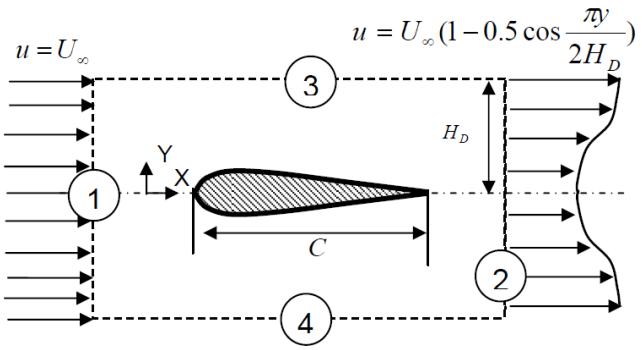
ME 572 Aerodynamic Design
HW #2 (Due at 11:59 pm on Friday, Feb 16)

Problem 1 [20 pt]
The shock waves on a vehicle in supersonic flight cause a component of drag called supersonic wave drag D_w. Define the wave-drag coefficient as $C_{D,w} = D_w/q_\infty S$, where S is a suitable reference area for the body. In supersonic flight, the flow is governed in part by its thermodynamic properties, given by the specific heats at constant pressure c_p and at constant volume c_v. Define the ratio $c_p/c_v \equiv \gamma$. Using Buckingham's pi theorem, show that $C_{D,w} = f(M_\infty, \gamma)$. Neglect the influence of friction.

Problem 2 [10 pt]
Consider a body of arbitrary shape. If the pressure distribution over the surface of the body is constant, prove that the resultant pressure force on the body is zero.

Problem 3 [30 pt]
Velocity profiles are measured at the upstream end (surface 1) and at the downstream end (surface 2) of the control volume shown in the figure. The flow is incompressible, two dimensional, and steady. The gage pressure on the surfaces along the dashed line is equal to zero.



(a). What is the total volume flow rate crossing the horizontal surfaces (surface 3 and 4)
(b). If $H_D = 0.025\,c$, where c is the chord length of the airfoil, what is the drag coefficient C_D of the airfoil?