Surname **Name** **Student's code.:**

Section 1. QUIZ

1. The nominal pressure PN is the one for which a component of piping breaks

   true ☐ false ☐

2. The pressure sensor with capacitive cell is a strain gage transducer

   true ☐ false ☐

3. The "U-shaped" liquid manometer measures the differential pressure only

   true ☐ false ☐

4. The Coriolis flowmeter is a mass flow transmitter

   true ☐ false ☐

Section 2. QUIZ

5. Which of the following elements is not present in an industrial sensor?

a. ☐ primary sensing element
b. ☐ transducer
c. ☐ amplifier
d. ☐ servomotor

6. This property of the sensors depends on the full scale
   NB: only mark the wrong answer!

a. ☐ accuracy
b. ☐ precision
c. ☐ *rangeability*
d. ☐ measuring range

7. The principle on which is based the thermocouple is

a. ☐ Peltier effect
b. ☐ Fourier effect
c. ☐ Soret effect
d. ☐ Seebeck effect

8. With ref. to the operation of the control valve, which of the following statements is wrong?

a. ☐ the normal flow is to $p_{vc} > p_v$
b. ☐ the flow is semicritico $p_{vc} \leq p_v$ e $p_2 > p_v$
c. ☐ the contracted vein is è $p_{vc} \geq p_1$
d. ☐ the flow limit is for $p_{vc} < p_v$ e $p_2 \leq p_v$

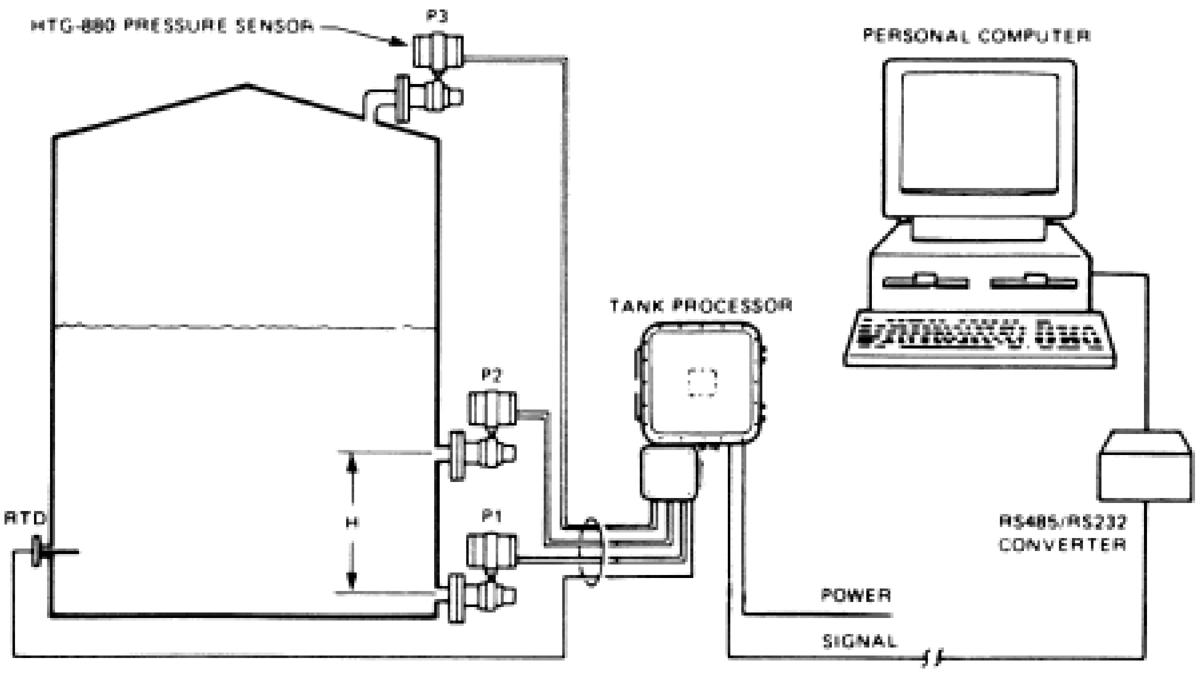
Section 3: SENSORS AND MEASURING INSTRUMENTS PROCESS

3.1. RTD

a. Describe its working principle in 3 lines of text

3.2. Pressure Sensors

The system for the measurement, monitoring and data acquisition of process variables in a large tank of a liquid is shown in figure.



a) Based on the sketch in figure, which process variables are actually measured in the tank (TEMPERATURE, PRESSURE, FLOW RATE, LEVEL) ?

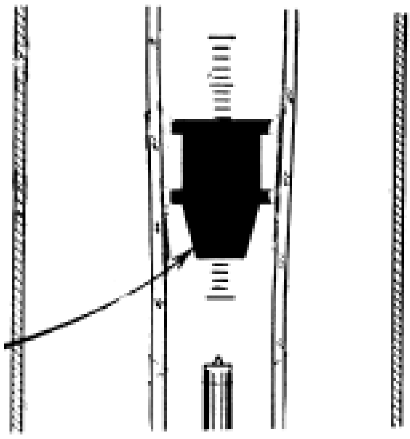
In the following, you can assume that

- the storage tank is 15.0 m high, that is H_{roof} =15.0 m > H
- the tank contains liquid styrene (specific gravity 0.909)
- a pressure sensor (P1) at the bottom in the liquid phase and another pressure sensor (P3) in the gas phase above the liquid enable you to determine the level of liquid in the tank

b) Determine the gage pressure when the tank is full of styrene

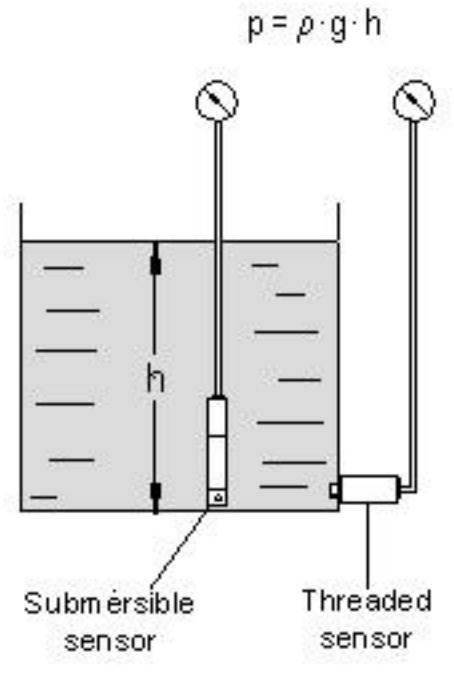
3.3. Level meters

a) Is the one sketched in figure a type of level sensor (YES/NO) ?



b) If the answer is YES, which type is it? Which is its working principle?

c) Is the next one sketched in figure a type of level sensor (YES/NO) ?



d) If the answer is YES, which type is it? Which is its working principle?

3.4 The general properties of the sensors

a. Give definition and meaning of **precision**

3.5 Contraction-based flow meters

Draw a <u>sketch</u> of at least one **contraction-based flow meter.**

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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. Recognize the main **component parts** of valve in the figure
e. Is this type of valve potentially subject to **cavitation**?

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

4.2. Sizing Problem

Select a globe valve for the following conditions:

fluid: lineseed oil
density: $\rho_f = 58.0$ lb/ft^3
nominal flow rate: $\dot{m} = 7$ lb/s
nominal diameter of the line: DN = 100 mm
pressure upstream of the valve: $P_1 > 14.7$ 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. Propose a suitable value for the upstream pressure P_1 which should be coherent with the other valve operation data
2. Calculate the flow coefficient C_v for the conditions of operation of the valve which meet the above constraints and the $\mathbf{C_{vn}}$ available for:

A globe valve Combraco 57, steel mounting flange, with all **intrinsic characteristics** available, rangeabiity r = 20: 1, and the manufacturer's Table listed below:

DN mm	**K_{vn} m^3 (H_2O) /h bar^{½}**
8	3.0
15	9.2
20	12.1
40	17.0
60	29.3
80	34.6
100	52.8
120	70.3
150	88.4

The conversion between the flow coefficient K_{vn} and the flow coefficient C_{vn} is the following:

$$\mathbf{C_{vn} = 1.16\ K_{vn}}$$

3. Size the valve for the problem under consideration, choosing the one with the more appropriate DN
4. Verify cavitation according to the IEC norm
5. Determine a new vale of the vapor pressure P_v which would send the selected valve in cavitation
6. What is the definition of the **installed characteristic**?
7. Select and adopt a value of the authority V that is congruent with your previous choice about the **intrinsic characteristic**
8. Calculate the nominal flow rate $\dot{V}_n$ that will pass through the valve in the circuit
9. What is the flow rate $\dot{V}_1(h_1)$ that will pass through the valve for $h_1 = 0.35$?
10. What is the actual pressure drop across the valve ΔP_{v1} for $h_1 = 0.35$?
11. What is the relative stroke h_2 for which a flow rate $\dot{V}_2(h_2) = 60$ gpm is passed through the valve inserted in the circuit?