Fluid mechanics has been a whirlwind of a learning experience. In the beginning I was not sure how well I would do considering it was known to be a very challenging course. However, in the end I was able to learn a lot and be very successful in the course.

We started with the nature of fluids. We learned things like the equations for density, specific weight, and specific gravity, as well as touching on the topic of compressibility and surface tension. Following the nature of fluids, we started on topics about viscosity and pressure. We were introduced to dynamic and kinematic viscosity, newtons resistance law, Newtonian fluids, $\Delta p=\gamma h$ (which was an equation vital to the remainder of the course), and utube manometers. After pressure, we moved into one of the most important, if not the most important topic, Bernoulli's Equation. $\frac{V_2^2}{2g}+\frac{P_2}{\gamma}+z_2=\frac{V_1^2}{2g}+\frac{P_1}{\gamma}+z_1$ Energy conservation was also taken into consideration $Q_{in}=Q_{out}$ or $\upsilon_{in}A_{in}=\upsilon_{out}A_{out}$. I learned Bernoulli's equation the best by doing examples. Each problem that required this equation was different, depending on what was being asked. You could be asked for a height, velocity, or pressure.

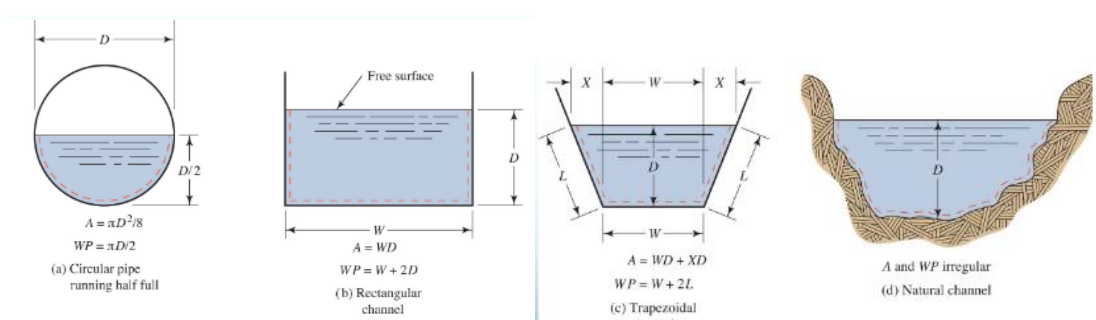
Friction losses also proved to be a valuable topic to be aware of. It began with learning the difference between laminar and turbulent flow. Understanding the difference required an understanding of Reynold's number. Laminar flow has a Re of below 2100 and turbulent flow Re is above 4000. Roughness in conjunction with friction factor and Reynolds number are used to interpret the Moody chart for energy losses. We were introduced to the energy loss equations and taught how to incorporate them into excel, the equations are as follows:

LAMINAR: $f=64/N_R$

TURBULENT: $f=\frac{0.25}{\left[\log\left(\frac{1}{3.7\,(D/\varepsilon)}+\frac{5.74}{N_R^{0.9}}\right)\right]^2}$

For minor losses such as fittings, we used the equation for hL: $h_L=K(v^2/2g)$. K values are determined depending on the type of fitting that is being used. For example a gate valve is K=8fT, for a square-edged inlet K=0.5, a standard 90° elbow K=30fT, and a flow through run tee is K=20fT.

Upon completion of losses, we studied topics in open channel flow, static and in motion fluid forces, buoyancy and stability, drag and lift, flow measurements, and water hammer and cavitation. Open channels can be trapezoidal, rectangular, circular, or natural.



When calculating open channels, you need to have the hydraulic radius, Reynolds number for open channels, Froude number, hydraulic depth, and manning's equation.

$$V = \frac{1.0}{n} S^{1/2} R^{2/3} \qquad Q = \frac{1.0}{n} A S^{1/2} R^{2/3} \qquad R = \frac{A}{WP} = \frac{\text{Area}}{\text{Wetted perimeter}} \qquad N_R = \frac{vR}{\nu}$$

Manning's Equation *Channel Flow Equation* *Hydraulic Radius* *Re for open channels*

$$y_h = A/T \qquad N_F = \frac{v}{\sqrt{g y_h}}$$

Hydraulic depth *Froude Number*

The n values for the equations are usually found on a table and organized by the material the channel is made of.

Forces of a static fluid were just as it sounds, learning the forces a fluid has on its container. If the surface was horizontal or a vertical wall it was simpler versus when it was an angled surface.

$$p_{\text{avg}} = \gamma(h/2) \qquad F_R = p_{\text{avg}} \times A \qquad F_R = \gamma h_c A$$

Pressure average *Resultant force (vertical walls)* *Resultant force (incline)*

Buoyancy involved looking at anything that floats or is partially submerged. We studied how to find the metacenter, centroid, and the stability of said floating object.

$$F_b = \gamma_f V_d \qquad MB = I/V_d$$

Buoyant Force *Metacenter*

Drag and lift was a topic that I thought was very interesting, but I struggled a little with fully understanding it. Since it was a topic that I was not 100% in understanding, I am just going to include examples in a separate document so it can be seen what kind of problems we were asked to understand.

Forces of fluids in motion was used for jets, turbines, pipes, etc. The equations for fluids in motion are as follows:

$$\vec{F} = \rho Q \,\Delta \vec{v}$$

$$F_x = \rho Q \,\Delta v_x = \rho Q(v_{2_x} - v_{1_x})$$
$$F_y = \rho Q \,\Delta v_y = \rho Q(v_{2_y} - v_{1_y})$$
$$F_z = \rho Q \,\Delta v_z = \rho Q(v_{2_z} - v_{1_z})$$

$$R_x = \rho Q v_1 + p_1 A_1$$
$$R_y = \rho Q v_2 + p_2 A_2$$

Force Equation *Force equations; x, y, z directions* *Forces in an Elbow*

Flow measurement in my opinion was more of the more complex chapters. It exposed us to a lot of different equations and charts, all of which had to be used to get to the desired solution. We studied venturi meters, flow nozzle, orifice plates, pitot tubes, and used manometry.

$$v_1 = C\sqrt{\frac{2g(p_1 - p_2)/\gamma}{(A_1/A_2)^2 - 1}} \quad v_1 = C\sqrt{\frac{2gh[(\gamma_m/\gamma_f) - 1]}{(A_1/A_2)^2 - 1}}$$

Variation of Bernoulli's *Bernoulli's using manometry*

Series pipeline systems started us into the second half of the semester. In a series pipeline system, the fluid flows through a single continuous path. The problems for series pipelines are classified into 5 categories, class 1, class 2, class 3, class 4, class 5. Class 1 determines energy losses, class 2 determines flow rate, class 3 determines pipe diameter, class 4 determines the K value of a valve, and class 5 determines pipe length. It is also important to note that we used a critical velocity of 3m/s. Another thing to note is that pipe diameter is typically decided by critical velocity and critical pressure drop gradient.

$$Q_1 = Q_2 = ... = Q_n = Q_{total} \quad h_{L_{total}} = \sum_n h_{L_n}$$

Important things to note when computing series systems:

In parallel and network pipeline systems, the fluid could flow through different paths or branches. The classes are the same as were used in series systems.

$$Q_{total} = \sum_n Q_i \quad h_{L_1} = h_{L_2} = ... = h_{L_n} = h_{L_{total}}$$

Important things to note in a parallel pipe system:

The final topic we discussed were pumps. We focused on positive displacement and kinetic pumps. We were introduced to the Sulzer catalog and taught how to read the performance data and manufacturers data for different pumps.

$$N_S = \frac{N\sqrt{Q}}{H^{3/4}} \quad P = \frac{\gamma Q h_A}{\eta}$$

Specific speed *Pump Power*

I have created another document with examples for each of the topics discussed. The examples were all organized according to a rubric that I will attach with the examples.