Last Name **Name** **Student's code**

Section 1. TRUE/FALSE QUESTIONS

1. The sensor **span** is the amplitude of the measuring range:
   true ☐ false ☐
2. The **needle valve** is commonly used for low flow rates and when a more accurate flow rate is required
   true ☐ false ☐
3. The **membrane valve** got this name just because has a **ceramic membrane** in contact with the flowing fluid
   true ☐ false ☐
4. 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 ☐
5. The **Bourdon pressure gauge** is based on the balance force principle
   true ☐ false ☐

Section 2. MULTIPLE CHOICE QUESTIONS

1. What is not used to measure **flow rate** from the following working principle?
   a. ☐ electrical resistance variation
   b. ☐ ultrasound
   c. ☐ heat conductivity
   d. ☐ magnetic field

2. The **Coriolis effect** is associated with the:
   a. ☐ Level meter
   b. ☐ Mass flowmeter
   c. ☐ Volumetric flowmeter
   d. ☐ Pressure meter

3. When the percentage variation of flow through a **valve** equals the percentage variation of plug movement, a valve has a
   a. ☐ Linear flow characteristic
   b. ☐ Equal percentage flow characteristic
   c. ☐ Quick opening flow characteristic
   d. ☐ Parabolic flow characteristic

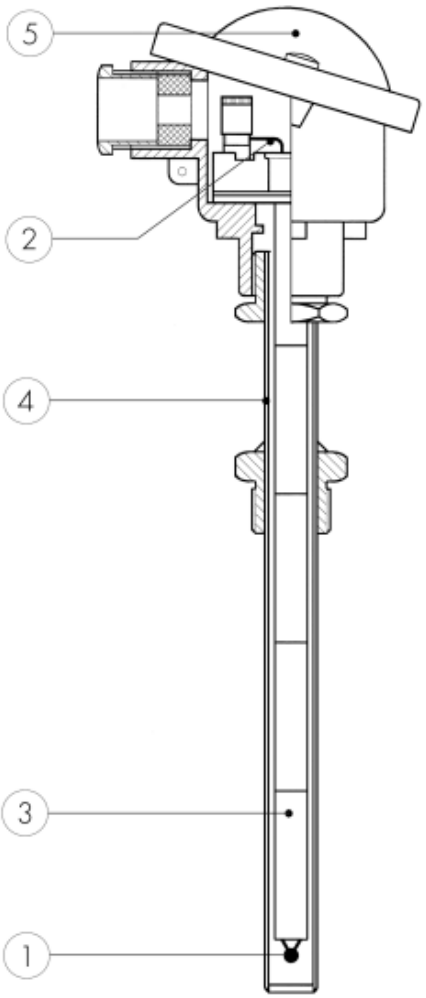
4. **Butterfly valves** are:
   a. ☐ rotary motion control valves
   b. ☐ linear stem motion control valves
   c. ☐ ball control valves
   d. ☐ motorized control valves

Section 3: SENSORS AND INSTRUMENTATION FOR PROCESS MEASURING

3.1. Thermocouples

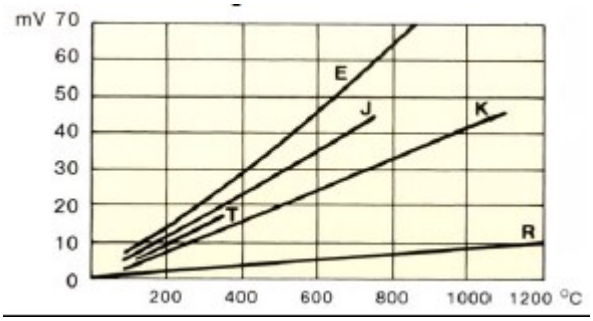
Look at the TC drawing:

a. Is it a TC for industrial or laboratory use?
b. Recognize the main parts, reporting briefly the description just on the drawing



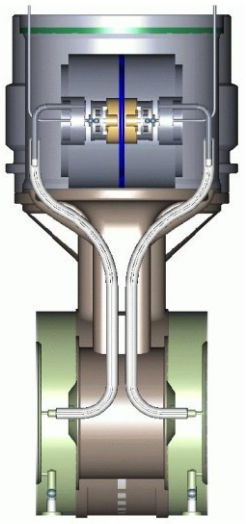
Then look at the diagram below:

a. What quantities do you have on the axes?
b. What do the curves represent? Pls. describe it briefly



3.2. Inductive Pressure Transducer

a) Recognize the constituent parts and indicate them just on the drawing.
b) Where is exactly the fluid the pressure of which has to be measured?



3.3. Radioisotope Level Sensor

a. Draw a **simple scheme** showing its working principle

3.4 The general properties of the sensors

a. Give definition and meaning of precision

3.5. Mass Flow meters

a. Describe the **working principle** of one device (of your choice) measuring the **mass flow rate** directly

Pls. describe it briefly

3.6. Contraction-based flow meters

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

Section 4: VALVES

4.1. Divert Valve

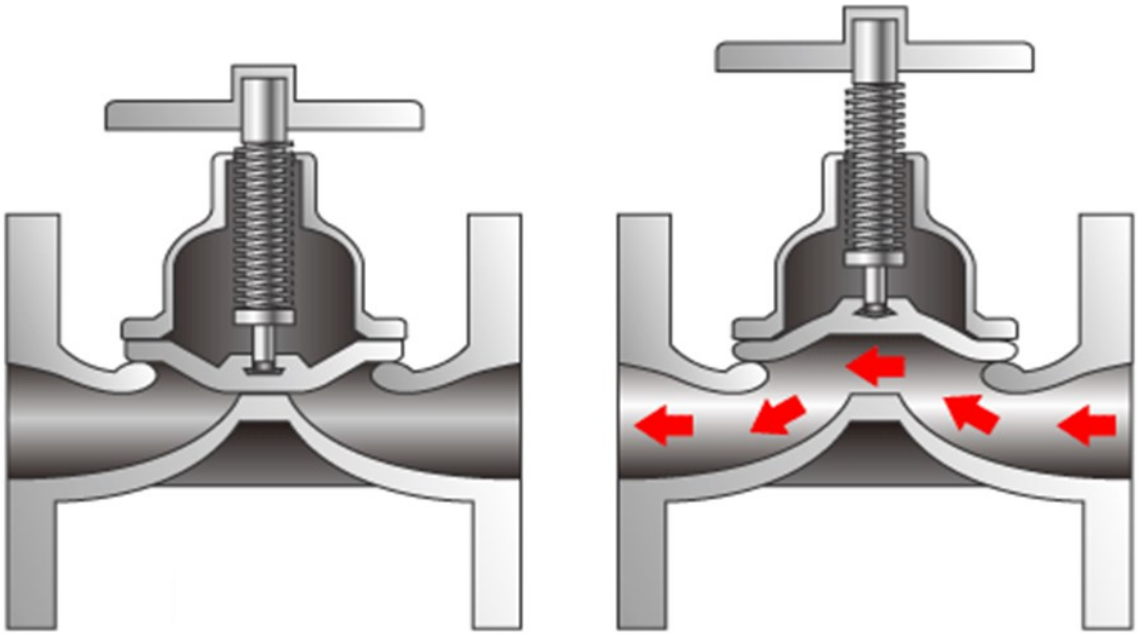
a. Describe the operating principle with the aid of a schematic drawing

b. Draw the **normalized symbol**

4.2. Valve technology

a. Recognize the type of this valve, which is shown at two different operation points in the figure
b. Is it a linear or rotary valve?
c. What is its application purpose?
e. Is this type of valve subject to possible cavitation?
d. Recognize the main component parts of valve in the figure

NOTE: It's possible to indicate parts directly on the following figure



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4.3. Sizing Problem

A globe valve is selected and must be sized in a factory, under the following conditions:

fluid: Sea water
density: $\rho_f = 1025$ kg/m^3
nominal flow rate: $\dot{m} = 18 \div 22$ lb/s
nominal diameter of the line: DN = 100 mm
pressure upstream of the valve: $P_1 = 18.1$ psi
pressure P_2 downstream of the valve: atmospheric
vapor pressure: $P_v = 0.1$ psi
coefficient of the ratio of the critical pressure for liquids: $F_F = 0.956$

1. Calculate the flow coefficient C_v reasonably expected for the conditions of operation of the valve

A globe valve **ENINE** is available with all **intrinsic characteristics**, rangeability r = 20:1, and the Manufacturer's Table for $\mathbf{C_{vn}}$ listed below:

DN mm	**C_{vn} US gal/(min•psi$^{0.5}$)**
8	1.16
15	3.64
20	6.65
40	28
50	48
65	70
80	111
90	131
100	198

2. Size the valve for the problem under consideration, choosing the one with the most appropriate DN and **intrinsic characteristic**
3. Verify cavitation according to the IEC norm
4. Determine a new value of the vapor pressure P_v which would send the selected valve to cavitation
5. What is the definition of the **installed characteristic**?
6. Select and adopt a value of the authority V that is congruent with your previous choice about the **intrinsic characteristic**
7. By setting $\Delta P_n = (P_1 - P_2)$, calculate the nominal flow rate $\dot{V}_n$ that will pass through the valve installed in a circuit
8. What is the flow rate $\dot{V}_1(h_1)$ that will pass through the valve for $h_1 = 0.28$?
9. What is the actual pressure drop across the valve ΔP_{v1} for $h_1 = 0.28$?
10. What is the relative stroke h_2 for which a flow rate $\dot{V}_2(h_2) = 130$ gpm is passed through the valve inserted in the circuit?