MAE 308, Fluid Mechanics
Fall 2018
Practice Exam

Materials covered in the finals:
1. Hydrostatics
2. Integral Relations for Continuity and Momentum
3. Different Analysis for fluid flow
4. Dimensional analysis
5. Internal flows
6. External flows

Format of the test problems:
1. Multiple choice
2. Calculation

Some sample calculation problems:

Problem 1
Gate B is 30 cm high and 60 cm wide into the paper and hinged at the top. What is the water depth $h$ which will first cause the gate to open?

Problem 2
Consider an incompressible, steady, two dimensional flow past a circular cylinder as sketched below. The velocity at the upstream end (surface 1) is measured by $V_1 = U_\infty i + 0j$. The velocity profile at the downstream end (surface 2) is given by

$$V_2 = \begin{cases} 
U_x i + 0j & \text{if } h < y \\
U_\infty \sin\left(\frac{\pi y}{2h}\right) & \text{if } -h \leq y \leq h \\
U_x i + 0j & \text{if } y \leq -h 
\end{cases}$$

where $U_\infty$ is the x-velocity (constant) at the upstream, and d is the diameter of the cylinder. Both $U_\infty$ and d are known.
(1) What is the height $h$?
(2) What is the drag coefficient $C_d$ for the cylinder?
Problem 3
A jet of alcohol strikes the vertical plate in the figure. A force $F \approx 425$ N is required to hold the plate stationary. Assuming there are no losses in the nozzle, estimate (a) the mass flow rate of alcohol and (b) the absolute pressure at section 1.

Problem 4
Consider the combined gravity-Couette driven flow between two parallel plates as depicted below. The lower plate is stationary, while the upper plate moves at constant upward velocity $V_{\text{TOP}}$. The plates are very long and wide and are separated by a small gap (distance = $h$). The fluid has viscosity $\mu$ and density $\rho$. 
a) Label this figure with the appropriate coordinate system and directions.
b) What assumptions can be made about this flow scenario?
c) What are the two Boundary Conditions for which information is KNOWN?
d) Write out the correct, full N.S. equation governing this flow.
e) Using the assumptions reduce this equation to a second order ordinary differential equation (ode).
f) Find the solution to this ode using appropriate Boundary Conditions.

**Problem 5**
The lift force $F$ on a missile is a function of its length $L$, velocity $V$, diameter $D$, angle of attack $\alpha$, density $\rho$, viscosity $\mu$, and speed of sound $a$ of the air. Find the dimensionless pi groups and rewrite the function in terms of pi groups.

**Problem 6**
An oil (SG = 0.9) issues from the pipe in the figure at $Q = 35$ ft$^3$/h. What is the kinematic viscosity of the oil in ft$^3$/s? Is the flow laminar?