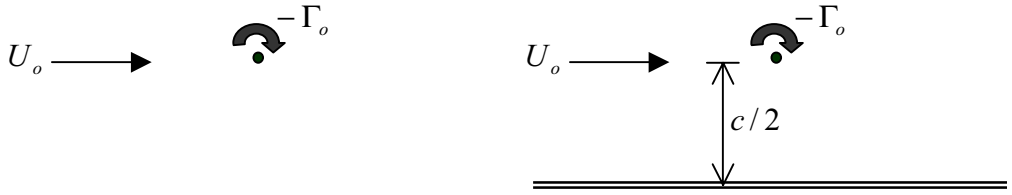
2.20 Problem Set 8A **Name: _____**

1. Supplementary Problem P9

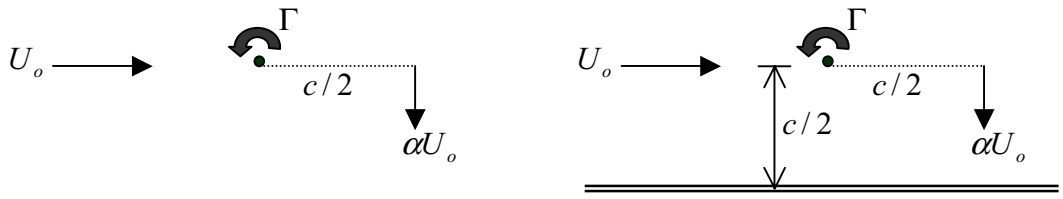
2. A two-dimensional hydrofoil is placed in a uniform stream of horizontal velocity U_0 and density ρ. For this problem, assume steady potential flow.



(a) If the hydrofoil is designed to generate a constant circulation $\Gamma = -\Gamma_o$, calculate the lift on the wing (per unit span) $L = L_{ow}$ in open water.

(b) If the hydrofoil now operates at a distance $c/2$ above a horizontal bottom, calculate $L = L_b$ for this near-bottom operation.

(c) For fixed hydrofoil geometry and orientation, the circulation generated is actually not fixed but given by a kinematic condition, in this case, that the vertical velocity at a distance $c/2$ directly behind the vortex has to be $V = -\alpha U_o$.



(i) Calculate the lift L_{ow} and the lift coefficient $C_{L_{ow}}$ ($\equiv L/(0.5\rho U_o^2 c)$, for the hydrofoil in open water in terms of α, U_o and c.

(ii) Again, this hydrofoil operates at a distance $c/2$ over the bottom. Obtain L_b and C_{L_b} in this case.

(iii) Calculate the ratio $C_{L_b}/C_{L_{ow}}$ in terms of α. What is this value for $\alpha = 0.1$?