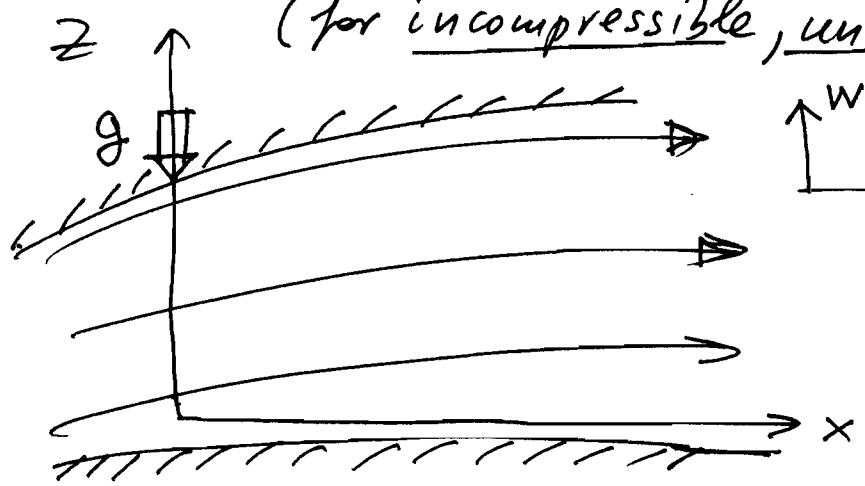
Navier-Stokes equations in 2-D

(for incompressible, unsteady flows)



u, w : velocity components along x & z

g : acceleration of gravity

p : pressure

u, w, and p are functions of x, z, and t (in the case of unsteady flow)

Navier-Stokes equations:

along x →
$$\rho\left[\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + w\frac{\partial u}{\partial z}\right] = -\frac{\partial p}{\partial x} + \mu\left[\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial z^2}\right]$$

along z →
$$\rho\left[\frac{\partial w}{\partial t} + u\frac{\partial w}{\partial x} + w\frac{\partial w}{\partial z}\right] = -\frac{\partial p}{\partial z} + \mu\left[\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial z^2}\right] - \rho g$$

(μ: dynamic viscosity)

continuity equation →
$$\frac{\partial u}{\partial x} + \frac{\partial w}{\partial z} = 0$$

The two N-S equations + the continuity equation must be solved in the flow domain (inside or around a body) with respect to u, w, p

Computational Fluid Dynamics solves the above equations numerically.