Surname **Name** **n° matr.**

Section 1: QUIZ

1. The RTD is characterized by a negative temperature coefficient

   True ☐ False ☐

2. A fail-safe valve with an electric motor actuator, in the absence of power, always comes into the opening position

   True ☐ False ☐

3. The pyrometer measures the temperature by means of a radiation measurement

   True ☐ False ☐

4. Fluid shifting direction is greater in a free-flow (*Y-body)* valve than in a guided-flow (*Z-body)* one.

   True ☐ False ☐

Section 2: QUIZ

1. What happens if the temperature of the hot coupling in a thermocouple is lower than the reference jumper temperature?

a. ☐ No output voltage is not generated
b. ☐ The polarity of the output voltage is inverted
c. ☐ The polarity does not change and the output voltage increases
d. ☐ The output voltage remains the same when the temperature changes

2. This property of the sensors depends on the full scale

   NB: Only mark the wrong answer!

a. ☐ Accuracy
b. ☐ Precision
c. ☐ R*angeability*
d. ☐ Measuring Range

3. Which of the following components does not exist in a temperature industrial sensor?

a. ☐ Protective tube
b. ☐ Threaded or flanged joint for piping attachment
c. ☐ Ceramic membrane
d. ☐ Electric terminal

Section 3: SENSORS AND INSTRUMENTATION FOR PROCESS MEASURES

3.1 The thermocouple

a. For a thermocouple, provide a schematic drawing in the case of **exposed joint**

3.2 Capacitive pressure sensor

a. Provide a schematic diagram of its operation

3.3 Throttling sensors: flow nozzle

Provide a schematic drawing

3.4 The sonar level meter

a. Provide a schematic diagram of its operation in a closed tank

3.5. Flow sensors

Discuss the 3 classification keys on flow rate measurement and related sensors.

NB:
More briefly, schematic, e.g., in a Table, text will be better evaluated.
A long and confused text will NOT BE CONSIDERED!

Sezione 4: Valves

4.1 Control valves

Prove how mathematically from Eq. of the **intrinsic equal percentage characteristic** for a control valve with rangeability equal to *r*

$$\Phi = \Phi_0 \, e^{\beta h}$$

we obtain the corresponding expression:

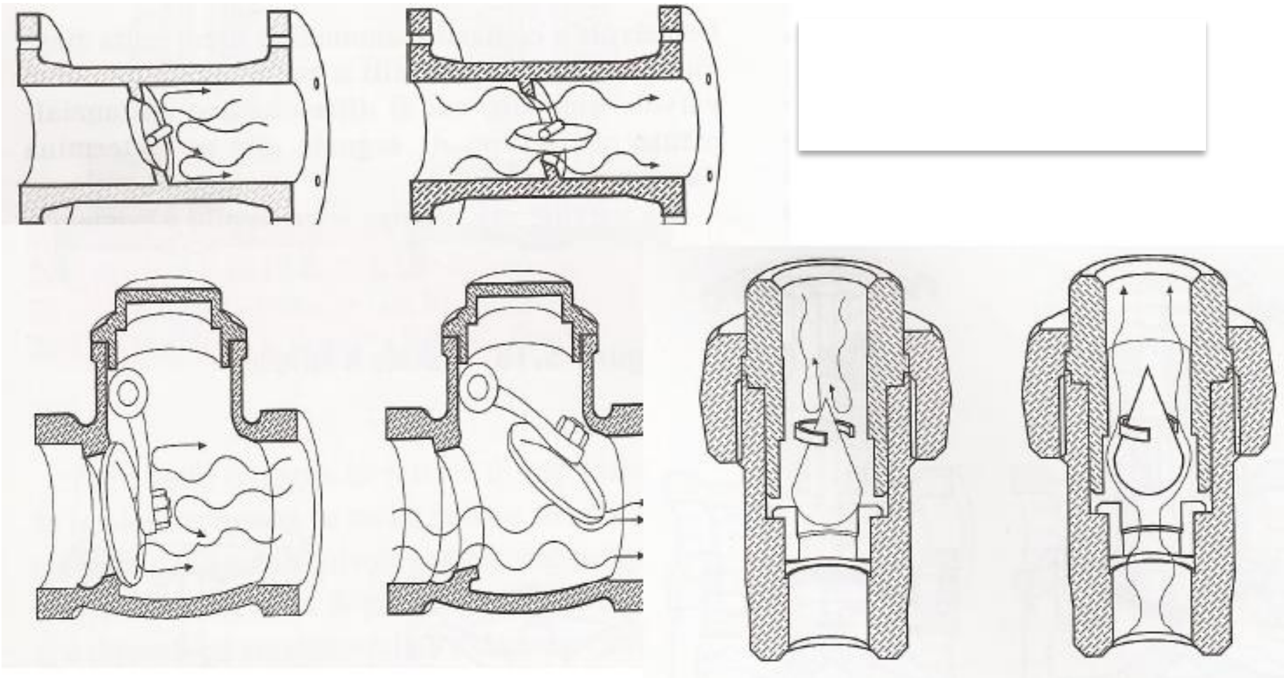
$$\Phi = r^{h-1}$$

4.2. Valve technology

The following figure shows 3 valves, each in 2 different operating situations.
For each valve:

a. What is its function?

b. Describe **briefly** the working principle



4.3. Sizing Problem

You must size a valve for the following conditions:

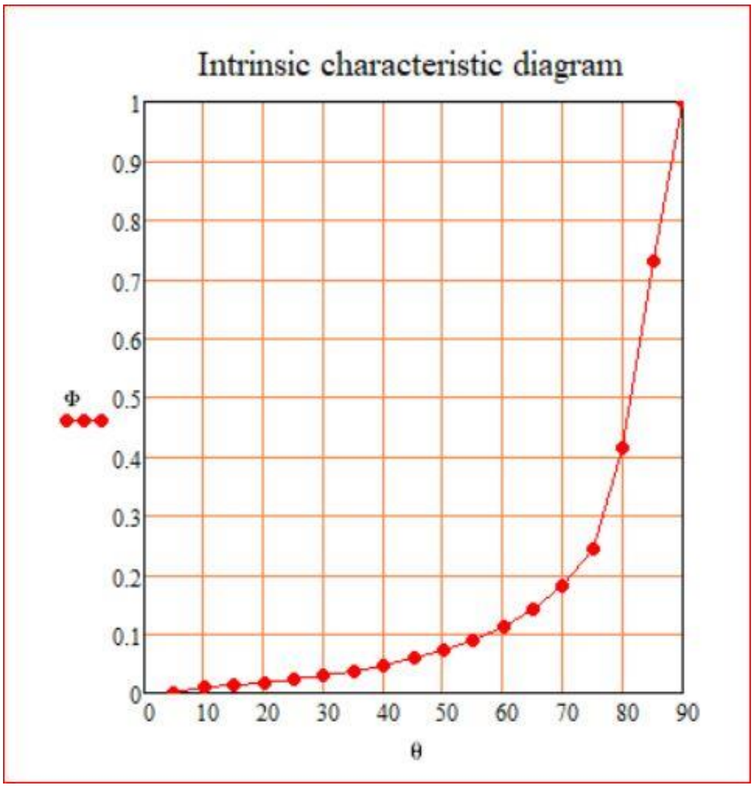
fluid: cocoa oil
density: ρ= 960 kg/m^3
nominal flow: $\dot{m}$ = 75÷85 kg s^{-1}
nominal diameter of the line : DN = 8”
pressure upstream of the valve : P_1= 20÷25 psi
pressure downstream of the valve : P_2= 16 psi
vapor pressure : P_v = 1.2 psi
Coefficient of the ratio of the critical pressure for liquids: F_F = 0.956

1. Calculate **flow coefficient** C_v for the valve

A **Pratt modulating ball valve** is available with the following C_{vn} table:

Valve Size, in	C_{vn} gpm psi$^{-1/2}$
6	5250
8	9330
10	14600
12	21000

and its **intrinsic characteristic** (see diagram in Figure).



Therefore:

2. Choose the valve with the most suitable DN among those in the table.
3. What type of intrinsic characteristic does the valve under test have?
4. Suggest what the rangeability might be for the chosen valve.
5. With ref. to the most suitable liquid, calculate the salient points of the **flow characteristic**, report them on a graph and determine if the valve operates in **normal flow** rate.

For the valve inserted in a circuit being ΔP_n = 4 psi and considering ΔP_u=12 psi as **utility drop pressure**:

6. Calculate the **Authority V** value and check if this value is suitable relating to the intrinsic characteristic of the valve.
7. Calculate flow rate $\dot{V}_n$ passing through the valve inserted in the circuit (**nominal condition**)
8. What is the flow rate $\dot{V}_1(\theta_1)$ passing through the valve when θ_1 = 35°?
9. How much is the actual pressure drop ΔP_{v1} across the valve for θ_1 = 35°?

10. Calculate the opening angle θ_2 which allows a flow rate $\dot{V}_2(\theta_2)$ = 1532 gal (US)/min

Furthermore, you have to face the **verification problem** for the previously sized valve:

11. In nominal conditions and assuming ΔP as used for valve sizing, is the chosen valve able to allow a flow of jojoba oil (ρ=865 kg/m^3) equal to $\dot{V}_v$ =10000 gpm ?
12. Again in nominal conditions and assuming ΔP as used for valve sizing, what is the max flow rate of jojoba oil that the valve is able to pass?