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

Section 1. QUIZ

1. Thermocouples (TCs) are the most common temperature measurement sensors used in the USA for process control. TC use is a proven technology in industry. They are rugged, relatively inexpensive, and easy to use.
true false
2. The nominal pressure PN is the one for which a component of piping breaks
true false
3. The pressure sensor with capacitive cell is a strain gage transducer
true false
4. The "U tube" liquid manometer measures the differential pressure only
true false
5. The Coriolis flowmeter is a mass flow transmitter
true false
6. The sonar level sensors always provide the contemporary measurement of temperature
true false

Section 2. QUIZ

1. Which of the following elements is not present in an industrial sensor?
 - a. primary sensing element
 - b. transducer
 - c. amplifier
 - d. servomotor
2. 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
3. The principle on which is based the thermocouple is
 - a. Peltier effect
 - b. Fourier effect
 - c. Soret effect
 - d. Seebeck effect

4. With ref. to the operation of the control valve, which of the following statements is wrong?
- the normal flow is for $p_{vc} > p_v$
 - the flow is semicritical for $p_{vc} \leq p_v$ e $p_2 > p_v$
 - the *vena contracta* pressure is $p_{vc} \geq p_1$
 - the choked flow is for $p_{vc} < p_v$ e $p_2 \leq p_v$

Section 3: SENSORS AND MEASURING INSTRUMENTS PROCESS

3.1. Temperature Measurement with thermocouple

A chromel-alumel thermocouple is used to measure the temperature of a fluid in a tank. Assuming that the reading of the voltmeter connected to the cold junction is 3.67 mV and that the latter is at a temperature of 289 K, determine the temperature of the fluid with the approximation $\pm 1 \text{ K} = \pm 1 \text{ }^\circ\text{C}$

- 105 $^\circ\text{C}$
- 101 $^\circ\text{C}$
- 382 K
- 373 K

3.2. Pressure transducers

- Which type of sensor is this?
- Can it be used for measuring a **relative pressure**?
- Recognize the most important parts and match them directly on the image
- Directly on the image, indicate exactly where the fluid actually is for pressure measurement



3.3. The level meter

A solvent storage tank contains liquid styrene (sp. gr. 0.909).

A pressure = 164000 Pa is measured at the base of the tank and a pressure = 130000 Pa is measured at a height H.

Determine the level of the liquid styrene H (m).

3.4 . Accuracy and precision

Draw a graph of measurements over time from which one can clearly catch the difference between accuracy and precision

3.5 Contraction-based flow meters

- a) Obtain the flow rate equation in the ideal case
- b) Calculate the flow rate measured for **gasoline** ($\rho=680 \text{ kg/m}^3$) with the following data: $P_1=80 \text{ kPa}$, $P_2=50 \text{ kPa}$, $d_1=65 \text{ mm}$, $d_2=35 \text{ mm}$
- c) Extend the flow equation to non-ideal cases
- d) Extend the flow rate equation to the case of non-constant density

Section 4: VALVES

4.1. Valve technology

- Recognize the **type of valve** shown at two different operation points in the figure
- Is it a **linear** or **rotary** valve?
- What is its **application purpose**?
- Recognize the main **component parts** of valve in the figure
- Is this type of valve subject to possible **cavitation**?

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



4.2. Sizing Problem

Select a globe valve in a vegetable oil factory, under the following conditions:

fluid: Tomato Juice

density: $\rho_f = 65.05 \text{ lb/ft}^3$

nominal flow rate: $\dot{m} = 20 \div 24 \text{ lb/s}$

nominal diameter of the line: $DN = 100 \text{ mm}$

pressure upstream of the valve: $P_1 > 14.7 \text{ psi}$

pressure P_2 downstream of the valve: atmospheric

vapor pressure: $P_v = 0.1 \text{ psi}$

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 line and 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 C_{vn} available for:

a globe valve **ENINE** is available with all **intrinsic characteristics**, rangeability $r = 20:1$, and the Manufacturer's Table listed below:

DN mm	C_{vn} 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

3. Size the valve for the problem under consideration, choosing the one with the most appropriate DN
4. Verify cavitation according to the IEC norm
5. Determine a new value of the vapor pressure P_v which would send the selected valve to 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 installed in a 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 $\dot{V}_2(h_2) = 150 \text{ gpm}$ is passed through the valve inserted in the circuit?