Basics

$g = 9.8$ m/s^2
$\rho_{water} = 998$ kg/m^3
$P_{atm} = 101.3$ kPa
$\boldsymbol{V} = u\boldsymbol{i} + v\boldsymbol{j} + w\boldsymbol{k}$
$\tau = \mu\, du/dy$
$\nu = \mu/\rho$
$SG = \rho/\rho_{H2O}$
Ideal gas: $P = \rho R_{gas} T$
$\vec{F} = -\int p d\vec{A}$
$P_{gage} = P_{abs} - P_{atm}$
$\bar{x}F_{total} = \sum x_i F_i = \int x dF$
$\bar{x}F_p = \int x p(x) dA$
$\vec{F}_{weight} = \int \rho \vec{g} dV$
$Re = \rho U L/\mu$
$F_R = \frac{V^2}{gh}$

Hydrostatics

$\vec{\nabla} p = \rho \vec{g}$
$p_2 - p_1 = \rho g(z_1 - z_2)$
$F_{buoyant} = +\rho_w g V_{TOT}$
$W = +\rho_o g V_{TOT}$
$\rho_o/\rho_f = V_{submerged}/V_o$
$-\boldsymbol{\nabla} p + \rho(\boldsymbol{g} - \boldsymbol{a}) = 0$
$\boldsymbol{g}_{eff} = \boldsymbol{g} - \boldsymbol{a}$
$p = p_0 - \rho g z + \frac{1}{2}\rho r^2 \Omega^2$

Bernoulli

$$\frac{p_1}{\rho} + \frac{V_1^2}{2} + g z_1 = \frac{p_2}{\rho} + \frac{V_2^2}{2} + g z_2$$
$p_{dyn} = \tfrac{1}{2}\rho V^2$
$p_0 = p_{dyn} + p_{stat}$

Integral Conservation Laws

$$M = \int_V \rho dV$$
$$\int_{CM} \vec{F}_{external} dt = \int \rho \vec{\mathbf{V}} dV$$
$$N = \int_{volume} \rho n dV$$
$$\dot{m} = -\int_A \rho \vec{V} \cdot d\vec{A}$$
$$Q = \int \vec{V} \cdot d\vec{A}$$
$$\dot{N} = -\int n \rho \vec{V} \cdot d\vec{A}$$
$$\left.\frac{dN}{dt}\right|_{CM} = \frac{d}{dt}\int_{CV} n\rho dV + \int n\rho \vec{V} \cdot d\vec{A}$$
$$0 = \frac{d}{dt}\int_{CV} \rho dV + \int \rho \vec{V} \cdot d\vec{A}$$
$$\Sigma F_{CV} = \frac{d}{dt}\int_{CV} \vec{V}_{xyz} \rho dV + \int \vec{V}_{xyz} \rho \vec{V}_{xyz} \cdot d\vec{A} + \int \vec{a}_{RF} \rho dV$$
$$\dot{Q}_{in} - \dot{W}_{\text{net out}} = \frac{\partial}{\partial t}\int_{CV} e\rho dV + \int_{CS}\left(u + pv + \frac{V^2}{2} + gz\right)\rho\left(\vec{V} \cdot d\vec{A}\right)$$

Differential Conservation Laws

$$0 = \frac{\partial \rho}{\partial t} + \vec{\nabla} \cdot \left(\rho \vec{V}\right)$$
$$\vec{a}_{particle} = \frac{DV_{particle}}{Dt} \equiv \left(\vec{V} \cdot \vec{\nabla}\right)\vec{V} + \frac{\partial \vec{V}}{\partial t}$$
$$\frac{\partial \vec{V}}{\partial t} + \left(\vec{V} \cdot \vec{\nabla}\right)\vec{V} = -\frac{1}{\rho}\vec{\nabla} p + \vec{g} + \frac{\mu}{\rho}\nabla^2 \vec{V}$$

Potential Flow

$\boldsymbol{\zeta} = \boldsymbol{\nabla} \times \boldsymbol{V} = 2\boldsymbol{\omega}$
Streamlines: $dy/dx = v/u$
Irrotational, 2D, steady: $\nabla^2 \psi = 0$
$\psi = -\int v dx + f_1(y)$
$\psi = +\int u dy + f_2(x)$
$\Delta \psi = Q/b$
$\vec{V} = \vec{\nabla}\phi \rightarrow u = \partial\phi/\partial x,\ v = \partial\phi/\partial y$
Irrotational, steady: $\nabla^2 \phi = 0$
$\Gamma = \int \vec{\nabla} \times \vec{V} dA = \oint \vec{V} \cdot d\vec{s}$
$w(z) = \phi + i\psi$, where $z = x + iy$
$\frac{dw}{dz} = v_x - i v_y$
Lift: $L = w\rho U_\infty \Gamma_{TOTAL}$