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

Section 1. TRUE/FALSE QUESTIONS

1. . The vortex flowmeter must be mounted horizontally

true □ false □

2. The typical span of a thermistor is: 50 – 250 °C.

true □ false □

3. The need of a stem guide arises in globe valves of large size

true □ false □

4. The change of direction imposed to the fluid is greater in a Z-body globe valve than in an Y-body globe valve

true □ false □

5. In all valves, the plug rotates only ever 90°

true □ false □

6. In the gate valve the closure member moves parallel to the main direction of flow

true □ false □

Section 2. MULTIPLE CHOICE QUESTIONS

1. Which of the following tools is not used to measure pressure?

a. □ manometer
b. □ vacuum meter
c. □ vacuum gauge
d. □ pyrometer

2. A bib cock can be

NB: Just mark the wrong answer!

a. □ three-way
b. □ conically tapered plug
c. □ double seat
d. □ butterfly

3. A bib cock can be

NB: Just mark the wrong answer!

a. □ globe
b. □ double seat
c. □ ball

d. □ butterfly

4. A globe valve cannot be

a. □ linear
b. □ rotary
c. □ free-flow
d. □ three-way

5. With reference to a control valve, which of the following statements is incorrect?

a. □ the normal flow is for $p_{vc}>p_v$
b. □ the semicritical flow is for $p_{vc}\leq p_v$ and $p_2>p_v$
c. □ at *vena contracta* it is $p_{vc}\geq p_1$
d. □ the flow limit is for $p_{vc}<p_v$ and $p_2\leq p_v$

Section 3: SENSORS AND INSTRUMENTATION FOR PROCESS MEASURING

3.1 Application of a thermocouple

A thermocouple type **J** is employed to measure the temperature of superheated steam
The **cold junction** of the measuring circuit is located at the known temperature T_{gf}=300 K.
The voltmeter connected to the junction provides a measure of the electromotive force: E=40 mV.

a. Determine the temperature T_{gc} of the steam in °C, to the nearest ± 1°C value

3.2 The Bourdon Manometer

a. Draw a simple scheme of operation

3.3 The electromagnetic flowmeter

a. Draw a simple scheme of operation

3.4 Time-of-travel ultrasound level sensor

a. Provide a simple explanation of the working principle

3.5. Sensor properties

a. Draw in a qualitative manner the **static characteristic** of a sensor affected by hysteresis

3.6. Contraction-based flow meters

a. Derive the flow equation in the **ideal case for liquids**
b. Use the flow equation to calculate the volumetric flow rate of water in the **ideal case** where P_1=100 kPa, P_2=50 kPa, d_1=100 mm, d_2=20 mm
c. Extend the flow equation to the case the flow is **not ideal**
d. Extend the flow equation to fluids with a **non-constant density**
e. Discuss applications, advantages e disadvantages

NB:

A well-organized and short paragraph will be assessed more than a long and confused text!

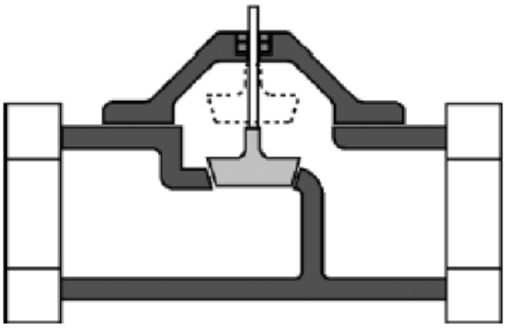
Section 4: VALVES

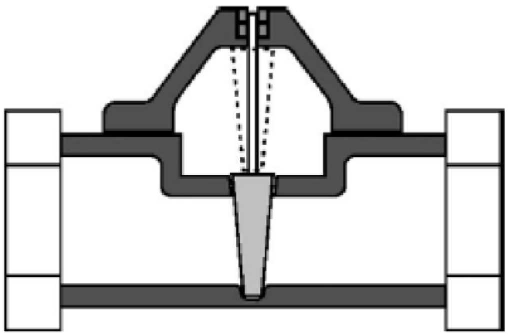
4.1. The technology of valves

For the valve in each of the two drawings:

a. What type is the valve
b. What is the valve purpose?
c. Is it a linear or rotary valve ?
d. Identify the main component parts

NB: It's possible to put answers directly on or near the following drawings





4.2. Valve sizing problem

You're required to size and to choose a **valve** for the following conditions:

nominal diameter of the line: DN = 150 mm
two possible fluids: sea water with a density ρ_f = 1.025 kg/L or chloroform with density ρ_f=1.465 kg/L
pressure upstream of the valve: P_1= 2.58 ÷ 3.5 bar
pressure downstream of the valve: P_2= 1.57 bar
nominal flow rate: $\dot{m}$ = 70 ÷ 90 kg/s
vapor pressure: P_v = 4000 Pa
liquid critical pressure ratio factor: F_F = 0.956

1. Calculate the flow coefficient $\mathbf{C_v}$

You have available a **POLARIS** butterfly valve with the following manufacturer's table of $\mathbf{C_v}$ (US gal min^{-1} psi$^{-½}$) as a function of the opening angle θ (as reported in a row for each DN):

DN (mm)	C_v (gpm psi$^{-1/2}$)							
	20°	30°	40°	50°	60°	70°	80°	90°
40	3	5	11	18	26	45	70	80
50	8	9	18	28	55	72	110	135
65	10	15	27	44	85	110	168	210
80	15	23	39	65	130	165	250	310
100	27	41	71	115	230	300	465	540
125	58	86	150	245	480	610	980	1100
150	96	140	245	400	785	1010	1615	1910
200	165	245	410	685	1275	1715	2670	3185

2. Choose the best suitable DN for the valve
3. Plot the **intrinsic characteristic** of the chosen valve in a diagram
4. Which type is the **intrinsic characteristic**?
5. Calculate the salient points of the **flow curve**, plot them back in a diagram and determine if the valve operates under normal flow.

Next, you are requested to insert the chosen valve in a flow circuit, assuming ΔP_n equal to the value (P_1 - P_2) originally adopted before, and considering the following three cases for the **utility pressure drop**:

a. $P_2 – P_3 = \Delta P_u = \Delta P_n$
b. $\Delta P_u = \Delta P_n/2$
c. $\Delta P_u = 2\Delta P_n$

6. How much is the **authority** V in the 3 cases?

Furthermore, under the condition $\Delta P_u = 2\Delta P_n$

7. How much is the volumetric flowrate $\dot{V}_\theta$ passing through the valve for θ = 40 °?
8. How much is the **pressure drop** $\Delta P_{v,\theta}$ through the valve for θ = 40 °?