Faculty of Civil Engineering
Department of Civil Engineering

Hydraulics and Water Resources Division

Homework-III

Notes about submitting the homework:

- Deadline for submitting the home works: ***26.04.2016***
- Homework should be done in a format according to the engineering standards (smooth, clean and comprehensible).

Question 1. Write the Newtonian shear stress formula and define every term in the formula. Interpret the consequences of this law for hydrostatic conditions and for the flow of ideal fluids.

Question 2. Define the terminologies given below.

Viscosity, uniform flow, uniform velocity distribution, velocity gradient, absolute pressure, gage pressure, Lagrangian method of flow description, Eulerian method of flow description, cross-sectional average velocity, temporal average velocity, dynamic pressure, kinetic correction factor, momentum correction factor, circulation, discharge, steady-state (permanent) flow, two-dimensional flow (2D), ideal (inviscid) fluid, irrotational flow, Newtonian fluid, neo–surface (iso-pressure surface), molecular mechanic, continuum mechanics, vapor pressure, Liquid in relative equilibrium, vertical oscillation component, cylindrical cross-section.

Question 3. Is there a possibility of shear stress formation in a hydrostatic mass fluid? Justify your answer.

Question 4. Derive the Bernoulli equation for the situation of irrotational and two dimensional flow case by the help of Euler equations of motion.

Question 5. Derive the acceleration formula for one dimensional flows and explain the physical meanings of the terms in the equation in detail.

Question 6. Compare the continuity, energy, and impulse-momentum equations for one-dimensional ideal and viscous fluids.

Question 7. Show that the circulation is zero for irrotational fluid flows (potential flow).

Question 8. Show that oscillating turbulence velocity components generate some kind of shear stress in a flow field where there exists perpendicular velocities.

Question 9. For two dimensional flows, derive the irrotationiality condition and interpret it physically.

Question 10. Derive the continuity equation for compressible and unsteady flows for two-dimensional case. What form will the equation have under the special cases given below?

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(a) Fluid is incompressible

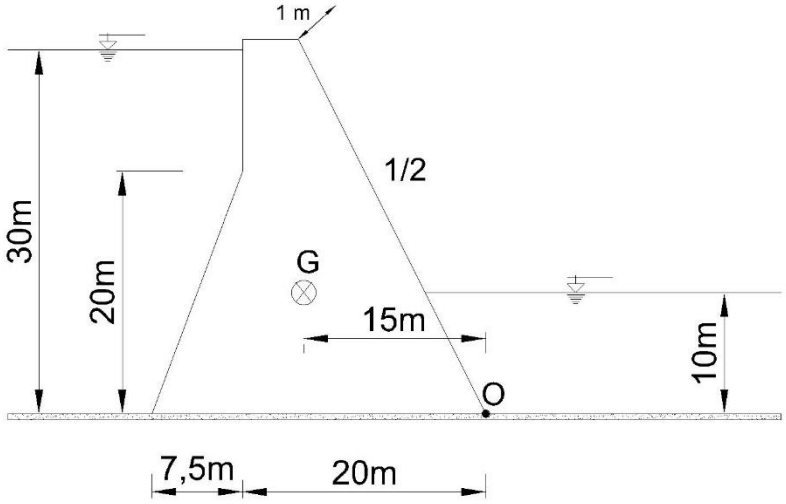
(b) Flow is steady (permanent)

Question 11. What are the reasons of occurrence of shear stress in the laminar and for turbulent flows? How can we distinguish if a flow is laminar or turbulent? Explain.

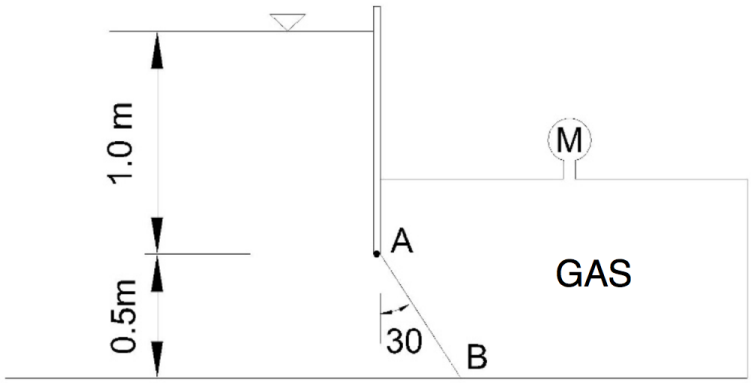
Question 12. Derive the formula of shear stress generated by turbulence and interpret it.

Question 13. (a) In a gravity field, write the NAVIER-STOKES equations for two dimensional viscous fluids. (b) Assuming the fluid is ideal (inviscid), what does the equation simplify to? (c) For a hydrostatic state, derive the hydrostatic pressure distribution formulas from these equations.

Question 14. Dam's height in the figure is 30 m. Calculate the components of the hydrostatic pressure force acting on the dam when it is full of water and determine the weight of the dam not to fall over point O. The horizontal distance between the center of gravity (point G) and point O is 15 m.



Question 15. The width of the gate in Figure is 3 m. What should be the gas pressure to hold the gate in its position considering the water pressure force on the left side?



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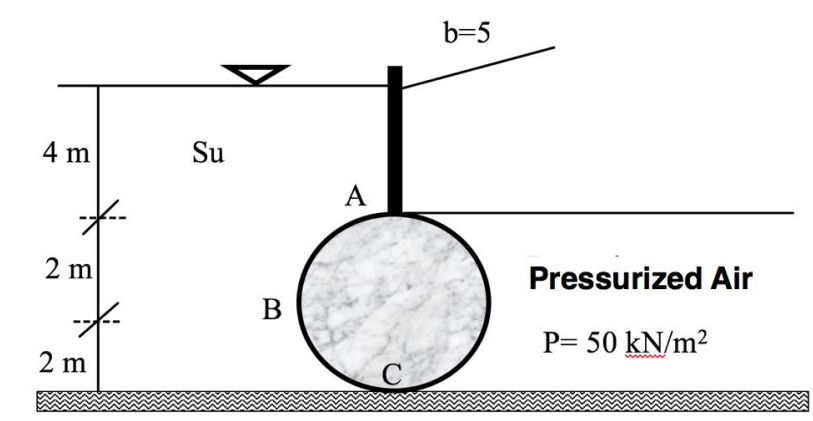
Question 16. Width of the semi-circular gate ABC shown in the figure given below is 5 meters. The right side of the gate is pressurized air. Find the horizontal and vertical components of the hydrostatic force acting on the gate.



Question 17. In a two dimensional flow (2-D), the velocity field is given as $u = 2xy + 3t$ and $v = x^2 - y^2 + 2t$

a- Is this flow physically possible?

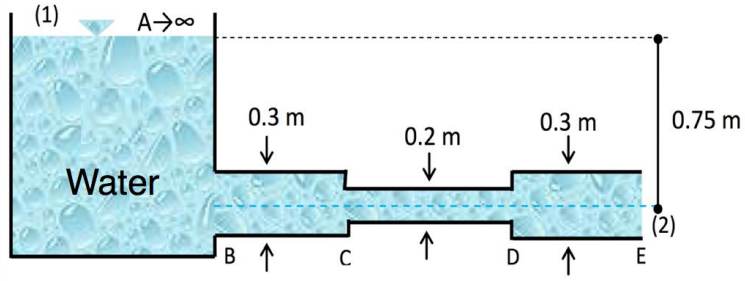
b- Is this flow steady (permanent)?

c- Is this a potential flow (irrotational flow)? If it is a potential flow determine, the potential function.

Question 18. From a large reservoir, water is drained into the atmosphere by a horizontal pipe system as shown in the figure.

a- Calculate the discharge of the system.

b- Without changing the discharge, calculate the minimum possible value of the diameter at section CD and draw the absolute piozemeter, gage energy and gage piozemeter lines for this case. D_{BC}=0.30 m, D_{CD}=0.20 m, D_{DE}=0.30 m, $(p_{at})_m$= 1kg/cm^2 and $(P_v)_m$=0.025 kg/cm^2



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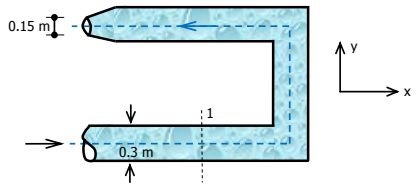
Question 19. Define laminar and turbulent flows. Draw the graphs of the three components of the velocity gradient with respect to time at a point.

Question 20. The water jet flowing through an elbow on the horizontal plane is discharged into the atmosphere. Given the average flow velocity at cross-section (1) is v_1=2 m/s, gage pressure is p_1=19.62 N/cm^2 and assuming the fluid is viscose and absolute atmospheric pressure is 9.81 N/cm^2, find:

a- the energy loss occurs in the elbow.

b- x and y components of the force that the flow applies on to the elbow.



Question 21. The velocity components of an ideal (inviscid) and incompressible fluid in two-dimesions (2-D) are given as $u = -2ax$, $v = 2ay$ (a=constant)

a- Is this flow physically possible?

b- Is it a potential flow? If it is, find the velocity potential function of this flow.

c- Determine the stream function of this flow.

d- For a=1 and at point M (1, 1), determine the velocity and acceleration, and their components.

Question 22.

a) Write the energy equation of an ideal (inviscid) fluid for a unit weight flowing between the cross-sections (1) and (2) shown in the figure.

b) Show each term on the figure below that exists in the equation.

c) Fill in the table below.

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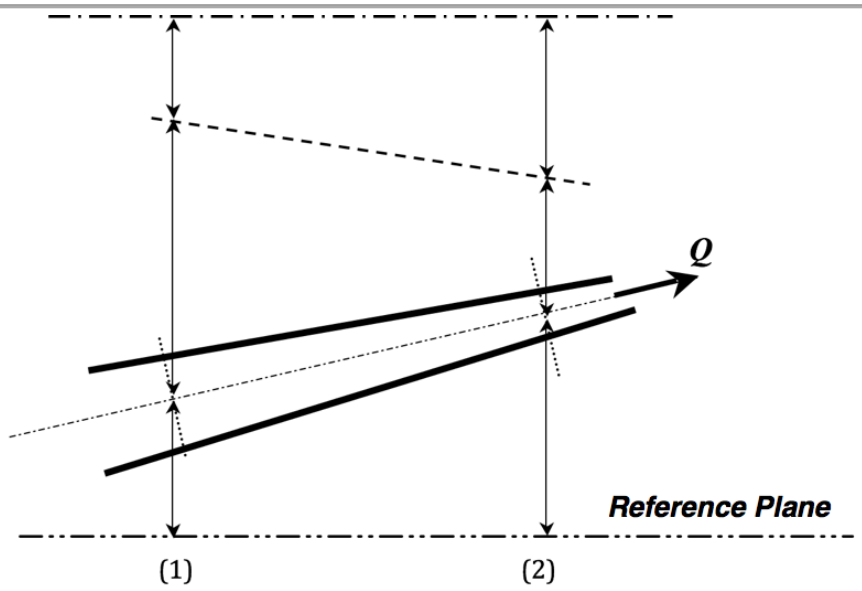

Term	Dimension	Physical / Mechanic Meaning	Geometric Meaning

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