Surname **First Name** **Code (matricola)**

Section 1. TRUE/FALSE QUESTIONS

1. The **membrane valve** got this name just because has a **ceramic membrane** in contact with the flowing fluid
   true ○ false ○
2. The **sonar level sensors** always provide the contemporary measurement of the temperature
   true ○ false ○
3. In a **"air-to-open" valve** the air operates on the actuator in order to move away the closure member from the seat
   true ○ false ○
4. **Closed liquid column manometers** ("U" tube manometers) containing mercury are used for measuring pressure in a vacuum
   true ○ false ○

Section 2. MULTIPLE CHOICE QUESTIONS

1. **Saunders valves** are:
   a. ○ rotary motion control valves
   b. ○ linear stem motion control valves
   c. ○ ball control valves
   d. ○ angle control valves

2. Which one is a dimensionless **sensor property**?
   a. ○ accuracy at the full scale
   b. ○ accuracy at the measured value
   c. ○ *rangeability*
   d. ○ sensitivity

3. The working principle of a **pressure transducer** can be:
   NOTE: check only the wrong answer!
   a. ○ piezoelectric
   b. ○ radio
   c. ○ inductive
   d. ○ electric resistance

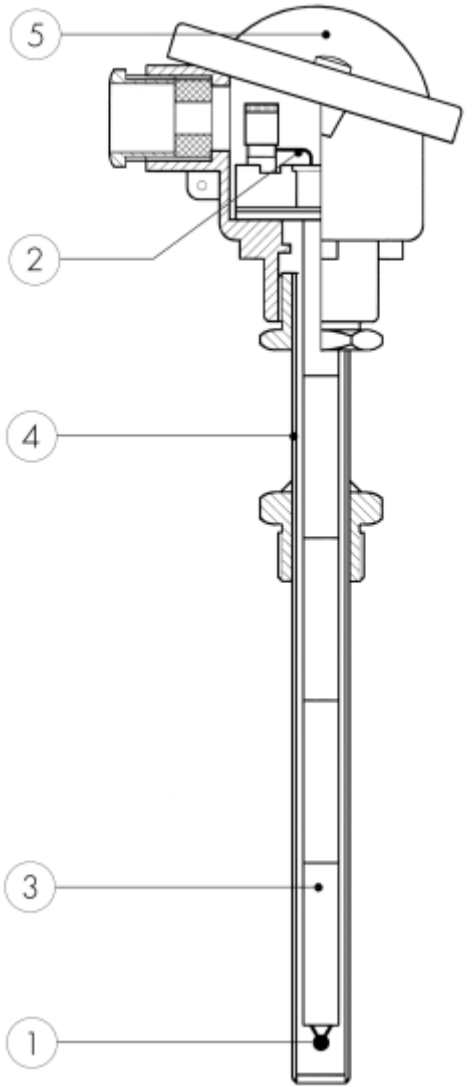
Section 3: SENSORS AND INSTRUMENTATION FOR PROCESS MEASUREMENTS

3.1. Thermocouple

Look at the TC drawing below:

a. Is it a TC for industrial or laboratory use?

b. Recognize the main parts, reporting briefly the description just on the drawing



3.2 Contraction-based flow meters

a. Draw a sketch of at least one **contraction-based flow meter**

b. What is the **basic principle (necessary measurement)** of **contraction-based flow meters?**

3.3 Capacitance pressure sensor

Provide the **working principle** and the **main characteristics** of this sensor

3.4 Capacitance level sensor

Provide the **working principle** and the **main characteristics** of this sensor

3.5 Sensor properties

Describe briefly differences between the definitions of **accuracy** and **repeatability**.

3.6 Rotameter

a. Draw a sketch

b. What is the **basic principle (necessary measurement)?**

Section 4: VALVES

4.1 Valve technology

a. Recognize the **type of valve** in the figure

b. Is it a **linear** or **rotary** valve?

c. What is its **application purpose**?

d. Is this type of valve subject to possible **cavitation**?

e. Recognize the main **component parts** of valve directly in the figure

4.2 Sizing problem

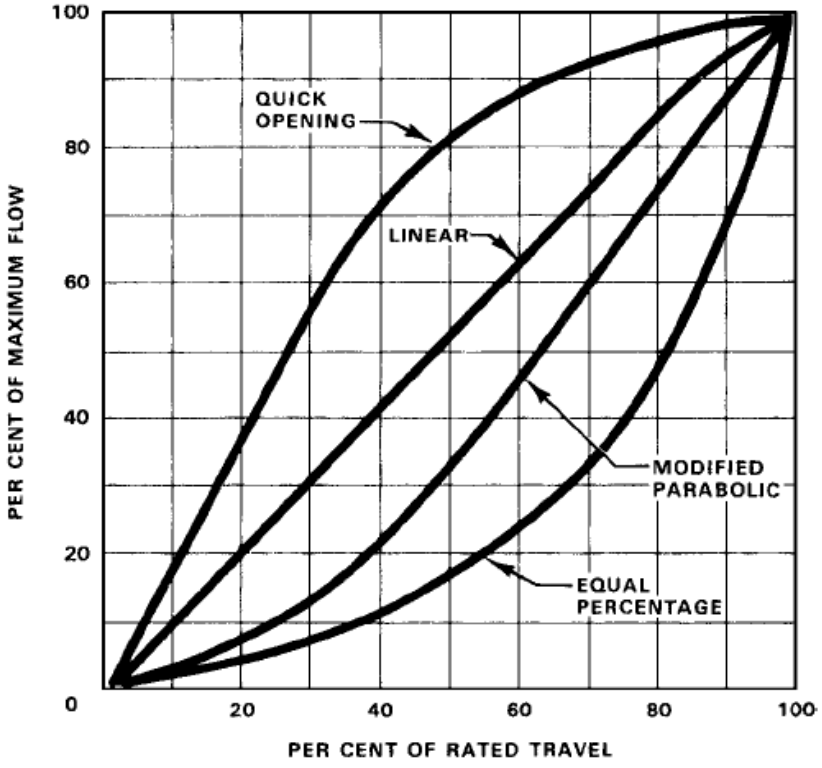
A control valve for water flow has to be chosen and sized at the following conditions:

nominal flow rate: $\dot{V}$ = 10.5 L/s
nominal pipe size: NPS = 3”
upstream pressure: P_1 = 36.75 psi
downstream pressure: P_2 = 10.3 – 13.3 psi
vapor pressure: P_v = 3.7 psi
recovery factor: F_L = 0.9
liquid critical pressure ratio factor: F_F = 0.956

1. Calculate the **flow coefficient C_v** for the nominal valve pressure drop that appears to be the most demanding

A single seat control **globe valve** is available.
The diagram of the valve **inherent characteristics** and the table of C_{vn} values are provided below:

Valve nominal size	C_{vn} (gpm $psi^{-1/2}$)
1”	14
1.5”	31
2”	54
3”	115



Commonly observed inherent flow characteristic types

2. **Size the valve** and choose that one with the most appropriate nominal diameter and inherent characteristic.
3. Check **cavitation** according to the IEC norm.

Let us consider the chosen valve now installed in a **circuit plant**, assuming ΔP_n equal to the value ($P_1 - P_2$) previously chosen, and the following value of the **user's equipment pressure drop**:

$$\Delta P_u = 30 \text{ psi}$$

4. What is the value of ΔP_0 ?
5. What is the **valve authority** V?
6. What is the nominal flow rate $\dot{V}_n$ through the valve?
7. What is the new flow rate $\dot{V}_1$ through the valve for $h_1 = 0.4$?
8. What is the valve pressure drop ΔP_1 for $h_1 = 0.4$?
9. What is the value of the relative stroke h_2 which determines a flow rate $\dot{V}_2$= 95 gal(US)/min through the valve in the circuit?