NAME_____

HOUR_____

MECH-322 FINAL EXAM

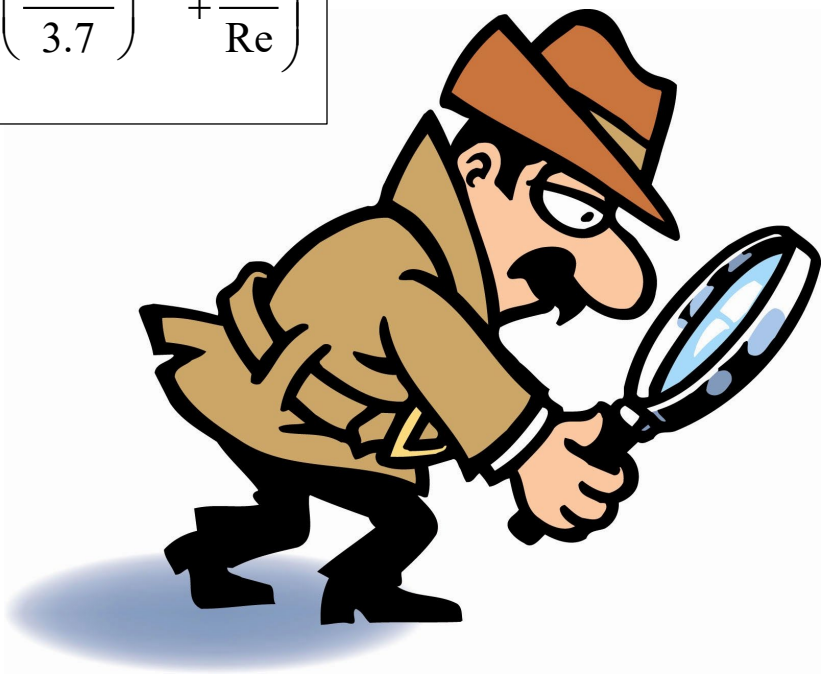
1	/10
2	/20
3	/20
4	/20
5	/20
6	/20

EXTRA CREDIT:

BE METICULOUS!!!!!

HALLAND EQUATION

$$\frac{1}{\sqrt{f}} = -1.8 \log_{10}\left(\left(\frac{\varepsilon / D}{3.7}\right)^{1.11} + \frac{6.9}{\mathrm{Re}}\right)$$



1. DEFINITIONS (10 Points)

What is the definition of Fluid Mechanics?

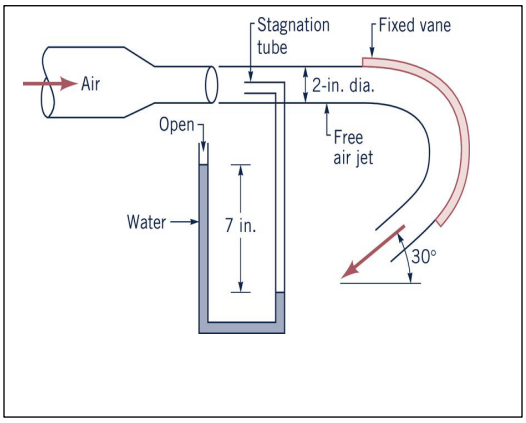
What is the difference between Compressible and Incompressible fluids?

When is it necessary to apply time varying mass continuity?

What is the basic definition of a shock wave?

What is basic difference between sub-sonic and super sonic flow in a “diverging” rocket nozzle?

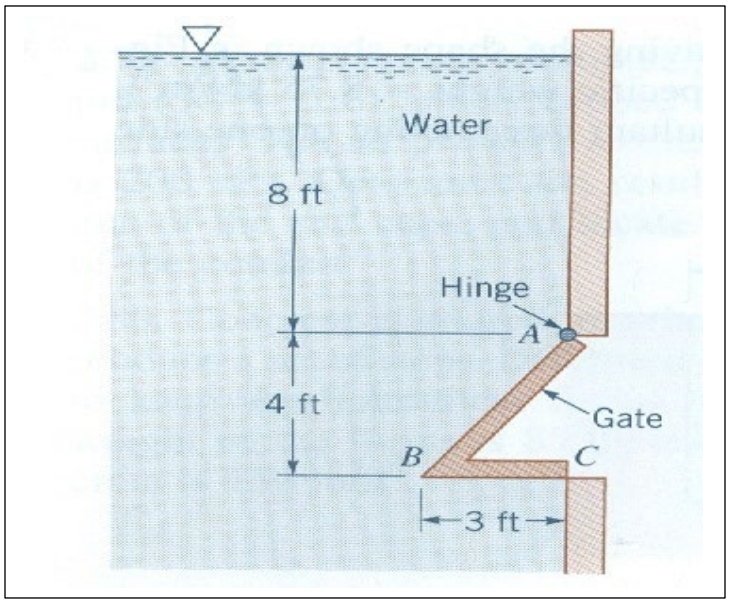
2. Air discharges steadily from a 2”-dia nozzle as a free jet and strikes a fixed vane as shown. Neglect weight of air and elevation. For conditions as shown, compute:
    a. Stagnation Pressure (PSF).
    b. Vane inlet velocity and volume flow rate,
    c. If the vane friction energy head loss is 3 ft, determine the vane exit velocity.



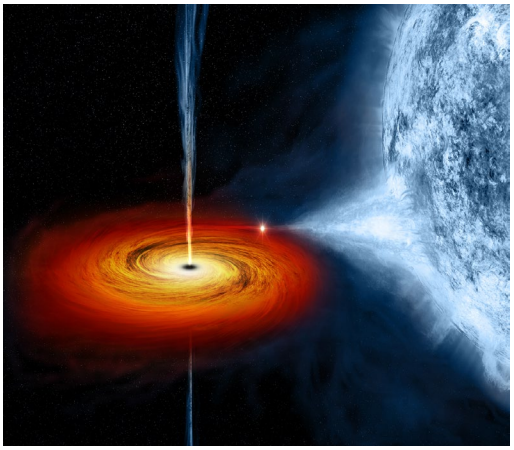
3. A gate as shown is 5 ft wide and is hinged at A with a weight of 1000 lbs. It's "CENTER of GRAVITY" is 1 ft to the left of AC and 2 ft above BC.

a. Provide a complete Free Body Diagram showing ALL forces.
b. Determine the magnitude of the pressure force on water surfaces AB and BC (lbf).
c. Determine the magnitude of the <u>HORIZONTAL</u> reaction force shown on the gate at C.
d. Determine the reaction forces at HINGE A.

$$(I_{xc} = \frac{1}{12}bh^3; \gamma = 62.4 lb_f / ft^3)$$



4. The comet Centaur is headed straight for a BLACK HOLE emitting thermal radiation causing the temperature of comet to be measured as:



$$T(x,y,z,t) = (2xt + 12y^2x^2z - 34y^3xz)\ ^0K$$

And velocity vector is mapped by the US Mars Space Station Galaxy One as:

$$V(x,y,z) = \left(12xyz^4\right)\hat{i} - \left(34xy^2\right)\hat{j} + \left(345x^3y^3z\right)\hat{k} \quad m/s$$

Determine:

a. Correct Units on constants within the T and V relationships.

b. The expression/relationship for the *Time Rate of Change of Temperature* $\frac{DT}{Dt}(^0K/s)$ for the doomed comet Centaur AND VERIFY UNITS.

5. Assume frictionless 1D flow of water through the horizontal tee connection as shown. Let $\rho_{H20} = 1000 \frac{kg}{m^3}$. Ignore the weight of the tee and let AREA 1 and 2 = 1.5 m^2, and AREA 2 = 0.10 m^2, the fluid volume is 0.20m3 and the gravitational vector is: $\vec{g}(x,y)[m/s^2] = \{10[]\hat{i} - 7.23[]\hat{j}\}[m/s^2]$.

Determine the:

a. Pressure forces and velocity on each inlet/exit.
b. External reaction forces to hold the tee in-place.

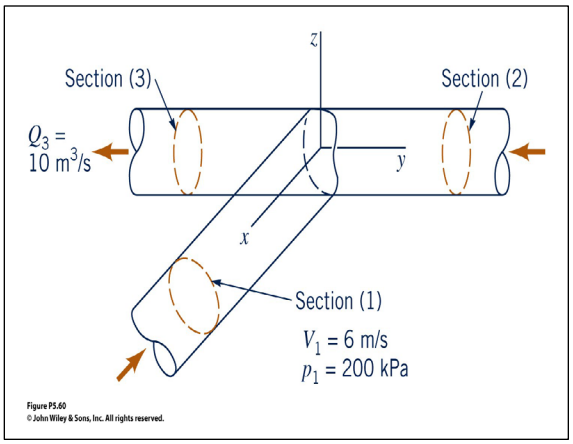


Figure P5.60

6. A water flow rate of is to be maintained in a horizontal copper drawn tubing heat exchanger bend as shown. The fluid is **Benzene** with properties of:

$$\rho = 1.70 \frac{slugs}{ft^3}, \mu = 1.26x10^{-5} \frac{lbf - s}{ft^2} .$$

The available liquid pump can supply this flow rate only if the pressure drop head is less than 45 ft.

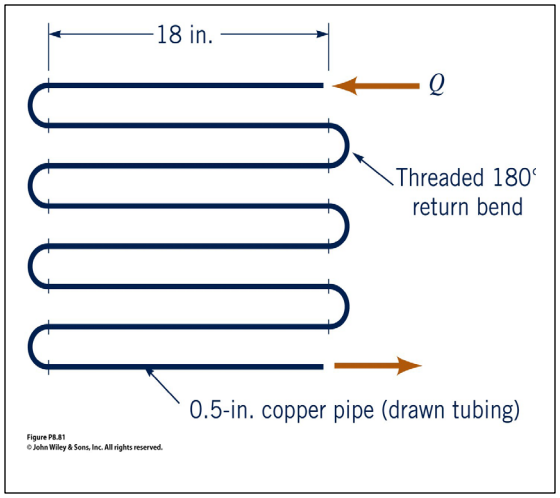


Figure P8.81

Determine:

a) Friction Characteristic Equation (10 Points),
b) Pipe Flow Rate, Q.
c) Pump power input (hp) if efficiency is 89%,
d) Total Power (W) loss due to major and minor friction losses in hp.

EXTRA CREDIT

5 POINTS EACH

The static pressure to stagnation pressure ratio at a point in a compressible gas flow field is 0.6. The stagnation temperature of the gas is 20C. Determine the flow speed in m/s and the Mach number if the gas is air (k = 1.4). If the gas flows around a 0.5 m diameter sphere with a drag coefficient Cd of 0.23, what is the power (W) necessary to balance drag.

A 25-mm diameter shaft is pulled through a cylindrical bearing as shown. The lubricant that fills the 0.3-mm gap between the shaft and bearing is an oil having a **kinematic** viscosity $\nu = 8.0x10^{-4}\frac{m^2}{s}$ and specific gravity of 0.91.

c. Determine the force P (N) required to pull the shaft at a velocity of 3 m/s. Assume the velocity in the gap is linear.
d. Determine the power required.