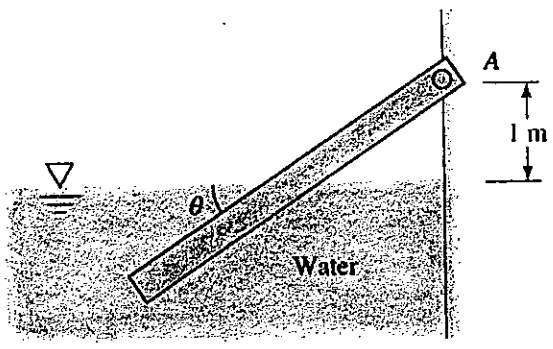
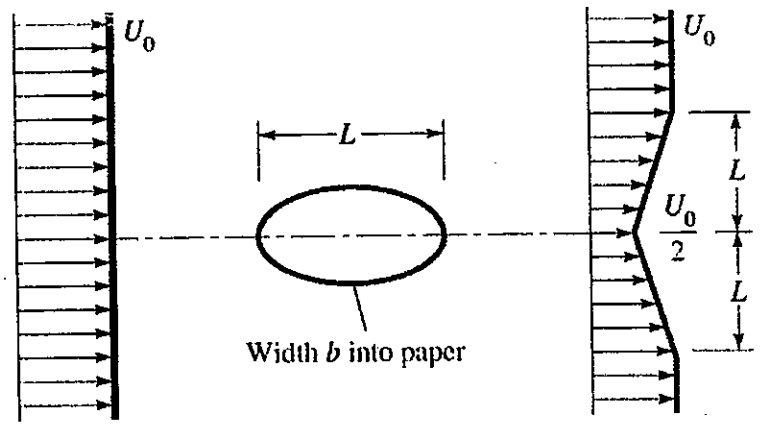
1. (25%) A uniform wooden beam (specific gravity = 0.65) is 10 cm by 10 cm by 3 m and is hinged at A, as in the following figure. At what angle will the beam float in the 20°C water ($\rho = 998$ kg/m^3)?



2. (25%) When immersed in a uniform stream, a thick elliptical cylinder creates a broad downstream wake, as idealized in the following figure. The pressure at the upstream and downstream sections are approximately equal, and the fluid is water at 20°C ($\rho = 998$ kg/m^3). If $U_0 = 4$ m/s and $L = 80$ cm, estimate the drag force (N) on the cylinder per unit width into the paper. Also compute the dimensionless drag coefficient $C_D = 2F/(\rho U_0^2 bL)$.



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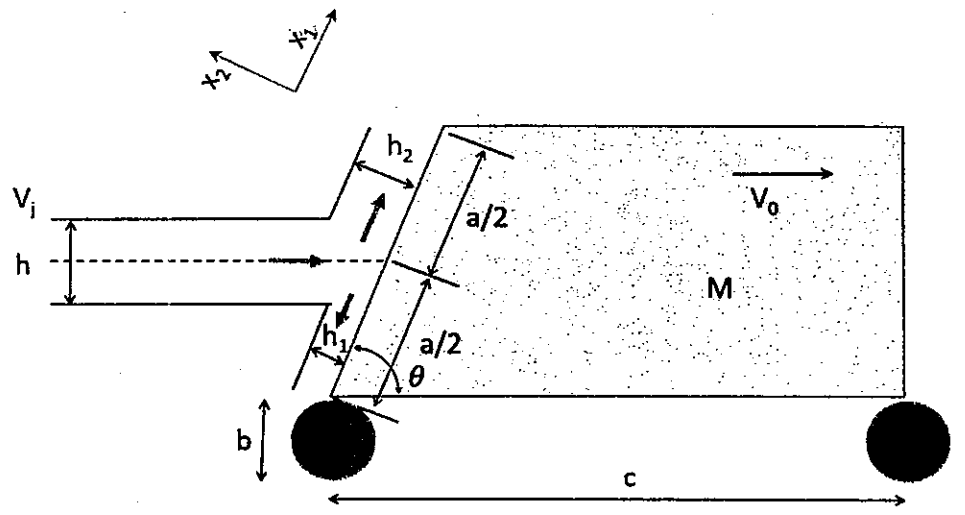
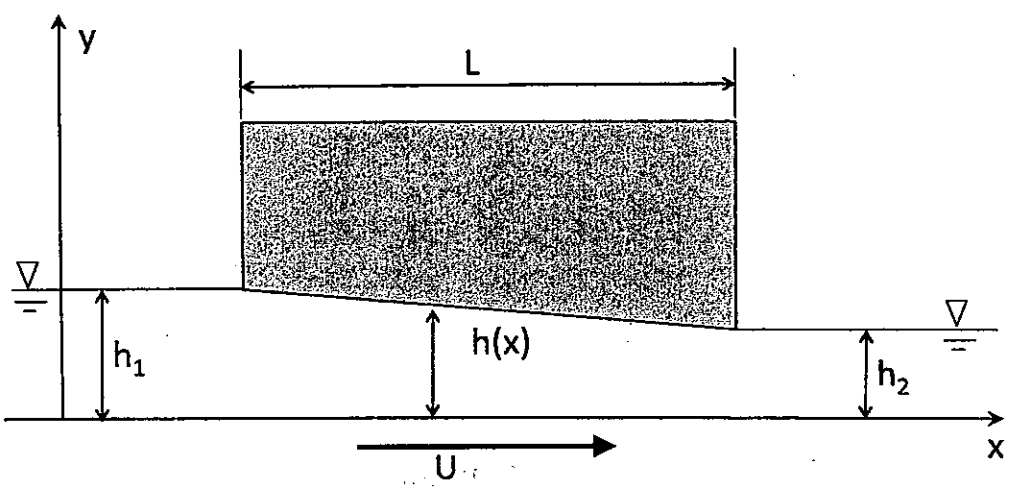
3. (25%) A steady, incompressible, frictionless (inviscid), two dimensional jet of water with density ρ, width h, velocity V_j, impinges on a cart, moving at a constant velocity V_0, as shown below. The gravity is to be neglected.
   (a.) (10%) Determine h_1 and h_2, which are, respectively, the water-level heights at the lower and upper parts after the jet impinges the cart.
   (b.) (5%) Determine the friction acting on the cart.
   (c.) (10%) Determine the reaction (including force and torque) of each wheel.



4. (25%) The flow pattern in bearing lubrication is illustrated by a steady two-dimensional flow as shown below. A viscous oil with density ρ and viscosity μ is forced into the thin gap $h(x)$ between a fixed slipper block and a wall moving at velocity U.
   (a.) (5%) Is there a velocity component (v) in the y −direction? If yes, under what condition can it be neglected?
   (b.) (5%) What are the boundary conditions for the x −component velocity u within the gap?
   (c.) (15%) If the condition in (a.) applies ($v = 0$ or to be neglected), neglecting gravity, find $u = u(y)$ (in terms of $h(x)$, h_1, h_2, μ, U, and y).



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