Chris Betton
MET 330 Fluid Mechanics
Spring 2021

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.

After completing the course material, up to and including Test-1, I feel that I have successfully worked toward many of the MET 330 Fluid Mechanics course learning objectives. The objectives that were reached are as follows:

1. Apply the principles of conservation of energy (Bernoulli's equation) and mass to fluid flow systems.

   The most fundamental element to fluid dynamics I learned is Bernoulli's principle and equation. I learned that Bernoulli's equation is an adaption of the concept of conservation of energy. Each term in Bernoulli's equation represents a form of molecular energy of a fluid as it passes through a pipe or system. Internal energy, potential energy, and kinetic energy are represented by pressure head, elevation head, and velocity head respectively.

2. Identify and solve for different very specific industrial problems, such as, open-channel flow, cavitation, water hammer, drag, lift, forces in pipes, and learn about different instruments to measure fluid flow quantities (such as, pressure, fluid velocity, flow velocity, etc.).

   This objective was covered by demonstrating how pressure measurement devices can be used to monitor pressure in a system. U-tube manometers were shown to be a viable means of monitoring differential pressure across a component in a system. It was also shown that the performance of a system component can be analyzed by monitoring differential pressure across that component. The mechanism of a bourdon tube pressure gage was analyzed and shown that they are capable of measuring pressure in a variety of systems. Pressure measurements were calculated using principles of differential manometers and barometers as well. Furthermore, Test 1 was an example of how the principles of fluid dynamics can be applied to solve a real-world engineering problem. The test asked that a system be designed that is capable of transferring water from an open channel reservoir to an elevated storage facility given a preselected pump and valve configuration. This test question required that real world factors be considered in designing this system. After completing this test, I feel confident that I would be able to apply my knowledge of fluid mechanics to design a system to transfer a fluid for a costumer.

3. Compute friction losses in pipes for a variety of configurations (series, parallel, network, etc.).

   I learned that pipe flow is influenced by friction losses that can be determined using Darcy's friction factor. The required data to use Darcy's formula can be found if you know the diameter and material of a pipe. It is also important to consider that pipes, fittings, valves, and elbow joints all have a resistance coefficient known as a "k-value". This value is a constant value based on material and geometry that represents how much velocity head will be lost by a fluid as it passes through a given part.

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4. Describe the nature of fluids and define different fluid properties such as viscosity and pressure.

Viscosity was shown to be a measure of a resistance of a fluid to deform under shear stress. It was established that dynamic viscosity is the resistance to flow as an external force is applied to a non-Newtonian fluid as opposed to kinematic viscosity is an inherent property of Newtonian fluids, independent of a force applied to a fluid. Newtonian fluids can be defined as a fluid that exhibit a linear viscosity in relation to temperature that is independent of the force applied to them. Viscosity is especially important in systems requiring oil lubrication as oil is identified by its viscosity and other unique characteristics for specific applications. Viscosity can also be used as a means of monitoring the efficiency of strainers. Data was analyzed that showed viscosities relationship with temperature.

Regarding the fluid property of pressure, it was established that when discussing a fluid's pressure, it is a reference to the pressure that the fluid exerts on the pipe or container it is confined in. This pressure is generated by molecular collisions of the fluid onto the walls of its container. While studying static fluids, it was also shown that pressure changes with respect to the height of the point of reference of the fluid while pressure is constant if comparing two points that are on the same horizontal plane in that fluid.

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?

The only mistake in my calculations in part a of the test was that I incorrectly assumed that the minor losses due to the piping elbows was negligible and I did not consider the minor loss due to the fitting at the piping entrance. If I were to retake the test with the knowledge I have now, I would find the k value of the elbow and use the minor loss equation, $h = kv^2/2g$ to find the loss due to the elbow and the fitting at the piping entrance. V is the average velocity of flow in the vicinity in question, and g is the gravitational constant.

In part b I made a mistake in calculating the height of the fluid in the manometer that was used to measure differential pressure across the pump discharge valve. I incorrectly assumed that the distance that the water deflected downward in the manometer was equal to the distance that the mercury rose in the manometer. These distances were different and should have been represented as two different variables. The rest of my calculation was incorrect as I carried out this error through my calculations.

In part c I used an excel spreadsheet to find half of the required power that was calculated in part a. My calculations were incorrect. My error in calculating the manometer reading gave me bad data for part c. Lastly, I ran out of time while working on this portion of the test. If I could retake the test with the knowledge I have now, I would have worked on this part of the test earlier. I was overconfident in my excel skills and did not accurately assess the time it would take to calculate the experimental data requested in part c of the test.

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3) ***What your grade should be. Base it 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 strength on this test was knowing what equations to use and when to use them. My biggest weakness was time management.

1. Purpose	10.0/10.0 out of 0.5/10.0
2. Drawings	10.0/10.0 out of 1.0/10.0
3. Sources	10.0/10.0 out of 1.0/10.0
4. Design considerations	10.0/10.0 out of 1.0/10.0
5. Data and variables	10.0/10.0 out of 0.5/10.0
6. Procedure	10.0/10.0 out of 2.0/10.0
7. Calculations	7.0/10.0 out of 2.0/10.0
8. Summary	7.0/10.0 out of 0.5/10.0
9. Materials	10.0/10.0 out of 0.5/10.0
10. Analysis	7.0/10.0 out of 1.0/10.0
TOTAL	9.1/10.0 out of 10.0/10.0

<u>PART 1)</u>

1. Select pipe diameter	7/7 out of 1/7
2. Use Bernoulli's to get ha (ref & points in pict.)	7/7 out of 1/7
3. Pipe energy losses	7/7 out of 1/7
4. Minor losses	4/7 out of 2/7
5. Pump power with efficiency	7/7 out of 1/7
6. Correct results	6/7 out of 1/7

PART 2)

1. Use geometrical relation	4/6 out of 2/6
2. Use gamma*h procedure	5/6 out of 1/6
3. Proper manipulation of eqs and solve for "h"	4/6 out of 2/6
4. Correct results?	2/6 out of 1/6

<u>PART 3)</u>

1. Use spreadsheet from previous parts to get pump power (P) for diff Q. Did losses change with Q?	5/5 out of 1/5
2. Plot pump power (P) vs Q	2/5 out of 1/5
3. Read Q for pump power equal to ½P in part 1	3/5 out of 1/5
4. What is the new manometer reading?	0/5 out of 1/5
5. Correct results?	0/5 out of 1/5

<u>FINAL GRADE:</u>
10.0 + (80/3)*(7/7 + 6/6 + 5/5) = 90 (if everything is correct)

9.1 + (80/3)*(.857 +.639+.4) = 59.7

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4) Discuss the following:

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

While taking this test my biggest issue was time management. I spent two days working on this test as opposed to using the full week we were given to meet the deadline. To make up for time lost I did not complete part c of the test. This was not the right thing to do. With the knowledge I have now, I can see that this type of assignment requires more time to complete than what I allotted.

b. What steps did you take to complete the whole test? Would you change something?

To complete this test, I worked sequentially through the parts as they were presented. I think this was a good approach for this type of assignment. I did not run into any issues with this approach.

c. What new concepts have you learned?

This test taught me how to use Darcy's equation in an excel spreadsheet. I also learned that every component must be considered when finding major and minor losses in a system.

d. Where you think engineers use those concepts (provide specific examples)?

I believe design engineers must consider major and minor losses when establishing conditions for a system. I also think that major and minor losses are considered when observing the efficiency of a system.

e. Where do you think you will be using everything you learned?

The concepts covered on this test can be applied to many things I will face in life. I can use the fluid dynamic concepts covered in this course in designing irrigation systems at home as well as any other renovations at home that may require plumbing. I will also encounter engineering problems of this nature in my professional career.

f. Do you think what you learn is important for your professional career?

My dream job is to design nuclear powered systems for space exploration. I will undoubtably have to consider system losses as well as many other fluid dynamic concepts to design effective systems.

g. How, when, where and why you might use this information or skill in the future?

In any job as a mechanical engineer, I will encounter problems related to fluid mechanics. Even in structural design, fluid dynamics play a role in ventilation design. Fluid mechanics plays a role in aviation as well since aircraft are designed based on fundamentals of Bernoulli's equation. No matter what career path I choose, fluids are all around and play a key role in engineer's day to day responsibilities.

h. Have you been able to apply concepts you have learned in the course to what you do at work or in other courses?

I have seen concepts in this course covered in MET335W Fluid Mechanics laboratory. Voscosity, pressure gage calibration and buoyancy have been discussed in that class. I have not seen any related material in other classes.

i. What areas did you feel you were most successful, or improved the most?

I feel that I was most successful in manipulating Bernoulli's equation to fit the necessary elements of a problem that was presented. For example, in open channels, the pressure variable can be negated due to the internal energy of the fluid being released to atmosphere.

j. How do you see this course's content intersecting with your field or career?

In my career, I will have to consider fundamentals of fluid mechanics when designing systems. I will also use data related to fluid characteristics to analyze performance of systems.

k. How much time did you spend on the test? How was the time organized? What would you do differently? Why?

As previously stated, time management was my biggest setback on this test. In the future, I will draw system diagrams as soon as the test material is provided. This way I will have an idea of what components are in the system and how they are integrated with the overall system. As I read the test questions, I will be able to visualize the problems being asked as I read the questions. I believe this will allow me to have a better understanding of how to approach a problem more quickly. While taking test 1, I had to reference the drawing while reading the questions. This took a lot of time. I will also have a list of known variables and applicable equations handy before taking another test. I needed to look at the Fluid Mechanics textbook often, to figure out what equation to use for finding parts of Darcy's friction factor.