Lebanese University | **Partial Exam** | Date: 18 / 3 / 2022

Faculty of Engineering – III | Time: 1h

Fluid mechanics

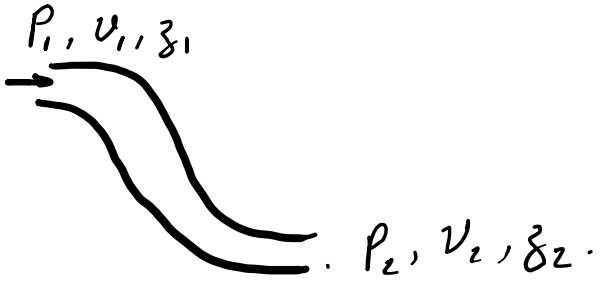
Department: Petrochemical Semester : V | Closed books

Problem 1: (25 points)

Through a refinery, fuel ethanol is flowing in a pipe at a velocity of 3 m/s and a pressure P_1= 101300 Pa. The refinery needs the ethanol to be at a pressure P_2= 3 atm (303900 Pa) on a lower level z_2.

- Determine the change of height Δz in order to achieve this pressure?

Assume the velocity does not change and neglect all effect of friction. (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!)

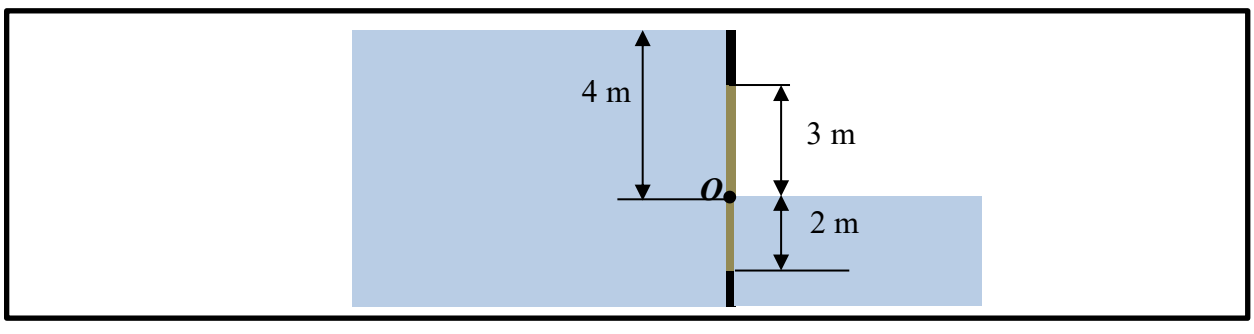


Problem 2: (25 points)

A rectangular gate of height 5 m and width of 1m seals a hole of the same size and shape in a vertical partition in a tank. The gate is pivoted about a horizontal axis through ***O***, leaving 3 m of the gate above ***O*** and 2 m below it. The tank contains oil of density **ρ**; on the left hand side its free surface is at a height ***c*** above the pivot ***O*** , on the right hand side the free surface is level with the pivot. Both free surfaces are exposed to atmospheric pressure. Take the second moment for rectangular surface: $I = \frac{b\,h^3}{12}$.

a- Find the expression of the total force exerted by the oil on the gate.

b- Determine the position of the forces exerted on the gate and show it on the figure.



Problem 3: (20 points)

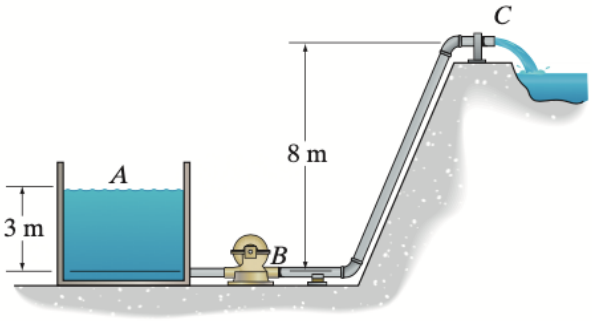
A velocity field is given by $\vec{V} = (3y^2 - 3x^2)\vec{\imath} + cxy\,\vec{\jmath} + 0\,\vec{k}$.

Determine the value of the constant *C* if the flow is to be incompressible.

Problem 4 (30 points)

The pump draws water from the large reservoir *A* and discharges it at 0.2 m^3/s at *C*. If the diameter of the pipe is 200 mm. Neglect friction losses.

- Determine the power that the pump delivers to the water.



In all problems take: the density of water ρ = 1000 kg/m³ the gravity g = 9.81 m/s².
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.