Important Elementary Flows Formulas PDF

Formulas
Examples
with Units

List of 16
Important Elementary Flows Formulas

1) Doublet Flow Formulas

1.1) Stream Function for 2-D Doublet Flow Formula

Evaluate Formula

Formula

$$\psi = \frac{\kappa \cdot \sin(\theta)}{2 \cdot \pi \cdot r}$$

Example with Units

$$38.7337\,\text{m}^2/\text{s} = \frac{3400\,\text{m}^3/\text{s} \cdot \sin(0.7\,\text{rad})}{2 \cdot 3.1416 \cdot 9\,\text{m}}$$

1.2) Velocity Potential for 2-D Doublet Flow Formula

Evaluate Formula

Formula

$$\phi = \frac{\kappa}{2 \cdot \pi \cdot r} \cdot \cos(\theta)$$

Example with Units

$$45.9863\,\text{m}^2/\text{s} = \frac{3400\,\text{m}^3/\text{s}}{2 \cdot 3.1416 \cdot 9\,\text{m}} \cdot \cos(0.7\,\text{rad})$$

2) Source Flow Formulas

2.1) Radial Velocity for 2-D Incompressible Source Flow Formula

Evaluate Formula

Formula

$$V_r = \frac{\Lambda}{2 \cdot \pi \cdot r}$$

Example with Units

$$2.3696\,\text{m/s} = \frac{134\,\text{m}^2/\text{s}}{2 \cdot 3.1416 \cdot 9\,\text{m}}$$

2.2) Source Strength for 2-D Incompressible Source Flow Formula

Evaluate Formula

Formula

$$\Lambda = 2 \cdot \pi \cdot r \cdot V_r$$

Example with Units

$$133.4549\,\text{m}^2/\text{s} = 2 \cdot 3.1416 \cdot 9\,\text{m} \cdot 2.36\,\text{m/s}$$

2.3) Stagnation Streamline Equation for Flow over Semi-Infinite Body Formula

Evaluate Formula

Formula

$$\psi = 0.5 \cdot \Lambda$$

Example with Units

$$67\,\text{m}^2/\text{s} = 0.5 \cdot 134\,\text{m}^2/\text{s}$$

2.4) Stream Function for 2-D Incompressible Source Flow Formula

Evaluate Formula

Formula

$$\psi_{source} = \frac{\Lambda}{2 \cdot \pi} \cdot \theta$$

Example with Units

$$14.9287\,\text{m}^2/\text{s} = \frac{134\,\text{m}^2/\text{s}}{2 \cdot 3.1416} \cdot 0.7\,\text{rad}$$

2.5) Stream Function for Flow over Rankine Oval Formula

Evaluate Formula

Formula

$$\psi_r = V_\infty \cdot r \cdot \sin(\theta) + \left(\frac{\Lambda}{2 \cdot \pi}\right) \cdot (\theta_1 - \theta_2)$$

Example with Units

$$-48.2001\,\text{m}^2/\text{s} = 6.4\,\text{m/s} \cdot 9\,\text{m} \cdot \sin(0.7\,\text{rad}) + \left(\frac{134\,\text{m}^2/\text{s}}{2 \cdot 3.1416}\right) \cdot (10\,\text{rad} - 14\,\text{rad})$$

2.6) Stream Function for Semi-Infinite Body Formula

Evaluate Formula

Formula

$$\psi = V_\infty \cdot r \cdot \sin(\theta) + \frac{\Lambda}{2 \cdot \pi} \cdot \theta$$

Example with Units

$$52.0357\,\text{m}^2/\text{s} = 6.4\,\text{m/s} \cdot 9\,\text{m} \cdot \sin(0.7\,\text{rad}) + \frac{134\,\text{m}^2/\text{s}}{2 \cdot 3.1416} \cdot 0.7\,\text{rad}$$

2.7) Velocity Potential for 2-D Source Flow Formula

Evaluate Formula

Formula

$$\phi = \frac{\Lambda}{2 \cdot \pi} \cdot \ln(r)$$

Example with Units

$$46.8597\,\text{m}^2/\text{s} = \frac{134\,\text{m}^2/\text{s}}{2 \cdot 3.1416} \cdot \ln(9\,\text{m})$$

3) Uniform Flow Formulas

3.1) Stream Function for Uniform Incompressible Flow Formula

Evaluate Formula

Formula

$$\psi = V_\infty \cdot y$$

Example with Units

$$37.12\,\text{m}^2/\text{s} = 6.4\,\text{m/s} \cdot 5.8\,\text{m}$$

3.2) Stream Function for Uniform Incompressible Flow in Polar Coordinates Formula

Evaluate Formula

Formula

$$\psi = V_\infty \cdot r \cdot \sin(\theta)$$

Example with Units

$$37.1069\,\text{m}^2/\text{s} = 6.4\,\text{m/s} \cdot 9\,\text{m} \cdot \sin(0.7\,\text{rad})$$

3.3) Velocity Potential for Uniform Incompressible Flow Formula

Evaluate Formula

Formula

$$\phi = V_\infty \cdot x$$

Example with Units

$$37.248\,\text{m}^2/\text{s} = 6.4\,\text{m/s} \cdot 5.82\,\text{m}$$

3.4) Velocity Potential for Uniform Incompressible Flow in Polar Coordinates Formula

Evaluate Formula

Formula

$$\phi = V_\infty \cdot r \cdot \cos(\theta)$$

Example with Units

$$44.0549\,\text{m}^2/\text{s} = 6.4\,\text{m/s} \cdot 9\,\text{m} \cdot \cos(0.7\,\text{rad})$$

4) Vortex Flow Formulas

4.1) Stream Function for 2-D Vortex Flow Formula

Evaluate Formula

Formula

$$\psi_{vortex} = \frac{\gamma}{2 \cdot \pi} \cdot \ln(r)$$

Example with Units

$$-146.8736\,\text{m}^2/\text{s} = \frac{-420\,\text{m}^2/\text{s}}{2 \cdot 3.1416} \cdot \ln(9\,\text{m})$$

4.2) Tangential Velocity for 2-D Vortex Flow Formula

Evaluate Formula

Formula

$$V_\theta = -\frac{\gamma}{2 \cdot \pi \cdot r}$$

Example with Units

$$7.4272\,\text{m/s} = -\frac{-420\,\text{m}^2/\text{s}}{2 \cdot 3.1416 \cdot 9\,\text{m}}$$

4.3) Velocity Potential for 2-D Vortex Flow Formula

Evaluate Formula

Formula

$$\phi = -\left(\frac{\gamma}{2 \cdot \pi}\right) \cdot \theta$$

Example with Units

$$46.7916\,\text{m}^2/\text{s} = -\left(\frac{-420\,\text{m}^2/\text{s}}{2 \cdot 3.1416}\right) \cdot 0.7\,\text{rad}$$

Variables used in list of Elementary Flows Formulas above

- **r** Radial Coordinate *(Meter)*
- V_∞ Freestream Velocity *(Meter per Second)*
- V_r Radial Velocity *(Meter per Second)*
- V_θ Tangential Velocity *(Meter per Second)*
- **x** Distance on X-Axis *(Meter)*
- **y** Distance on Y-Axis *(Meter)*
- **γ** Vortex Strength *(Square Meter per Second)*
- **θ** Polar Angle *(Radian)*
- θ_1 Polar Angle from Source *(Radian)*
- θ_2 Polar Angle from Sink *(Radian)*
- **κ** Doublet Strength *(Cubic Meter per Second)*
- **Λ** Source Strength *(Square Meter per Second)*
- **ϕ** Velocity Potential *(Square Meter per Second)*
- **ψ** Stream Function *(Square Meter per Second)*
- ψ_r Rankine Oval Stream Function *(Square Meter per Second)*
- ψ_{source} Source Stream Function *(Square Meter per Second)*
- ψ_{vortex} Vortex Stream Function *(Square Meter per Second)*

Constants, Functions, Measurements used in list of Elementary Flows Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- Functions: **ln**, ln(Number) *The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.*
- Functions: **sin**, sin(Angle) *Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Angle** in Radian (rad) *Angle Unit Conversion*
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s) *Volumetric Flow Rate Unit Conversion*
- Measurement: **Velocity Potential** in Square Meter per Second (m²/s) *Velocity Potential Unit Conversion*

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