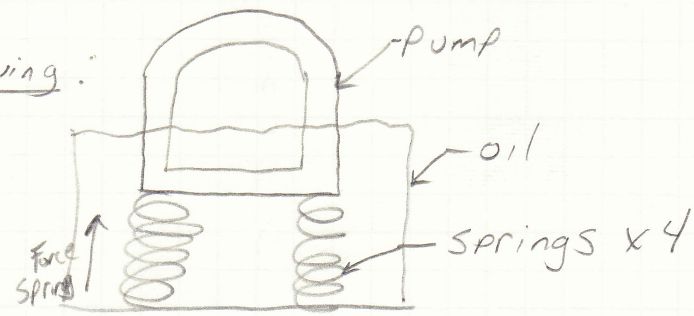
HW #1.4 | MET 330 | STEVEN BLEA

PROBLEM: FIND the force exerted by the springs of a Pump Partially submerged in oil w/ sg = 0.90

Given: Weight (pump) = 14.6 lb, submerged volume = $40 in^3$

Drawing:



Solution: need to find the force of buoyancy of submerged part of the pump:

$$Force_{buoy} = \gamma_{oil} V_d$$

γ_{oil} = Specific weight of oil

V_d = displacement of submerged pump

$$Sg = \frac{\gamma_{oil}}{62.4 lb/ft^3}$$ from (1-8) in book

$$\gamma_{oil} = Sg \times 62.4 \; lb/ft^3 = 0.90 \times 62.4 \; lb/ft^3$$

$$\gamma_{oil} = 56.16 \; lb/ft^3$$

$$V_d = 40 in^3 \times \frac{0.00058 ft^3}{1 in^3} = 0.0232 \; ft^3$$

Plug known values into equation for force above:

$$Force_{buoy} = \gamma_{oil} \times V_d = 56.16 \; lb/ft^3 \times 0.0232 \; ft^3$$

$$Force_{buoy} = 1.303 \; lb$$

Since pump is not moving all forces in X & Y direction = 0

Since springs support vertically we are only concerned w/ Forces in Y-dir

So, $\Sigma F_y = 0 \Rightarrow Force_{buoy} + Force_{spring} - W = 0$

$$Force_{spring} = W - Force_{buoy} = 14.6 lb - 1.303 lb$$

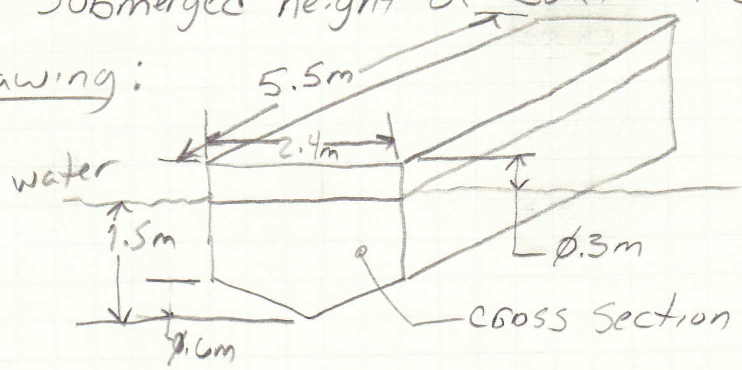
$$\boxed{Force_{spring} = 13.297 \; lb \uparrow}$$

Problem #5.61: Is the boat pictured in figure stable?

Given: boat dimensions are: 5.5m Long x 2.4m Wide x 1.8m High

Submerged height of boat = 1.5m

Drawing:



Solution: Need to calculate area of cross section

$$A_{cs} = A_{rec} + A_{triangle}$$

$$A_{rec} = 2.4m \times (1.5m - 0.6m + 0.3m)$$

$$A_{rec} = 2.4m \times 1.2m = 2.88m^2$$

$$A_{triangle} = \tfrac{1}{2}(0.6m \times 2.4m) = 0.72m^2$$

$$A_{cross\ sect} = 2.88m^2 + 0.72m^2$$

$$A_{cs} = 3.6m^2$$

Area of submerged part of boat:

$$A_{sub} = (1.5m - 0.6m)(2.4m) + \tfrac{1}{2}(0.6m \times 2.4m) = 2.88m^2$$

Centroid of the whole area:

$$Y_{cg} = \frac{A_1 Y_1 + A_2 Y_2}{A_{tot}} = \frac{(\frac{1}{2} \times 2.4 \times 0.6) \times \frac{2h}{3} + (1.2 \times 2.4) \times (0.6 + \frac{1.2}{2})}{3.6}$$

(h = 0.6)

$$Y_{cg} = 1.04m$$

Centroid of submerged area:

$$Y_{c_{submerged}} = \frac{A_1 Y_1 + A_2 Y_2}{A_{sub}} = \frac{(\frac{1}{2} \times 2.4 \times 0.6) \times 2h + (0.9 \times 2.4) \times (0.6 + \frac{0.9}{2})}{2.88}$$

(h = 0.6)

$$Y_{c_{submerged}} = 0.8875m$$

Total displacement volume of the boat

$$V_d = A_{sub} \times Length = 2.88m^2 \times 5.5m = 15.84m^3$$

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Problem #5.61 cont

MOI is $I = \frac{BH^3}{12} = \frac{5.5m \times 2.4m^3}{12} = \underline{6.336\ m^4}$

$MB = \frac{I}{V_d} = \frac{6.336\ m^4}{15.84\ m^3} = \underline{0.4m}$

$Y_{mc} = Y_{csub} + MB = 0.8875m + 0.4m = 1.2875m$

IF center of gravity is below Metacenter boat is stable

$Y_{mc} > Y_{cg}$

$1.2875m > 1.04m$ ✓ true

boat is Stable

Steven Blea

MET 330

HW 1.4, Part 2

Test Chosen: Test 1 (Spring 2016)

Problem #1 – When initially reading the problem and seeing the displacement of the Mercury at P1 = 5 psi is h1, I immediately thought that increasing the pressure to 10 psi, which is double the initial pressure would cause the height of the Mercury to also double. After reading through the solution and following along with the calculations of course that was not the case. The height did not increase by double, but instead, increased by slightly less than half. This seems to be due to the difference between gamma for Water and gamma for Mercury. Mercury is much denser than Water so increasing the pressure of Water by double does not translate to an increase in the level of the Mercury by double.

Problem #2 – While reviewing problem 2 there were many equations that I had not remembered from statics and strength of materials such as the equation for Lp. I had to review the problem many times to understand how and where the variable came in to play. Also, initially, I assumed the distance (w) the question was asking for was equal to the length of the door the water was touching. I quickly realized that was not the case and that we needed to figure out the distance (w) so that the center of the mass of the gate was positioned so that the force of the water was keeping the gate in a balanced position.

Problem #3 – This problem was very unfamiliar to me since I did not select to do a problem from the homework like this. I was able to follow along with the solution based on what we went over in class. Before the test I will complete a few practice problems similar to this one so that I will be able work problems like this in the future. The problem is basically the differences in the forces of the weight of the ball and air going down minus the force of buoyancy divided by the mass of the steel and air. To find the thickness of equilibrium the weight of the steel needs to equal the force of buoyancy (water displaced)

Problem #4 – This problem was very difficult for me to follow. I understand what the calculations represent, but I could not come up with the equations on my own. I will look to solve a few example problems from the book. I hope that it will help me to better understand.