

## Exercises – Serie 8 – Vortex shedding

### Exercise 1 - Vortex Induced Vibrations

Consider a cylinder of diameter  $D = 6\text{cm}$  with a smooth surface. The cylinder is placed in a wind tunnel (in air) and is subjected to a uniform flow  $U = 5.2\text{ m/s}$  at a temperature of  $T = 20^\circ\text{C}$ .

- Determine whether or not vortices are periodically shed from the cylinder.
- What might occur if the cylinder was placed in water at the same velocity?
- How would the surface roughness influence the vortex shedding frequency. Alternatively, if the same cylinder is placed in a water tunnel at a speed of  $U = 20\text{ m/s}$ , what would be the effect of the surface roughness on the shedding frequency.
- The video and the file given with the exercise are the results of a numerical simulation with the flow parameters of question a). From these results, extract the Lift and Drag coefficients as a function of time.
- The cylinder is now mounted on a set of springs and dampers allowing it to move in both the  $x$  and  $y$  direction. Considering the Lift and a Drag force found above, write the equation of motion of the system. (Note that, for simplicity, we neglect any  $y$ -component of the velocity in  $U_{rel}$ , and we assume that the cylinder movement has no influence on vortex shedding i.e.,  $C_L(t), C_D(t)$  are the same than ones found in the static numerical simulation).

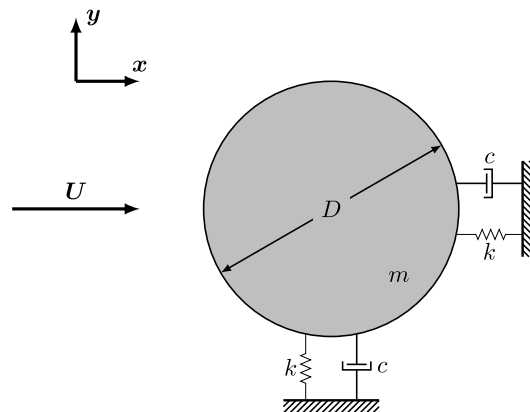


Figure 1: Spring-mass-damper Cylinder

- Numerically compute the  $x - y$  motion of the cylinder. The stiffness is equal to  $k = 10^4\text{ N/m}$  and consider the following dampings:  $c = [10, 75, 180, 500]\text{ Ns/m}$ .