2.016 Hydrodynamics
Fall 2005
Prof. A. Techet

Out: November 8, 2005
Due: November 15, 2005

---

1. Consider a flexibly-mounted circular cylinder in a steady flow of water (see Figure 1), where the mass per unit depth of the cylinder is M and its diameter is d:

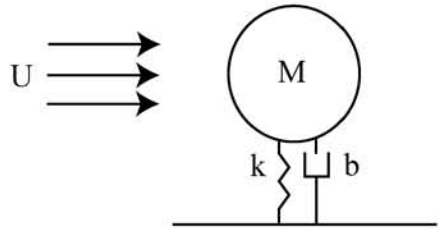

Figure 1 – Flexibly -mounted cylinder in a steady flow

   a. Write down an expression for the natural frequency of the system in terms of the given parameters.

   b. Given that U = 10 m/s and d = 0.1 m, find the frequency of vortex shedding. (Assume that the cylinder has a smooth surface and that the distance between the cylinder and the wall is >>d .)

   c. Given that the system is in lock-in, what is the frequency of vortex shedding, of the cylinder response, and of the unsteady drag force (in terms of the expression derived in part a.)? What is the speed of the flow at Lock in?

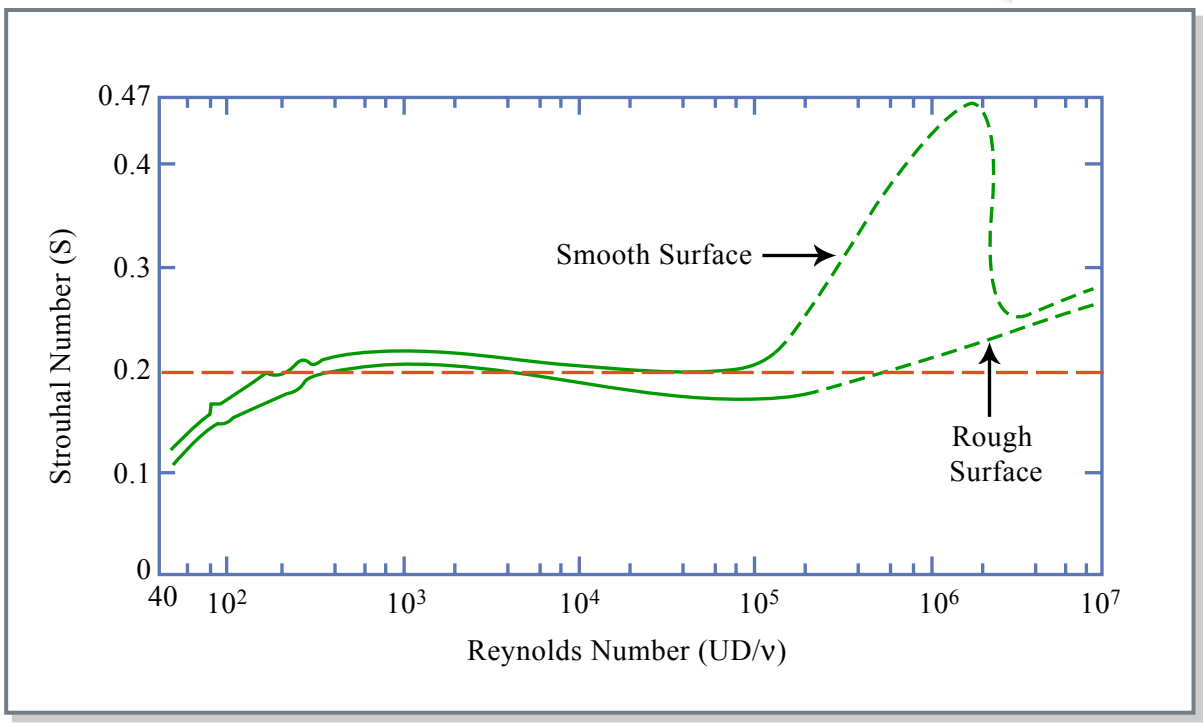

Figure by MIT OCW.

2) A fishnet is made of 1mm-diameter strings knotted together into 2cm x 2cm squares. Estimate the horsepower required to tow a 300 ft^2 of this netting at 3 knots in seawater. Assume that the net plane is normal to the direction of towing (flow). Assume the string can be modeled as a cylinder with drag coefficient 1.2, consider only viscous drag force.

3) A spar buoy is essentially a cylinder floating vertically in the water. The buoy is free to heave in the z-direction and has a heave period, T, which depends on the waterline cross-sectional area *A,* buoy mass m, and fluid density r.

   How does the period change if we double the mass? Double the water plane area?

   Oceanographic instrument buoys should have long heave periods to avoid wave resonance. Sketch a possible long period heave buoy design.

4) An offshore riser can be modeled as a long rigid cylinder with diameter 0.25 meters. Determine the vortex shedding frequency for a current of 1.0 m/s. What is the frequency of the unsteady component of the lift force? The unsteady drag force?

5) An overhead power line is "humming" on a windy day. You are with a friend who has a very good ear and determines that the power line is vibrating at a frequency of 100 Hz. The wind is quite strong and is blowing at 8 m/s. Determine the diameter of the power line.