

# Fundamentals of Fluid Mechanics A

## Assignment 11 — Potential Flow IV

1. 6469 N.

Due on Tuesday December 7th at 11:00.

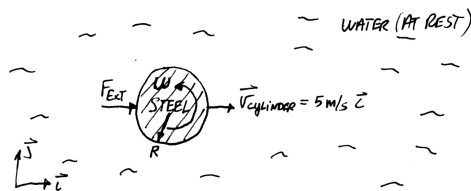
### Instructions

Write your solutions in single column format, with one statement following another vertically. Write your solutions neatly so that they are easy to read and verify. Don't write one line with two equal signs. Highlight your answers using a box. Failure to do this will result in a lower score and fewer comments on my part.

### Question #1

Consider a rotating cylinder interacting with an accelerating freestream flow ( $du_{\infty}/dt \neq 0$ ). Do the following:

- Find the force acting on the cylinder as a function of the freestream velocity and density, the circulation  $\Gamma$ , and the rate of change of the freestream velocity.
- Find the virtual mass associated with this accelerating cylinder.
- Consider a cylinder composed of solid steel and that rotates at a rate of 10 rad/s, has a radius of 0.1 m and a length of 1 m. An external force is applied on the cylinder as indicated below:



Note that the force can have  $\vec{i}$  and  $\vec{j}$  components. Calculate the magnitude of the external force needed to cause an acceleration of  $20 \text{ m/s}^2$  of this cylinder in liquid water when the cylinder moves at a velocity of  $5 \text{ m/s}$  with respect to the water and has no acceleration along  $\vec{j}$ .

The density of steel can be taken as  $8000 \text{ kg/m}^3$  and the density of water as  $1000 \text{ kg/m}^3$ .

### Answers