PROBLEM 1—AEOLIAN TONE GENERATION FROM TWO CYLINDERS

Aeolian tones, sound generation by flow over cylinders, are relevant to airframe and power plant noise (heat exchanger, power transmission lines and chimneys). The purpose of this problem is to test the ability of a CFD/CAA code to accurately predict sound generation by viscous flows and sound propagation through interactions between acoustic wave & solid wall and between acoustic waves & shear layers.

Consider the cylinder configuration shown in Figure 1. The Reynolds number $Re_\infty = 1.58 \times 10^4$ based on inflow velocity $U_\infty = 24.5$ m/s and cylinder diameter D = 0.955 cm are imposed on the computation. It is known that the streets of regularly spaced vortices exist with laminar cores over the range of Reynolds numbers from 65 to approximately 400. The range of Reynolds numbers above which vortices with turbulent cores are shed periodically extends to approximately 2×10^5. The governing equations are the 2-D Navier-Stokes Equations. We are interested in the acoustic waves emitted from unit span.

1) Calculate the Strouhal No. of vortex shedding from two cylinders.
2) In the far field, calculate the intensity $\overline{(p')^2}$ on the circle $x^2+y^2= (100D)^2$ at $\Delta\theta = 3^\circ$, θ measured from the x-axis.
3) In the near field, compute the intensity $\overline{(p')^2}$ on the circle $x^2+y^2= (10D)^2$ at $\Delta\theta = 1^\circ$, θ measured from the x-axis.

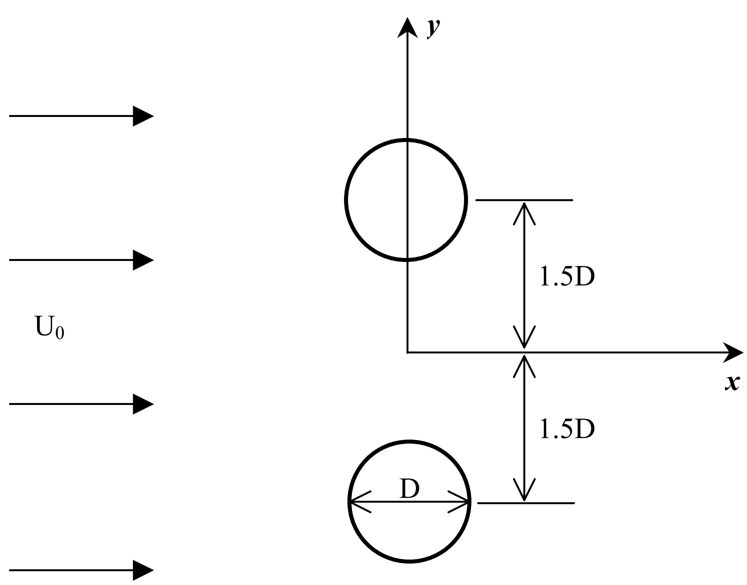

Figure 1

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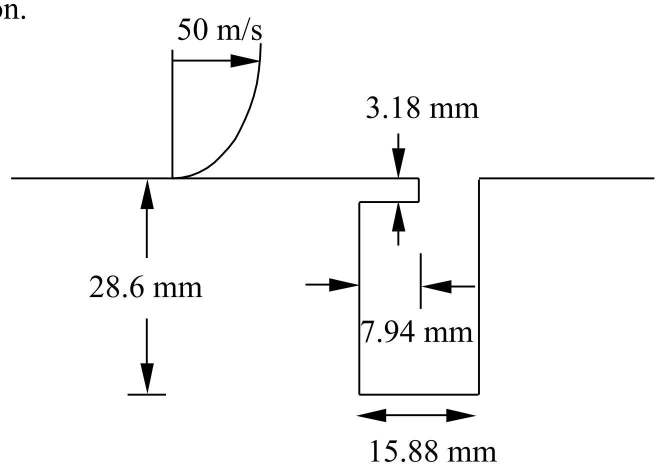
PROBLEM 2—SOUND GENERATION BY FLOW OVER A CAVITY

Air flows over the cavity shown below with a mean approach flow velocity of 50 m/s. The boundary layer that develops over the flat plate is turbulent with a thickness of 14 mm at the entrance to the cavity. Calculate the power spectra at the center of each cavity wall and the center of the cavity floor. Experimental data will be available for comparison.



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