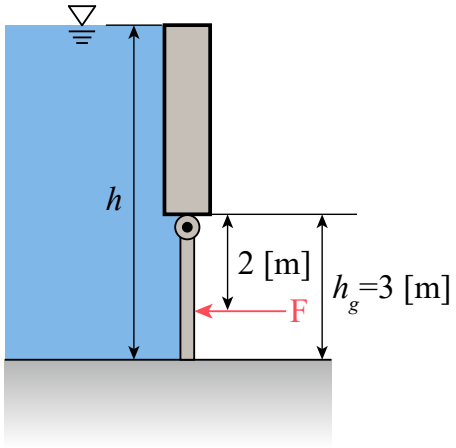
Homework #3

MEMS 0071 - Introduction to Fluid Mechanics

Assigned: September 14th, 2019
Due: September 20th, 2019

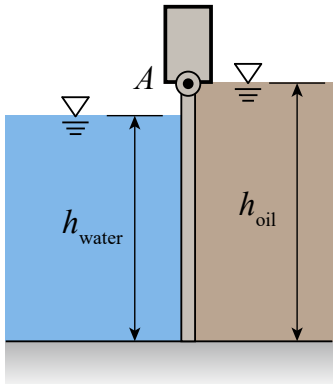
Problem #1

The tank shown below has a width, b, of 1 [m]. The height of the rectangular gate, h_g, is 3 [m]. The fluid is water at 20°C. A force F of maximum value 1 [MN] is applied at 2 [m] below the top of the gate. Determine the maximum depth of the fluid h that the gate can hold.



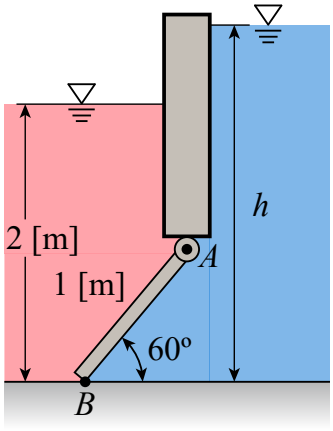
Problem #2

Consider an open tank with a partition separating oil and water. A gate is located at the bottom of the partition, with a height and width of 2 [m], hinged as A. For a height of 2 [m] of oil, determine the height of water needed to keep the gate closed. Take the density of water to be 998 [kg/m^3] and that of oil to be 900 [kg/m^3].



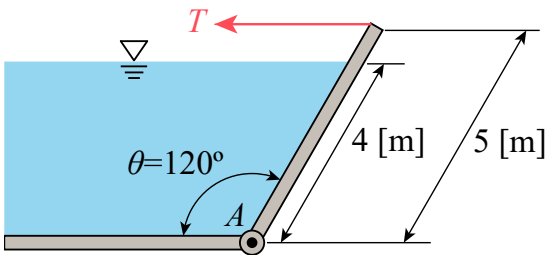
Problem #3

Consider a gate separating mercury and water. If the gate is 1 [m] wide, a length of 1 [m], the depth of mercury is 2 [m], and the SG of mercury is 13.6, determine the height of water that would generate a zero moment about point A



Problem #4

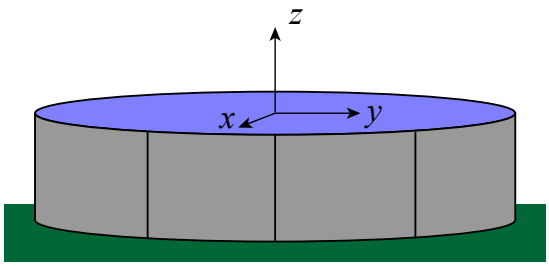
A 5 [m] by 5 [m] rectangular gate is hinged at point A and is supported by a cable, as shown in the figure below. The gate is holding back water, with a density of 998 [kg/m^3]. Determine the tension T in the cable, neglecting the weight of the gate.



Problem #5

Consider an above-ground pool with a diameter of 10 [m] and a depth of 1.5 [m]. The x- and y- directions can be taken as the lateral directions, whereas the positive y-direction is upward and perpendicular to the surface of the water. Using the formulation of forces acting on curved surfaces, determine:

a) The net horizontal force acting on the pool structure in the x-direction;
b) The net horizontal force acting on the pool structure in the y-direction;
c) The net vertical force acting on the pool structure in the z-direction.



Problem #6

Consider a sphere with a radius of 0.5 [m]. The sphere is submerged in water to a depth of 3 [m] (from the surface of the water to the center of the sphere). The x- and y- directions can be taken as the lateral directions, whereas the positive y-direction is upward and perpendicular to the surface of the water. Using the formulation of forces acting on curved surfaces, determine:

a) The net horizontal force acting on the sphere in the x-direction;
b) The net horizontal force acting on the sphere in the y-direction;
c) The net vertical force acting on the sphere in the z-direction.

Problem #7

Consider a triangular body submerged in water with a base of w, a height of h, and a length into or out of the page of unity, where the top the triangle is h below the surface of the water. Determine:

a) The x-component of the net resultant force acting on the inclined surfaces of the body;
b) The y-component of the net resultant force acting on the inclined surfaces of the body;
c) The y-component of the net resultant force acting on the bottom of the body;
d) The net force acting on the body in the y-direction via the summation of b) and c);
e) The buoyant force acting on the body;
f) The weight of the body;
g) The net force acting on the body in the y-direction via the summation of e) and f).