ME2240: Fluid Mechanics
Assignment - 3
Instructor: Harish N Dixit
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Due date: Friday, 30th September 2022, before the class begins.

Note: Please write your solutions on a neat blank sheet of paper (preferably on both sides) with the roll number and name clearly written at the top. Loose sheets will not be accepted, so make sure you staple the sheets. And don't forget to number the sheets. Any evidence of copying will result in getting a zero mark for the entire assignment. Make sure that you work out the solutions on your own. Draw the plots on a graph paper or neatly on a plane sheet of paper with the axis clearly marked.

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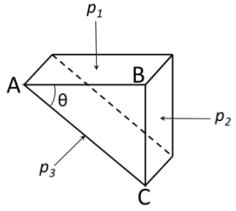
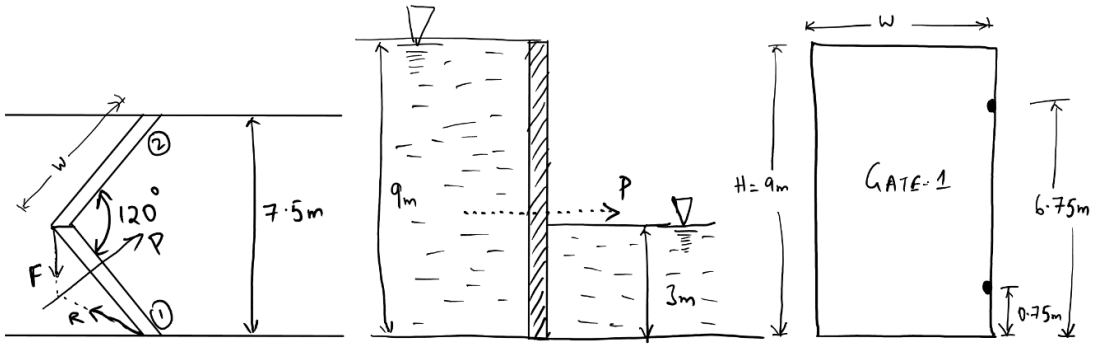
1. Using the figure below, show that the pressures are the same in all direction for a fluid at rest.



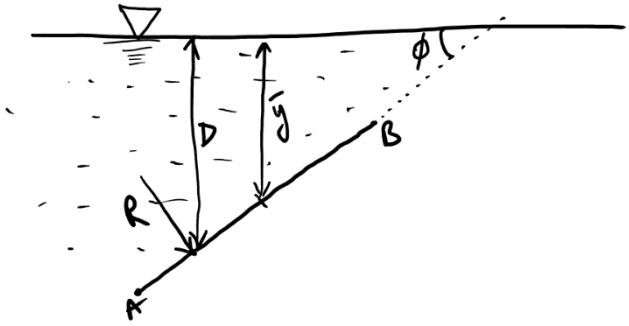
2. The gates of a lock which is 7.5m wide make an angle of 120° with each other in plan view (left figure). The depths of water on the two sides of the gate are 9m and 3m respectively (middle figure). Each gate is supported on two hinges which are situated 0.75m and 6.25m above the bottom of the lock (right figure). Find the force on each hinge and the thrust between the gates.
(Hint: The force due to water on each gate is P, the resultant of the reactions of the two hinges on each gate is R while F is the reaction between the gates which acts normal to the meeting surfaces as shown. Assume that all these forces are in the same horizontal plane).



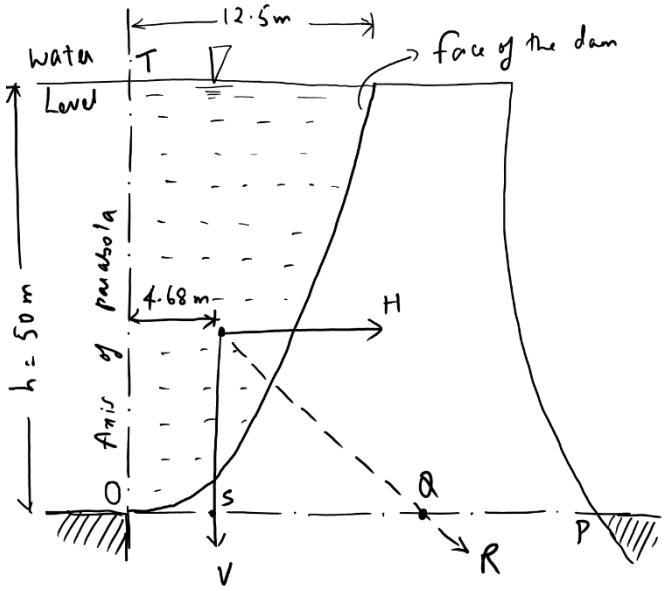
3. A plane surface of arbitrary shape and area A is totally immersed in a liquid of specific weight, w. If this surface is inclined at an angle φ to the horizontal and its centroid is at a vertical depth $\bar{y}$ below the free surface, show that

$$D = \sin^2 \varphi \, \frac{k_G^2}{\bar{y}} + \bar{y}.$$

You will have to use the following definition of the second moment: $I_{xx} = A\,k_o^2$ about x-axis passing through 0 and $I_{\bar{x}\bar{x}} = A\,k_G^2$ measured about the centroidal axis. Here k_o and k_G are called the radius of gyration of the area A.



4. Figure below shows the cross-section of a dam with a parabolic face facing the water. The vertex of the parabola is at O. If the parabola is given by the equation $y=ax^2$, determine the value of a. The axis of the parabola is vertical and 12.5m from the face at the water level. Assuming a depth of 1m, estimate the resultant force, R, due to the water, its inclination to the vertical, and how far from O its line of action cuts the horizontal OP. The centroid of the half parabolic cross-section of water is 4.68m from the vertical through O.



5. A dam has its water face in the shape of a circular arc as shown in the figure below. Calculate the resultant force on the curved surface per unit breadth of the dam and obtain its inclination to the horizontal.