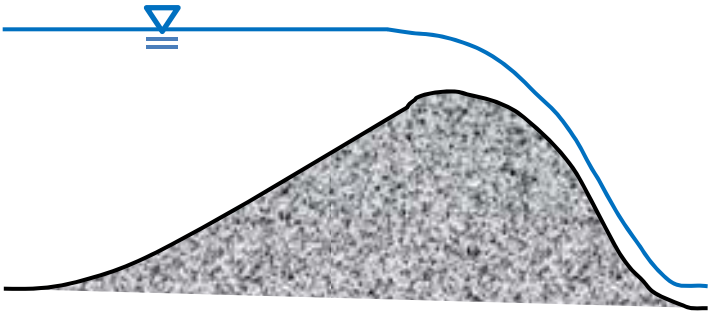
CE 251, Fluid Mechanics, Exam 3, Fall 2016 **Name: _____**

If you would like to receive partial credit, show all your work and state assumptions.
If you believe you are missing something, or you need clarification on a problem, *please ask!*
If you cannot finish in the allotted time, write down how you would complete the problem(s).

1. 100 cfs of water (50˚F) flows over the 70-ft wide 3rd Street dam on Bushkill Creek behind the Spot (see pic and schematic X-section below).



(a) To reproduce the field conditions using a 3-ft wide scaled model of the dam in our hydraulics laboratory, what flow rate of water (70˚F) should we use? Give answer in cfs

Ans = 0.038 cfs

(b) If we wanted specifically to study the shear forces mobilizing sediment along the submerged upstream face of the dam, what flow rate should be used in the model? Can both (a) and (b) be done at the same time?

Ans = 3.22 cfs

Ans = No

3. A do-it-yourself homeowner is carrying a 4 ft x 8 ft sheet of plywood across the parking lot at Home Depot on a December day like today. The wind speed is 10 mph and the air temperature is 35° F. How much easier will it be for him/her to hold the plywood parallel to the wind than perpendicular to the wind? Give your answer in lbs.

Ans = 23 lbs

4. The Hydraulic Retention Time (HRT) for the 3.75-m deep settling tanks at the Easton Water Treatment plant is about 6 hours. For dirt particles to be removed, they must settle to the bottom in less than 6 hrs. Most of the sediment in the raw water from the Delaware River is silt. Will 0.01-mm diameter silt particles (SG = 2.65) settle out in the tank (assume they are spherical and the water temp is 15°C)?

Ans = No ($V_s = 7.88 \times 10^{-5}$ m/s so won't hit bottom in 6 hrs)

5. Water (10°C) flows in a 10-cm ID steel pipe at 10 Liters/sec. Determine:

(a) The friction factor **Ans = 0.0203**

(b) The head loss per unit length of pipe **Ans = 0.0167**

(c) The pressure difference between two locations along the pipe a distance of 200 m apart, where the downstream location is 6 m higher than the upstream location. Give your answer in kPa

Ans = 92 kPa

6. A rural third-world community is developing a water supply system with a reservoir located in the hills above the town, and a pipeline that connects the reservoir to a storage tank located within the town. The reservoir surface elevation is 950 ft and the tank surface elevation is 425 ft. The pipeline is 2 miles long, with the upper half being 3-inch ID PVC pipe and the lower half being 2-inch ID PVC pipe. Assuming that local head losses (expansion, entrance, valves etc) are insignificant relative to frictional losses, what is the steady flow rate of water (60°F) from the reservoir to the tank?

[Case 2 problem – iterative, and challenging because two different Velocities]

Ans = 0.16 cfs

Conversion Factors etc.

g = acceleration of gravity = 9.81 m/s^2 = 32.2 ft/s^2
p_{atm} (standard conditions) = 14.7 psi = 101.3 kPa
air-water surface tension (σ) at 20°C = 0.0728 N/m
temperature lapse rate in the troposphere (α) = 0.00587 K/m

Lbf = slug-ft/sec^2 1 hp = 550 ft-lbs/sec
N = kg-m/sec^2 Pa = N/m^2 Joule = N-m Watt = Joule/sec

1 mile = 5280 ft 1 km = 1000 m
1 ft = 12 inches 1 m = 100 cm = 1000 mm
1 ft^3 = 7.48 gal 1 gal = 3.785 L 1 m^3 = 1000 L = 10^6 mL
1 in = 2.54 cm 1 m = 3.28 ft

1 psi ≈ 2.3 ft of water
cfs = cubic feet per second gpm = gallons per minute MGD = million gallons per day

K = °C + 273 R = °F + 460

NOTE: you will be given charts and tables with C_f C_D data and the Moody diagram