57:020 TEST # 3 Fall 2006

1. Given $u = 10y^{1/6}$, where u is the velocity of water in meters per second and y is the distance from the boundary in mm, determine the shear stress in the water at $y = 2mm$. The viscosity of water is $\mu = 10^{-3}\ N \cdot s/m^2$.

2. A water turbine is connected to a reservoir as shown. The flow rate is 5cfs. What power can be delivered by the turbine if its efficiency is 80%? The pipe material is commercial steel and the loss coefficient for the pipe entrance is 0.5.

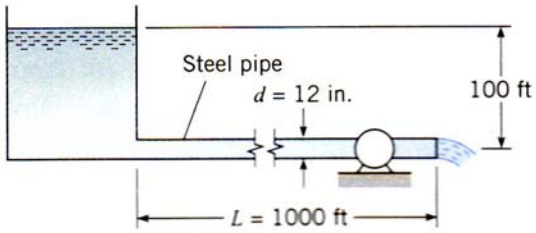

Figure 2 (for Problem 2)

3. The wave resistance of a model of a ship at 1/16 length scale ratio is 12N at a speed of 3 m/s. What are the corresponding velocity and wave resistance of the prototype? Assume both the model and the prototype are to operate in fresh water. The ship model tests are made according to Froude-number criterion and wave resistance scales to the third power of the length scale.

4. Light oil flows over a 15-ft-long flat plate with a free stream velocity of 6ft/s. Determine the total drag force per unit width of the plate. The density and kinematic viscosity of light oil are $\rho = 55.3 lbm/ft$ and $\nu = 7.751 \times 10^{-3}\ ft^2/s$.

5. Air flows parallel to a smooth, thin, flat plate at 15.5ft/s. The plate is 10.6ft long. Determine whether the boundary layer on the plate is most likely laminar, turbulent, or somewhere in between (transitional). The critical Reynolds number is 5×10^5. Compute the boundary layer thickness at the end of the plate for two cases: (a) the boundary layer is laminar everywhere, and (b) the boundary layer is turbulent everywhere.

Figure 6 (for Problem 6)

6. The aerodynamic drag on a truck can be reduced by the use of appropriate air deflectors. A reduction in drag coefficient from C_D=0.96 to C_D=0.70 corresponds to a reduction of how many horsepower needed at a highway speed of 65 mph?