Surname **Name** **Student code**

Section 1. TRUE/FALSE QUIZZES

1. The Coriolis effect is associated with the positive displacement meter

   True ☐ false ☐

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

   True ☐ false ☐

Section 2. MULTIPLE ANSWER QUIZZES

1. 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

2. The principle on which is based the thermocouple is

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

Section 3: SENSORS AND MEASURING INSTRUMENTS PROCESS

3.1 The capacitive pressure sensor

a. Provide a schematic drawing of how it works

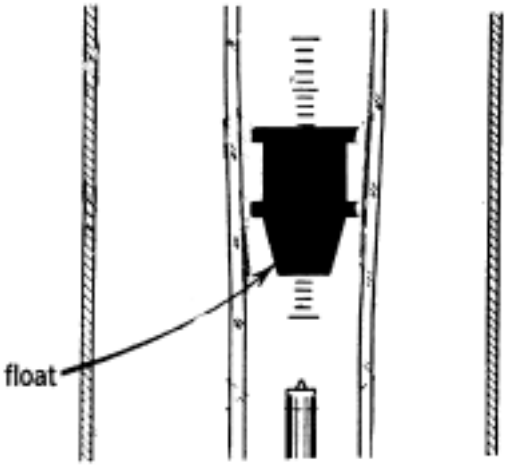
3.2 The orifice plate for flow measurement

a. Provide a schematic drawing of how it works

3.3 The radioisotope-emission level sensor

a. Provide a schematic drawing of how it works

3.4 The rotameter



With ref. to the Fig.:

a. Classify this one according to the 1st classification of flow sensors

b. Classify this one according to the 2nd classification of flow sensors

c. Can it work for liquids?

d. Can it work horizontally?

e. Derive mathematically the fundamental flow equation according to its working principle

Section 4: VALVES

4.1 The intrinsic characteristic law

Starting from the original formula of the **exponential intrinsic characteristic**:

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

derive mathematically the corrisponding equation based on *rangeability*:

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

4.2 Valve technology

For the valve in figure:

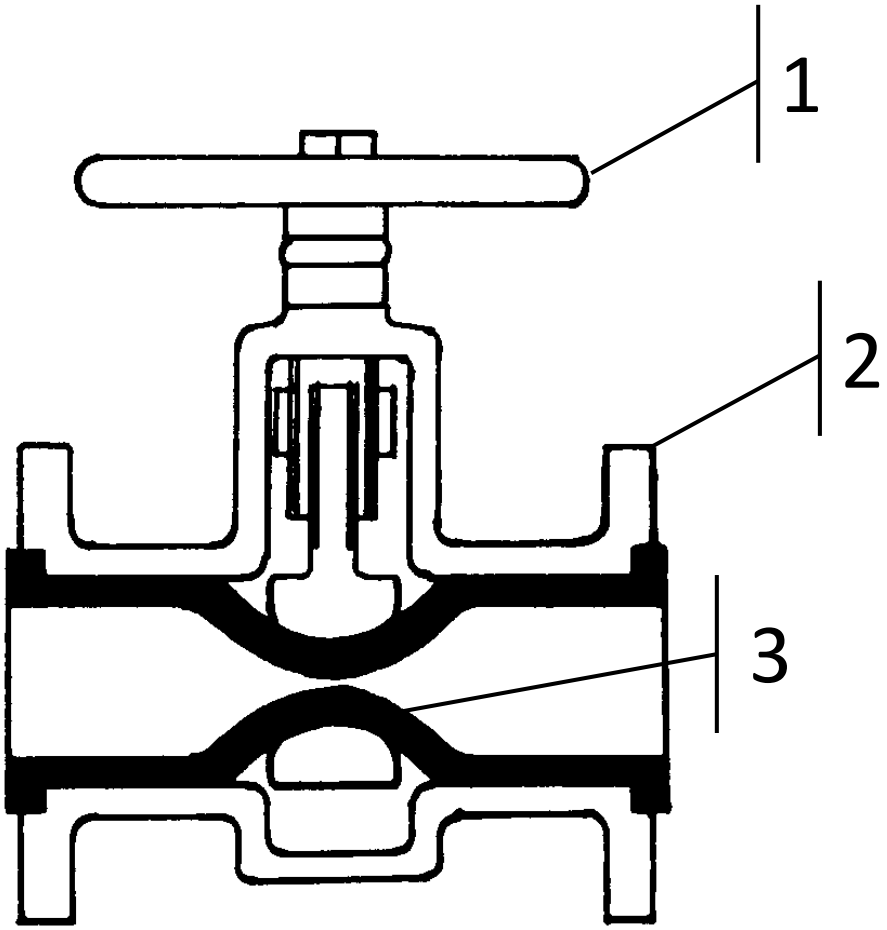
a. recognize its **type**

b. What is its **function**?

c. Is this valve a **linear o rotary** one?

d. Is this valve a **bi-directional** one?

e. Recognize and shortly describe the **component parts** denoted by a number in the figure



4.3. Valve sizing problem

A valve is to be sized for the following conditions:

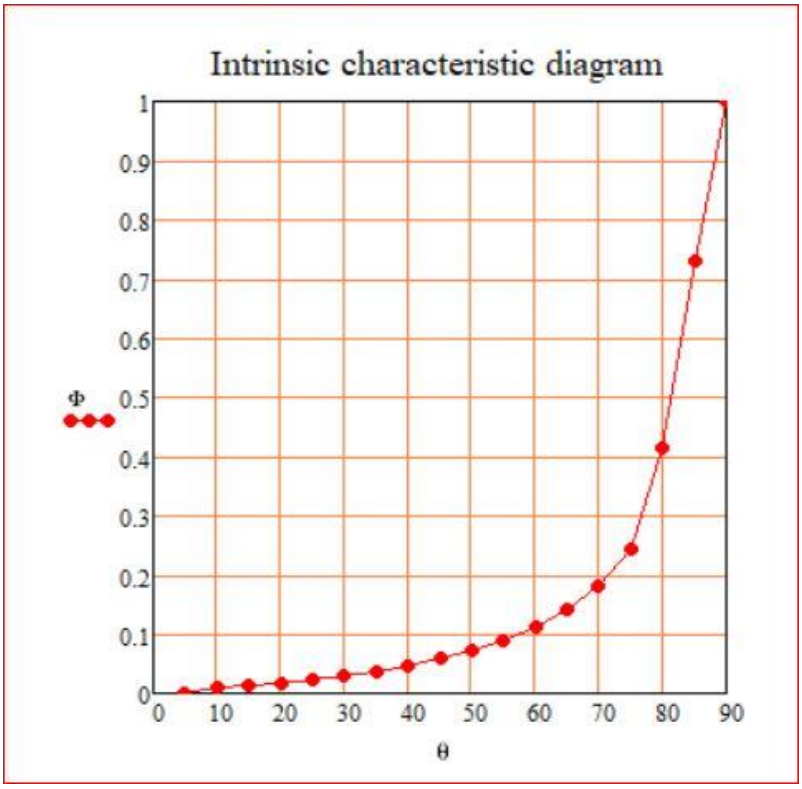
liquid: cocoa oil
density: $\rho = 960$ kg/m^3
nominal flow: $\dot{m} = 75 \div 85$ kg s^{-1}
nominal diameter of the line : DN = 8”
pressure upstream of the valve : $P_1 = 20 \div 25$ psi
pressure downstream of the valve : $P_2 = 16$ psi
vapor pressure: $P_v = 1.2$ psi
Coefficient of the ratio of the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

1. Calculate the **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 the **intrinsic characteristic** diagram in the Figure, with θ expressed in degree (°).



Therefore:

2. Choose the valve with the most suitable DN among those in the table.
3. Suggest what the rangeability might be for the chosen valve.
4. Calculate the salient points of the **flow characteristic**, report them on a graph and determine if the valve operates in **normal flow** rate.

Next,
for the valve inserted in a circuit being $\Delta P_n = 4$ psi and considering $\Delta P_u = 12$ psi as **utility pressure drop**:

5. Calculate the **Authority V**
6. Calculate flow rate $\dot{V}_n$ passing through the valve inserted in the circuit (nominal condition)

7. How much is the flow rate $\dot{V}_1(\theta_1)$ passing through the valve when $\theta_1 = 35°$?
8. How much is the actual pressure drop ΔP_{v1} across the valve for $\theta_1 = 35°$?
9. Calculate the opening angle θ_2 which allows a flow rate $\dot{V}_2(\theta_2) = 1532$ gal (US)/min

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

10. In nominal conditions and assuming ΔP as used for the initial 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 ?
11. Again in nominal conditions and assuming ΔP as used for valve sizing, what is the max flow rate of jojoba oil that the chosen valve is able to allow?