Hydrostatics (gravity in $-y$ direction):

$$
\begin{aligned}
dp/dy &= -\rho\, g \\
p &= p_0 - \rho g y \\
(F_y)_{\text{buoyancy}} &= \rho_{\text{fluid}}\, g\, \mathcal{V}
\end{aligned}
$$

Surface pressure integration for lift, moment:

$$
\begin{aligned}
L' &\simeq \int_0^c (p_\ell - p_u)\, dx \\
M'_{\text{LE}} &\simeq \int_0^c -(p_\ell - p_u)\, x\, dx \\
M'_{\text{ref}} &\simeq \int_0^c -(p_\ell - p_u)\,(x - x_{\text{ref}})\, dx \;=\; M'_{\text{LE}} + L' x_{\text{ref}}
\end{aligned}
$$

Aerodynamic parameter definitions:

$$
Re_\infty = \frac{\rho_\infty V_\infty\, \ell}{\mu_\infty} = \frac{V_\infty\, \ell}{\nu_\infty} \qquad\qquad M_\infty = \frac{V_\infty}{a_\infty}
$$

Dynamic similarity between flows 1 and 2:

$$
\begin{aligned}
\alpha_1 &= \alpha_2 \\
Re_1 &= Re_2 \\
M_1 &= M_2 \qquad \text{(not required if } M_1^2, M_2^2 \ll 1\text{)} \\
c_{\ell_1} &= c_{\ell_2} \\
&\;\vdots
\end{aligned}
$$

Mass flow $= \rho \vec{V}\cdot\hat{n}\, A = \rho V_n\, A = \rho V A_s$

Mass conservation (steady flow):

$$
\begin{aligned}
\oint\!\!\oint \rho\, \vec{V}\cdot\hat{n}\, dA &= 0 \\
\rho V A &= \text{const.} \qquad \text{(for slowly-varying channel)}
\end{aligned}
$$

Momentum flow $= \rho\left(\vec{V}\cdot\hat{n}\right)\vec{V} A = \rho V_n \vec{V} A = \rho V \vec{V} A_s$

Momentum conservation (steady flow):

$$
\oint\!\!\oint \rho\left(\vec{V}\cdot\hat{n}\right)\vec{V}\, dA = \oint\!\!\oint -p\,\hat{n}\, dA + \iiint \rho\, \vec{g}\, d\mathcal{V} + \vec{F}_{\text{viscous}}
$$

$$
\oint\!\!\oint \rho\left(\vec{V}\cdot\hat{n}\right)\vec{V}\, dA + \oint\!\!\oint p\,\hat{n}\, dA + \vec{R} = 0 \qquad (\vec{R} = \text{fluid's force on object inside volume})
$$

Definition of a streamline:

$$
w\, dy - v\, dz = 0 \qquad\qquad u\, dz - w\, dx = 0 \qquad\qquad v\, dx - u\, dy = 0
$$

Time rate of change of any flowfield quantity $f(t,x,y,z)$, as seen by f-sensor drifting with flowfield velocity $\vec{V}$:

$$
\frac{Df}{Dt} \equiv \frac{\partial f}{\partial t} + u\frac{\partial f}{\partial x} + v\frac{\partial f}{\partial y} + w\frac{\partial f}{\partial z} = \frac{\partial f}{\partial t} + \vec{V}\cdot\nabla f
$$

Gauss's Theorem, for any vector field $\vec{v}(x,y,z)$: $\displaystyle \iiint \nabla\cdot\vec{v}\; dx\, dy\, dz = \oint\!\!\oint \vec{v}\cdot\hat{n}\, dA$

Gradient Theorem, for any scalar field $f(x,y,z)$: $\displaystyle \iiint \nabla f\; dx\, dy\, dz = \oint\!\!\oint f\,\hat{n}\, dA$