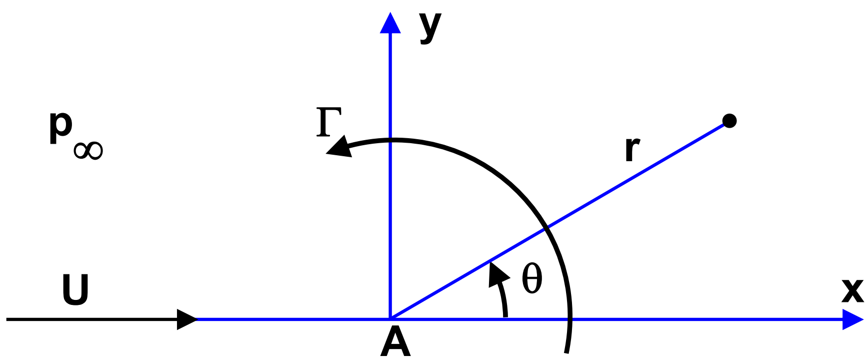
Problem 120G

A planar incompressible potential flow is generated by superposition of:

1. A uniform stream with velocity potential Ux.
2. A doublet with velocity potential $UR^2 \cos\theta/r$ at the point A in the sketch below.
3. A potential vortex at the point A with circulation, Γ, and velocity potential, $\Gamma\theta/2\pi$.



This generates the flow around a cylinder of radius, R, whose center is at A; the cylinder is also spinning in the counterclockwise direction. Find the velocity and pressure on the surface of the cylinder as a function of angular position, θ. Neglecting shear stresses and considering only the pressures on the surface of the cylinder find the total force on the cylinder per unit depth normal to the sketch. This is probably most readily done by separately evaluating the drag (the component of the force in the direction of the uniform stream, in other words the direction x) and the lift (the component of the force in the direction, y, perpendicular to the uniform stream). Denote the fluid density by ρ and the pressure far from the cylinder by p_∞.