Lebanese University | **Partial Exam** | Date: 3 / 3 / 2022

Faculty of Engineering – III | | Time: 1h

**Fluid mechanics**

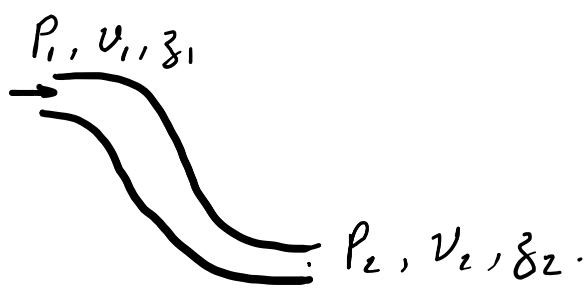
Department: Mechanical Semester : V | | Closed books

**Problem 1: (25 points)**

Through a refinery, fuel ethanol is flowing in a pipe at a velocity of 1 m/s and a pressure $P_1$= 101300 Pa. The refinery needs the ethanol to be at a pressure $P_2$= 2 atm (202600 Pa) on a lower level $z_2$.

- Determine the change of height $\Delta z$ in order to achieve this pressure?

Assume the velocity does not change. (Hint: Use the Bernoulli equation. The density of ethanol is 789 kg/m$^3$ and gravity g is 9.8 m/s$^2$. Pay attention to units!)

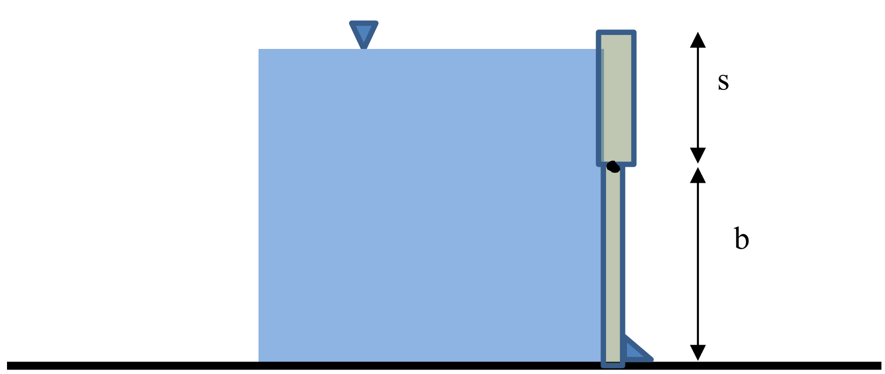



**Problem 2: (25 points)**

A rectangular gate of height ***b*** and width ***a*** (into the page) holds back water in a reservoir. (The gate can swing open to let some water out when necessary.) The height from the water surface to the hinge is *s*. take the density of water 1000 kg/m$^3$, g = 9.8 m/s$^2$ and the moment of inertia of the gate $I_{xx} = \frac{a\,b^3}{12}$.

a- Determine the expression of the resultant force exerted by the water on the gate.

b- Find the location of the resultant force on the gate.



**Problem 3: (20 points)**

An idealized incompressible flow has the proposed three-dimensional velocity distribution

$$\vec{V} = f(x)\vec{\imath} + zy^3\vec{\jmath} - \frac{3}{2}z^2y^2\vec{k}$$

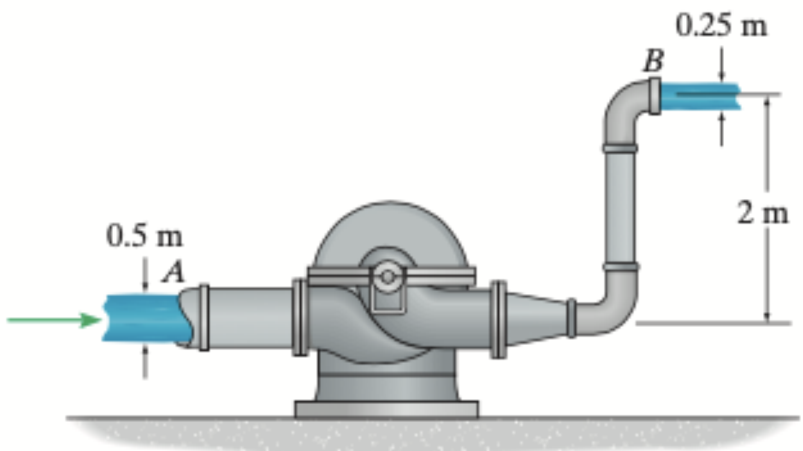
- Find the appropriate form of the function $f(x)$ which satisfies the continuity relation for incompressible flow.

**Problem 4 (30 points)**

The pump discharges water at $B$ at 0.05 $m^3/s$. Neglect the friction between the intake at $A$ and the outlet at $B$. Take the power input (electric power) to the pump is 8 kW. The efficiency of the pump is $e = 0.7$.

a- Determine the output power of the pump (power received by the water)

b- Determine the difference in pressure between $A$ and $B$ $(P_B - P_A)$ = ??.




**In all problems take: the density of water $\rho = 1000$ kg/m$^3$ the gravity $g = 9.81$ m/s$^2$.**
**The depth of the center of static pressure is: $l_p = l_C + \frac{I}{l_C A}$ where $l_c$ is the center of surface.**