

1. **How and why the test demonstrates your work toward one, or more, of the course learning objectives. Be specific on the course objectives you decide to mention.**

- a. **Problem 1 Example:** I was able to navigate the SI metric system by tracking water and oil densities ($\rho_w = 1000 \text{ kg/m}^3$ $\rho_o = 790 \text{ kg/m}^3$ and maintaining clean dimensional conversion across my manometric equations.
- b. **Problem 2 Example:** I was able to retrieve the specific weight of water ($\gamma_w = 62.4 \text{ lbf/ft}^3$) and set up the governing equation for a horizontal hydrostatic force. My answer yielded what was found in the Test 1 solutions, which proves I can correctly identify and calculate core quantities using US Customary systems. However, I messed up on the unit cancellation step, causing trailing errors throughout the rest of the problem where I put lbf when it should have been lb. Another course objective was to compute forces exerted by any static fluid acting on a horizontal plane area, a rectangular wall, any submerged plane area, and curved surfaces. By properly understanding the context of this problem and breaking the complex pressure profile into independent components, I demonstrated non-planar geometry under hydrostatic pressure. With my answer matching the solutions (other than the units), I showed a grasp of how a static fluid interacts with curved mechanical constraints.
- c. **Problem 3 Example:** One of the course learning objectives was evaluating bodies floating on a fluid using the equation for buoyant force and the principles of static equilibrium to solve for the forces involved in buoyancy problems. In this problem, I set up a vertical static equilibrium balance where the total downward weight of the floating ice block is perfectly countered by the upward buoyant force of the seawater $W = F_b$. I was able to retrieve the specific gravities and volumes, and my mathematical isolation of the draft depth, h , was exactly 1.534 m, matching the solution. This shows my application of static equilibrium to floating body problems. Additionally, I recognized that stability depends on the spatial relationship between the center of gravity (y_{cg}), the center of buoyancy (y_{cb}), and the metacenter. I calculated the waterline area moment of inertia to find the distance to the metacenter $MB = 0.1729 \text{ m}$. While the professor checked the absolute coordinate values $0.9399 \text{ m} > 0.892 \text{ m}$, I proved stability by showing that the net metacentric height (MG) was positive. Because my relative measurement matches the professor's coordinate gap 0.048 m, it proves understanding of engineering criteria used to establish floating body stability.

2. How your test compares against the available solution. State the mistakes you made and what you will do next time to avoid making same mistakes. Please point out exactly where you made the mistake, say why you made the mistake, and how you should have done it. If you were taking this test again, what advice would you give yourself to ensure that you had a successful test?

- a. Problem 1 for the u-tube manometer. My final answer matched the solutions. We both calculated the final oil column height (h_o) to be 50.67 cm (I had mine in meters, but these are equal) here I made zero conceptual or numerical mistakes. I showed understanding of volumetric displacement, knowing water level dropped 20cm on the right meant it had to rise 20cm on the left.
- b. Problem 2 for the curved cylinder gate: Comparing my results to the given solutions, I found that my horizontal force magnitude $F_H = 1747.2 \text{ lbf}$ and my center of pressure distance calculation = 0.0238ft matched. However, for the final equilibrium verification, my answer was 833.64 lbf/ft while the official answer sheet stated 1818.695lb. My faults lie in the units and practice proper unit cancelation. And when I calculated the center of pressure distance offset relative to centroid. I left it as standalone value when I should have added it back to the reference line.
 - i. My area moment of inertia equation was missing the offset. Because I kept the analysis local to cross sectional strips, my final calculation weight came out to be a distributed metric. The mistake was failing to scale this value up by the total gate system dimensions to meet the absolute total weight requirement of the question. I checked the fundamental fluid mechanic calculations, inertia steps, and division parameters were correct. I should have noted that there is a distance offset to the centroid depth- $h_p = 14\text{ft} + 0.0238\text{ft} = 14.024 \text{ ft}$. Also, when setting up static moment equilibrium balance I needed to integrate the values across the dimension system. My advice is don't forget to include all parameters of the problem. Do not stop halfway through the center of pressure equations. Remember to add your calculated distance offset backed to centroid height and pinpoint absolute line of action from the free surface. Check final target of units
- c. Prob 3: My immersion draft depth matched the solutions key. Towards the end is where the mistake or order of operations could be clearer. It was ultimately the formatting of my formula that I had used to check stability. I believe after reflecting on the solutions, it seems my thought process was incomplete. Answer sheet shows proving stability with absolute height of metacenter was greater than absolute height of center of gravity. I chose to evaluate the condition using relative distances via the metacentric height formula. The evaluation was

technically not as what was shown on the solution, as a result of not being correct. Subtracting in the answer set would show $0.9399\text{ m} - 0.892\text{ m} = 0.0479\text{ m}$ which matched my calculation for metacentric height of 0.048 m perfectly. Both methods clearly prove that the metacenter is above the center of gravity and that the floating ice block is completely stable. My work met objectively, though expressing the final step using an absolute coordinate system would encompass the full scope of the problem.

3. What your grade should be. Based on the writing rubric provided in the test and the correctness of your solution. What are the strengths and weaknesses of your test?

- a. My calculation work matched the answer sheet on several key steps across the exam. In Problem 1, I reached the correct fluid displacement height of 50.67 cm . In Problem 2, my individual horizontal force component calculation of 1747.2 lbf and my center of pressure distance calculation of 0.0238 ft were correct. In Problem 3, I accurately calculated the immersion draft depth to be 1.534 m and found the true metacentric clearance gap of 0.048 m .
- b. The main strength of my test was being able to know where to look in the book. And the time I put into working through the problems. I spent a lot of time going back to the textbook and rereading concepts to make sure I found a calculation path that made logical sense to me. Because of this, I understood the underlying fluid mechanics equations needed to solve the problems.
- c. My primary weakness was poor time management, which forced me to rush at the end of the test. I skimmed the rubric too fast and completely missed key formatting requirements. Instead of taking an analytical engineering approach to the test, I treated it like a basic math problem. I focused entirely on finding the numerical answers and did not write out the required non-math sections.
- d. Doing a final review would have helped me catch that I forgot to physically write down my assumptions, procedures, sources, summaries, and material properties on the paper. Ultimately, this test showed that while I could get the numbers to match the answer sheet, I dropped significant points by failing to follow the report format. Moving forward, I need to treat the written documentation with the exact same importance as the mathematical equations.
- e. For that, I believe I got a $10/10$ for homework portion, $10/10$ for the reading portion, and $30/80$ for the problems portion. If the rubric is based on just the solving for request concepts, per email rubric, $4/4$ for problem 1. $1/7$ for problem 2. With one point for finding the magnitude and location, however, because the units were off and missing centroid depth. $5/5$ for problem 3. A final grade of 77% is my assessment.

4. Discuss the following:

- a. **What issues did you encounter in completing the test? How did you troubleshoot them?**

- b. Issues I encountered during the test were related to the specific constraints of the problem and equation selection. In Problem 2 specifically, I ran into being unsure how to balance the forces of the curved boundary because I got stuck in a unit-width strip analysis (1ft length). This resulted in spatial units coming out to produce poor results. I tried troubleshooting this by going back to review my textbook and isolating the horizontal and vertical vectors independently. The other issue was not having enough buffer time to review, so by the end, I was rushing. Because of this, I still omitted the final step of scaling the distributed load up to the absolute lumped weight (1818.695 lb) required by the system, and I left the center of pressure as an unadded offset instead of combining it with the 14 ft centroid depth. I felt unfocused and stuck trying to determine which specific equation would best apply to this problem. I tried using Chapter 7 of the textbook to work backward from the problem's geometric constraints, trying to match what best fit and would help the approach to this problem.
- c. **What steps did you take to complete the whole test? Would you change something?** Steps were straightforward when completing the test. I will say I had a bit of tunnel vision during the process. I tried to complete this in two big sessions. Now reflecting back, feeling prepared wasn't enough. I actually struggled quite a bit. I realized during the test that I need to go back and should have focused on expanding my experience with even more problems. That's how I would change my approach. I also would have liked a situation where I could give myself a final buffer, getting to walk away from my completed test and come back with fresh and ready eyes to take a final review at the entirety of the test. Alternatively, I should have taken a minute to fully understand the rubric. The rubric flew over my head, and as a result, this was my biggest downfall on this test. I should have written out my thoughts and steps rather than kept them entirely in my head. This will be a learning moment and a reflection that this class is not only to build a math skill, but also to develop myself as a future engineer practicing using analytical and justification skills.
- d. **What new concepts have you learned?** Throughout this test and going over my errors while comparing to the solutions key, I learned that hydrostatic pressures distribute over non-planar, curved containment boundaries by decomposing them into independent vertical and horizontal force components. I was also able to solidify the practical application of metacentric stability theory for floating bodies, specifically learning how to compute the waterline area moment of inertia to verify if a body's metacenter sits safely above its center of gravity.
- e. **Where you think engineers use those concepts (provide specific examples)?** I think engineers use these concepts when working with systems involving liquids and gases. For example, a mechanical engineer with a specialization in either HVAC, pumps, or turbines would see these often. To produce energy, these

systems use the help of liquids, but a core part is understanding how the fluid can help or hinder the system. It is crucial to understand fluid mechanics concepts, specifically the concepts covered in the Unit 1 exam: fluid pressure, hydrostatic force, and buoyancy. All these concepts are necessary to understand and have safe control over the mechanical forces exerted by a fluid, or to safely design a structure that can contain or operate with resting fluids so that they don't burst or collapse. Another primary example would be using buoyancy to predict or control the vertical movement of a structure, such as in boat and naval designs.

- f. **Where do you think you will be using everything you learned?** I feel like I will be able to use these concepts in my upcoming classes, such as heat transfer and fluid mechanics labs. Outside of school, I will be using them in hydraulics, since I work heavily with hydraulic systems. Though there is no designing on my part at my current work, having a better understanding of these principles can greatly benefit me here.
- g. **Do you think what you learn is important for your professional career?** The information and concepts are critical for my professional career because working as an engineer in the future will require an analytical approach, not just basic math. In the future, I would like to reference back to this documentation and continue to use the skills I have practiced here. This will help me in the future whether it is designing, signing off on a design, conducting a safety review, specifying material properties, or writing technical reports; I can use these concepts to help back up these reviews down the line. I believe the driving focus of this test was to show that not only do the concepts have to be understood, but they also have to be backed up by explaining oneself in all related details. That is what makes a reliable engineer.
- h. **How, when, where and why you might use this information or skill in the future?** Like I said earlier, if I were to pursue either HVAC, manufacturing, or power plants, I would definitely be seeing these concepts in that field. Let's dive specifically into HVAC, because realistically it is what is closest to my actual work and is one of my choices for a career path. In HVAC, fluid mechanics holds a major foundation. You are constantly trying to design the best outcome, making sure systems are cost-effective and reliable according to the project scope and customer standards. Understanding pressure drops, sizing ductwork, and selecting the correct type of piping and tubing to ensure the unit can effectively do its job are all crucial areas where these fluid mechanics' topics apply. For instance, if an engineer is designing a fan or a pump system, they would need to calculate exactly how much energy is required to move the fluid, while fully accounting for the specific fan speeds or power consumption in effect.
- i. **Have you been able to apply concepts you have learned in the course to what you do at work or in other courses?** I work in a hydraulics facility, and my

other job is to oversee building and HVAC-related maintenance. First, let's talk about hydraulics. This system was designed to simulate flight and lunar environments. Below this system are 6 hydraulic double-acting cylinders that help produce a simulation of 6 degrees of motion. Diving deeper into the mechanics, I am able to apply the concepts covered in the Unit 1 exam by understanding these hydraulics in a much deeper sense. I can now understand the amount of force and the active pressures that are seen, and I can check the PSI given the density of the fluid, the volume, etc. I am only a technician, so my lens has been following drawings and the history of the equipment to help guide me, but now I can better understand the reasons why certain components were designed the way they are. Outside this course, I have been able to apply this to a different course: Fluid Mechanics Lab. We cover these concepts through lecture, which gives us a foundational understanding. We are then able to implement these concepts in a lab format, where we can really see and understand the physics that come into play. By constantly comparing the theory to the physical data being recorded, we can see how errors manifest between the lab results versus the theoretical computation of data.

- j. **What areas did you feel you were most successful, or improved the most?** I felt most confident in my first question regarding the nature of fluids, understanding the viscosity of a fluid, and what effects can have. I felt this way because I really understood the physics behind the problem; I could physically see the outcome, and it made sense to me, so I felt like I was going in the right direction when solving it. Through that section during class, this particular concept just made the most sense to me. I've seen this concept in different forms before and felt like I already had a grasp of it. Then, when the formal theory was introduced in class, it felt easily integrated into what I had already known. On the other hand, the second question was definitely an area where I could have improved.
- k. **How do you see this course's content intersecting with your field or career?** Like I said earlier, I can definitely see the benefit of this course, or specifically these concepts, in the job that I currently work now, or in the future if I do pursue either HVAC, power plants, or manufacturing. These concepts can greatly benefit me there. Additionally, because this course's learning objectives are structured through a more analytical approach, I know it is very important to constantly be able to justify your work. Designs need to be thoroughly backed up, as that is the true core of engineering.
- l. **How much time did you spend on the test? How was the time organized? What would you do differently? Why?** I spent a total of about 16 hours working through this test. My time was organized by focusing on each problem individually and making sure each final answer made sense to me. This approach

did make it so that my final calculation numbers aligned with the solution key, so I believe I did well in that specific area. What I would do differently, as I stated in a previous answer, is give myself more time or better prepare myself. I want to allocate more time so that once I complete a test, I have a buffer where I can walk away and come back with fresh eyes. More practice beforehand would also allow me to be more confident and expose me to a wider range of problem types, which would have helped me be better prepared. During this test, I was constantly getting stuck on questions, which consumed a lot of my time just trying to figure out the best plan of action to approach the problems.