ME 322 Worksheet Winter 2007

Friction Factor Calculation

1. Use the Moody chart to find the friction factor for these conditions
   a. $\mathrm{Re} = 5.5 \times 10^6$, $\varepsilon/D = 0.003$
   b. $\mathrm{Re} = 40,000$, $\varepsilon/D = 0.006$

2. For a particular pipe flow problem, $f = 0.04$ and $\varepsilon/D = 0.001$. What is Re?

3. You are checking pipe flow analysis performed by another engineer. For a particular pipe flow problem the engineer's calculations have $\mathrm{Re} = 100,000$, $f = 0.02$ and $\varepsilon/D = 0.0001$. Do you agree with this result? Explain your answer

4. The friction factor cannot be computed explicitly from Colebrook equation. An iterative or root-finding procedure is required. A simple form of root-finding is called fixed point iteration. Given the Colebrook equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}\sqrt{f}}\right) \qquad (\star)$$

   we can developed a fixed point iteration formula by assuming the f on the right hand side is a known or guessed value, and then solving for the f on the left hand side.

   Designate the f on the right hand side of Equation $(\star)$ as f_{old}, designate the f on the left hand side as f_{new}

$$\frac{1}{\sqrt{f_{\mathrm{new}}}} = -2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}_D\sqrt{f_{\mathrm{old}}}}\right)$$

   Solve for f_{new} to get

$$f_{\mathrm{new}} = \left[2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}_D\sqrt{f_{\mathrm{old}}}}\right)\right]^{-2} \qquad (\star\star)$$

   Equation $(\star\star)$ is now in the form of a fixed point iteration.

   Use the fixed point iteration to find f for $\mathrm{Re} = 5.5 \times 10^6$ $\varepsilon/D = 0.003$. Perform three iterations (i.e. apply Equation $(\star\star)$ three times) with a starting guess of $f = 0.02$.