Problem 133A

A circular cylinder (radius, R) moves with velocity, U, through an incompressible fluid (density, ρ) which is at rest far from the cylinder. Assume that the resulting planar flow is irrotational, potential flow.

(a) Determine the total kinetic energy of the fluid per unit depth normal to the plane of the flow.

(b) If the velocity of the cylinder is increased to $U + \delta U$ ($\delta U \ll U$), determine the increase in the kinetic energy contained in the fluid. Neglect terms which are quadratic (or higher order) in δU. Where does this additional energy come from?

(c) If the increase occurs over a time δt, determine the mean force, F, applied by the cylinder to the fluid during this time.