Definition of a streamline:

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

Rate of change seen by drifting sensor of any field quantity $f(t,x,y,z)$:

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

Convective form of mass equation:

$$\frac{D\rho}{Dt} + \rho\,\nabla\cdot\vec{V} = 0$$

$$\nabla\cdot\vec{V} = 0 \qquad \text{(low speed flow case, } \rho = \text{constant)}$$

Convective form of x, y-momentum equations:

$$\rho\frac{Du}{Dt} = -\frac{\partial p}{\partial x} + \rho g_x + (F_x)_{\text{viscous}}$$

$$\rho\frac{Dv}{Dt} = -\frac{\partial p}{\partial y} + \rho g_y + (F_y)_{\text{viscous}}$$

Definition of Vorticity:

$$\vec{\xi} \equiv \nabla\times\vec{V}$$

$$\xi \equiv \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \qquad \text{(in 2-D)}$$

Definition of Circulation around a specified circuit:

$$\Gamma \equiv -\oint \vec{V}\cdot d\vec{s} \qquad \text{(always valid, by definition)}$$

$$= -\iint \xi\; dA \qquad \text{(in 2-D, only for reducible circuits)}$$

Helmholtz Equation for inviscid flow:

$$\frac{D\xi}{Dt} = 0$$

$$\xi = 0 \qquad \text{(for flow which is uniform upstream)}$$

Bernoulli Equation for inviscid, low speed flow:

$$p + \frac{1}{2}\rho V^2 = p_o \qquad \text{(constant along a streamline)}$$

Definition of Pressure Coefficient:

$$C_p \equiv \frac{p - p_\infty}{\frac{1}{2}\rho_\infty V_\infty^2} \qquad \text{(always valid, by definition)}$$

$$= 1 - \frac{V^2}{V_\infty^2} \qquad \text{(only if } p_o \text{ is constant for all streamlines)}$$

Velocities given via potential function $\phi(x, y)$:

$$u = \frac{\partial \phi}{\partial x} \quad , \quad v = \frac{\partial \phi}{\partial y} \qquad \text{or} \qquad \vec{V} = \nabla \phi$$

Velocities given via stream function $\psi(x, y)$:

$$u = \frac{\partial \psi}{\partial y} \quad , \quad v = -\frac{\partial \psi}{\partial x} \qquad \text{or} \qquad \vec{V} = (\nabla \psi) \times \hat{k}$$

Governing equations for incompressible (low speed), irrotational flows:

Using ϕ	Using ψ	
$\nabla^2 \phi = 0$	$\nabla^2 \psi = 0$	(everyhere)
$\partial \phi / \partial n = 0$	$\psi = \text{constant}$	(on solid body)
$\partial \phi / \partial x = V_\infty$	$\partial \psi / \partial y = V_\infty$	(far away)

Simple 2-D incompressible, irrotational flows:

	ϕ	ψ	u	v	V_r	V_θ
Uniform flow :	$V_\infty x$	$V_\infty y$	V_∞	0	$V_\infty \cos\theta$	$-V_\infty \sin\theta$
Point source :	$\frac{\Lambda}{2\pi} \ln r$	$\frac{\Lambda}{2\pi} \theta$	$\frac{\Lambda}{2\pi} \frac{x}{r^2}$	$\frac{\Lambda}{2\pi} \frac{y}{r^2}$	$\frac{\Lambda}{2\pi r}$	0
Point vortex :	$-\frac{\Gamma}{2\pi} \theta$	$\frac{\Gamma}{2\pi} \ln r$	$\frac{\Gamma}{2\pi} \frac{y}{r^2}$	$-\frac{\Gamma}{2\pi} \frac{x}{r^2}$	0	$-\frac{\Gamma}{2\pi r}$
Doublet :	$\frac{\kappa}{2\pi} \frac{\cos\theta}{r}$	$-\frac{\kappa}{2\pi} \frac{\sin\theta}{r}$	$\frac{\kappa}{2\pi} \frac{y^2 - x^2}{r^4}$	$-\frac{\kappa}{2\pi} \frac{2xy}{r^4}$	$-\frac{\kappa}{2\pi} \frac{\cos\theta}{r^2}$	$-\frac{\kappa}{2\pi} \frac{\sin\theta}{r^2}$

Potential of source, vortex sheets:

$$\phi_{(x,y)} = \int_0^\ell \frac{\lambda_{(s)}}{2\pi} \ln r_{(s,x,y)} \, ds \qquad\qquad \phi_{(x,y)} = \int_0^\ell -\frac{\gamma_{(s)}}{2\pi} \theta_{(s,x,y)} \, ds$$

Jump conditions:

Source sheet:	$\Delta \vec{V} \cdot \hat{n} = \lambda$	$\Delta \vec{V} \cdot \hat{s} = 0$
Vortex sheet:	$\Delta \vec{V} \cdot \hat{n} = 0$	$\Delta \vec{V} \cdot \hat{s} = \gamma$

Kutta-Joukowsky Theorem, for any 2-D lifting object:

$$L' = \rho V_\infty \Gamma$$

Normal-momentum equation:

$$\frac{\partial p}{\partial n} = -\rho V^2 \kappa \qquad (\kappa = \text{streamline curvature})$$