INITIAL AND BOUNDARY CONDITIONS.

RECAP : The Navier–Stokes equations

Momentum: $\rho \left[\frac{\partial \underline{u}}{\partial t} + (\underline{u}\cdot\nabla)\underline{u} \right] = -\nabla p + \rho g + \mu \nabla^2 \underline{u}$ $\qquad \underline{u} = (u, v, w)$

Mass: $\nabla \cdot \underline{u} = 0$ $\qquad \underline{x} = (x, y, z)$

Rules for evolving $\underline{u}(\underline{x}, t)$.

Initial: $\underline{u}(\underline{x}, t=0) = \underline{u}_0$ for $\underline{x} \in \Omega$. where Ω = fluid domain.

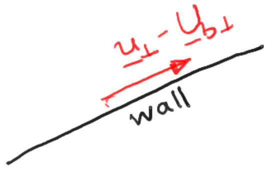
Boundary conditions :

1. No SLIP : $\underline{u}(\underline{x}, t) = \underline{U}_b(\underline{x}, t)$ for $x \in \partial\Omega$.

   Applies to viscous fluids next to solid walls.

2. Free slip a.k.a. no penetration :

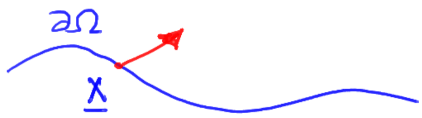
   $u_\perp(\underline{x}, t) = U_{b\perp}(\underline{x}, t)$ for $x \in \partial\Omega$



   Applies to inviscid fluids.

3. Kinematic boundary condition (for moving material boundaries)

   $\frac{D\underline{F}}{Dt} = \underline{u}(\underline{F}(\underline{X}, t), t)$ for $\underline{F}(\underline{X}, t) \in \partial\Omega$.



4. Dynamic boundary condition.

   unit normal to $\partial\Omega$.

   $\underline{\underline{T}} \cdot \hat{n} = \underline{t}$ specified on $x \in \partial\Omega$

$\underline{\underline{T}} \cdot \hat{n}$ = force per unit area on a surface w/ normal $\hat{n}$.