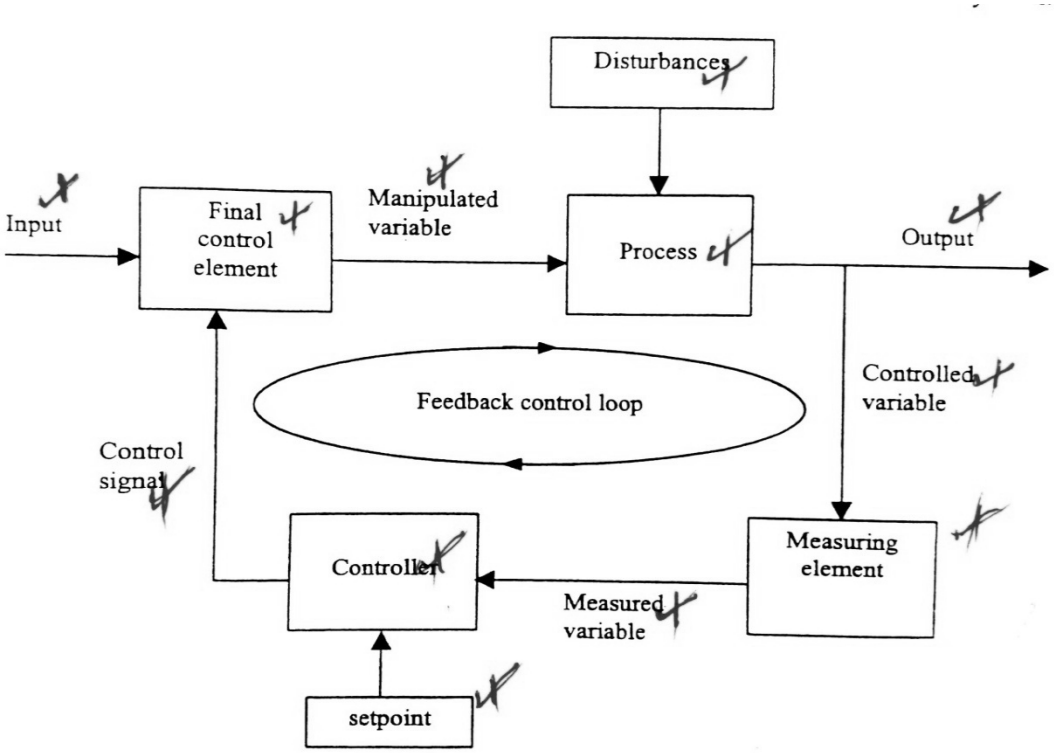
4.3



(5)
[23]

QUESTION 5: AUTOMATIC CONTROL AND VALVES

5.1



(5)

5.2 5.2.1 Measurement lag is the time taken for a detecting element to reach equilibrium with the process✓ so that the detecting element accurately represents the process.✓

5.2.2 Process lag is the time taken for the process to respond to the correcting element.✓ This rate response depends on the capacity of the process and the rate of transfer from the correcting element to the process.✓

5.2.3 Transfer lag is the time taken for the energy to be transferred from one inner tank (as an example) to another outer tank✓ if the content of the outer tank is heated indirectly via the content of the inner tank, the content of which is heated by a heating coil.✓

(3 × 2) (6)

5.3 $P_1 = 10{,}85 + 1{,}0135 = 11{,}8635 \text{ bar}$

$P_2 = 2{,}3 + 1{,}0135 = 3{,}3135 \text{ bar}$

$$C_v = \frac{Q}{295}\sqrt{\frac{G.T}{\Delta P(P_1 + P_2)}}$$

$$2{,}021 = \frac{Q}{295}\sqrt{\frac{0{,}86 \times (86 + 273)}{(11{,}8635 - 3{,}3135)(11{,}8635 + 3{,}3135)}}$$

$\therefore Q = 386{,}5 \text{ m}^3/\text{h}$ (4)

5.4 5.4.1 E
5.4.2 A
5.4.3 C
5.4.4 B
5.4.5 D

(5 × 2) (10)
[25]

QUESTION 6: DISTILLATION COLUMN AND BOILERS

6.1 6.1.1 Distillation
6.1.2 volatile constituents
6.1.3 vapour
6.1.4 condensation
6.1.5 furnace
6.1.6 fuel
6.1.7 heat or combustible gases

(7 × 1) (7)

6.2 This is due to the fact that in a series system, a time lag in measurement✓ or transmission of flow signals will seriously affect the combustion conditions within the boiler.✓ If this occur, alternating periods of deficient and excess combustion air is realised.✓ (3)

6.3 6.3.1 Single-element feedwater control system (1)

6.3.2 Only one process variable, namely the drum level, is used as input to the control loop.✓ The drum level is measured and transmitted to a level controller,✓ which in turn manipulates the feedwater control valve.✓ As the water level lowers, the valve is opened✓ and as the water level rises the valve closes.✓ (5)

6.4 The flow rate of measured fuel is easily measured and controlled,✓ e.g. gas and oil.✓ The amount of unmeasured fuels added to the burner is not easily determined,✓ e.g. coal or wood.✓ (2 + 2) (4)

[20]

QUESTION 7: INTRINSIC SAFETY

7.1
- Presence of combustible material
- Possibility for combustible material to form combustible mixture with air
- Presence of a source of ignition with sufficient energy
- When the source comes in contact with explosive gas
- Quantity of combustible material large enough to support combustion
- Explosive gas mixture continuing to burn after ignition (6)

7.2
- Identify the circuit in the hazardous location.
- Review the circuit for mechanical or electrical isolation.
- Adjust circuit voltage and current levels.
- Compute the voltage and current level under fault conditions.
- Adjust the circuit parameter as required.
- Compute the level of voltage and current in the intrinsically safe circuit under normal operation. (6)

[12]

TOTAL SECTION B: 80
GRAND TOTAL: 100