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Flow and Lift Distribution Formulas

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List of 24 Flow and Lift Distribution Formulas

Flow and Lift Distribution

Flow over Cylinder

Lifting Flow over Cylinder

1) 2-D Lift Coefficient for Cylinder

Open Calculator

fx $$C_L = \frac{\Gamma}{R \cdot V_\infty}$$

ex $$1.268116 = \frac{0.7\text{m}^2/\text{s}}{0.08\text{m} \cdot 6.9\text{m/s}}$$

2) Angular Position given Radial Velocity for Lifting Flow over Circular Cylinder

Open Calculator

fx $$\theta = \arccos\left(\frac{V_r}{\left(1-\left(\frac{R}{r}\right)^2\right) \cdot V_\infty}\right)$$

ex $$0.902545\text{rad} = \arccos\left(\frac{3.9\text{m/s}}{\left(1-\left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right) \cdot 6.9\text{m/s}}\right)$$

3) Angular Position of Stagnation Point for Lifting Flow over Circular Cylinder

Open Calculator

fx $$\theta_0 = ar\sin\left(-\frac{\Gamma_0}{4 \cdot \pi \cdot V_{s,\infty} \cdot R}\right)$$

ex $$-1.055971\text{rad} = ar\sin\left(-\frac{7\text{m}^2/\text{s}}{4 \cdot \pi \cdot 8\text{m/s} \cdot 0.08\text{m}}\right)$$

4) Freestream Velocity given 2-D Lift Coefficient for Lifting Flow

Open Calculator

$$V_\infty = \frac{\Gamma}{R \cdot C_L}$$

$$7.291667\text{m/s} = \frac{0.7\text{m}^2\text{/s}}{0.08\text{m} \cdot 1.2}$$

5) Location of Stagnation Point Outside Cylinder for Lifting Flow

Open Calculator

$$r_0 = \frac{\Gamma_0}{4 \cdot \pi \cdot V_\infty} + \sqrt{\left(\frac{\Gamma_0}{4 \cdot \pi \cdot V_\infty}\right)^2 - R^2}$$

$$0.091569\text{m} = \frac{7\text{m}^2\text{/s}}{4 \cdot \pi \cdot 6.9\text{m/s}} + \sqrt{\left(\frac{7\text{m}^2\text{/s}}{4 \cdot \pi \cdot 6.9\text{m/s}}\right)^2 - (0.08\text{m})^2}$$

6) Radial Velocity for Lifting Flow over Circular Cylinder

Open Calculator

$$V_r = \left(1 - \left(\frac{R}{r}\right)^2\right) \cdot V_\infty \cdot \cos(\theta)$$

$$3.912562\text{m/s} = \left(1 - \left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right) \cdot 6.9\text{m/s} \cdot \cos(0.9\text{rad})$$

7) Radius of Cylinder for Lifting Flow

Open Calculator

$$R = \frac{\Gamma}{C_L \cdot V_\infty}$$

$$0.084541\text{m} = \frac{0.7\text{m}^2\text{/s}}{1.2 \cdot 6.9\text{m/s}}$$

8) Stream Function for Lifting Flow over Circular Cylinder

Open Calculator

fx $$\psi = V_\infty \cdot r \cdot \sin(\theta) \cdot \left(1 - \left(\frac{R}{r}\right)^2\right) + \frac{\Gamma}{2 \cdot \pi} \cdot \ln\left(\frac{r}{R}\right)$$

ex $$1.466737\text{m}^2/\text{s} = 6.9\text{m/s} \cdot 0.27\text{m} \cdot \sin(0.9\text{rad}) \cdot \left(1 - \left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right) + \frac{0.7\text{m}^2/\text{s}}{2 \cdot \pi} \cdot \ln\left(\frac{0.27\text{m}}{0.08\text{m}}\right)$$

9) Surface Pressure Coefficient for Lifting Flow over Circular Cylinder

Open Calculator

fx $$C_p = 1 - \left((2 \cdot \sin(\theta))^2 + \frac{2 \cdot \Gamma \cdot \sin(\theta)}{\pi \cdot R \cdot V_\infty} + \left(\frac{\Gamma}{2 \cdot \pi \cdot R \cdot V_\infty}\right)^2\right)$$

ex $$-2.127524 = 1 - \left((2 \cdot \sin(0.9\text{rad}))^2 + \frac{2 \cdot 0.7\text{m}^2/\text{s} \cdot \sin(0.9\text{rad})}{\pi \cdot 0.08\text{m} \cdot 6.9\text{m/s}} + \left(\frac{0.7\text{m}^2/\text{s}}{2 \cdot \pi \cdot 0.08\text{m} \cdot 6.9\text{m/s}}\right)^2\right)$$

10) Tangential Velocity for Lifting Flow over Circular Cylinder

Open Calculator

fx $$V_\theta = -\left(1 + \left(\frac{R}{r}\right)^2\right) \cdot V_\infty \cdot \sin(\theta) - \frac{\Gamma}{2 \cdot \pi \cdot r}$$

ex $$-6.292089\text{m/s} = -\left(1 + \left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right) \cdot 6.9\text{m/s} \cdot \sin(0.9\text{rad}) - \frac{0.7\text{m}^2/\text{s}}{2 \cdot \pi \cdot 0.27\text{m}}$$

Nonlifting Flow over Cylinder

11) Angular Position given Pressure Coefficient for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$\theta = ar\sin\left(\frac{\sqrt{1 - (C_p)}}{2}\right)$$

ex $$1.083497\text{rad} = ar\sin\left(\frac{\sqrt{1 - (-2.123)}}{2}\right)$$

12) Angular Position given Radial Velocity for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$\theta = \arccos\left(\frac{V_r}{\left(1-\left(\frac{R}{r}\right)^2\right)\cdot V_\infty}\right)$$

ex $$0.902545\text{rad} = \arccos\left(\frac{3.9\text{m/s}}{\left(1-\left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right)\cdot 6.9\text{m/s}}\right)$$

13) Angular Position given Tangential Velocity for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$\theta = -ar\sin\left(\frac{V_\theta}{\left(1+\frac{R^2}{r^2}\right)\cdot V_\infty}\right)$$

ex $$0.99365\text{rad} = -ar\sin\left(\frac{-6.29\text{m/s}}{\left(1+\frac{(0.08\text{m})^2}{(0.27\text{m})^2}\right)\cdot 6.9\text{m/s}}\right)$$

14) Doublet Strength given Radius of Cylinder for Non-Lifting Flow

Open Calculator

fx $$\kappa = R^2\cdot 2\cdot\pi\cdot V_\infty$$

ex $$0.277465\text{m}^3\text{/s} = (0.08\text{m})^2\cdot 2\cdot\pi\cdot 6.9\text{m/s}$$

15) Freestream Velocity given Doublet Strength for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$V_\infty = \frac{\kappa}{R^2\cdot 2\cdot\pi}$$

ex $$5.470951\text{m/s} = \frac{0.22\text{m}^3\text{/s}}{(0.08\text{m})^2\cdot 2\cdot\pi}$$

16) Radial Velocity for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$V_r = \left(1 - \left(\frac{R}{r}\right)^2\right) \cdot V_\infty \cdot \cos(\theta)$$

ex $$3.912562\text{m/s} = \left(1 - \left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right) \cdot 6.9\text{m/s} \cdot \cos(0.9\text{rad})$$

17) Radius of Cylinder for Non-Lifting Flow

Open Calculator

fx $$R = \sqrt{\frac{\kappa}{2 \cdot \pi \cdot V_\infty}}$$

ex $$0.071236\text{m} = \sqrt{\frac{0.22\text{m}^3/\text{s}}{2 \cdot \pi \cdot 6.9\text{m/s}}}$$

18) Stream Function for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$\psi = V_\infty \cdot r \cdot \sin(\theta) \cdot \left(1 - \left(\frac{R}{r}\right)^2\right)$$

ex $$1.331221\text{m}^2/\text{s} = 6.9\text{m/s} \cdot 0.27\text{m} \cdot \sin(0.9\text{rad}) \cdot \left(1 - \left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right)$$

19) Surface Pressure Coefficient for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$C_p = 1 - 4 \cdot (\sin(\theta))^2$$

ex $$-1.454404 = 1 - 4 \cdot (\sin(0.9\text{rad}))^2$$

20) Tangential Velocity for Non-Lifting Flow over Circular Cylinder

Open Calculator

fx $$V_\theta = -\left(1+\left(\frac{R}{r}\right)^2\right)\cdot V_\infty \cdot \sin(\theta)$$

ex $$-5.879465\text{m/s} = -\left(1+\left(\frac{0.08\text{m}}{0.27\text{m}}\right)^2\right)\cdot 6.9\text{m/s}\cdot \sin(0.9\text{rad})$$

Kutta-Joukowski Lift Theorem

21) Circulation by Kutta-Joukowski Theorem

Open Calculator

fx $$\Gamma = \frac{L'}{\rho_\infty \cdot V_\infty}$$

ex $$0.698018\text{m}^2\text{/s} = \frac{5.9\text{N/m}}{1.225\text{kg/m}^3\cdot 6.9\text{m/s}}$$

22) Freestream Density by Kutta-Joukowski Theorem

Open Calculator

fx $$\rho_\infty = \frac{L'}{V_\infty \cdot \Gamma}$$

ex $$1.221532\text{kg/m}^3 = \frac{5.9\text{N/m}}{6.9\text{m/s}\cdot 0.7\text{m}^2\text{/s}}$$

23) Freestream Velocity by Kutta-Joukowski Theorem

Open Calculator

fx $$V_\infty = \frac{L'}{\rho_\infty \cdot \Gamma}$$

ex $$6.880466\text{m/s} = \frac{5.9\text{N/m}}{1.225\text{kg/m}^3\cdot 0.7\text{m}^2\text{/s}}$$

24) Lift Per Unit Span by Kutta-Joukowski Theorem

Open Calculator

fx $$L' = \rho_\infty \cdot V_\infty \cdot \Gamma$$

ex $$5.91675\text{N/m} = 1.225\text{kg/m}^3\cdot 6.9\text{m/s}\cdot 0.7\text{m}^2\text{/s}$$

Variables Used

- C_L Lift Coefficient
- C_p Surface Pressure Coefficient
- L' Lift per Unit Span *(Newton per Meter)*
- r Radial Coordinate *(Meter)*
- R Cylinder Radius *(Meter)*
- r_0 Radial Coordinate of Stagnation Point *(Meter)*
- V_∞ Freestream Velocity *(Meter per Second)*
- V_r Radial Velocity *(Meter per Second)*
- $V_{s,\infty}$ Stagnation Freestream Velocity *(Meter per Second)*
- V_θ Tangential Velocity *(Meter per Second)*
- Γ Vortex Strength *(Square Meter per Second)*
- Γ_0 Stagnation Vortex Strength *(Square Meter per Second)*
- θ Polar Angle *(Radian)*
- θ_0 Polar Angle of Stagnation Point *(Radian)*
- κ Doublet Strength *(Cubic Meter per Second)*
- ρ_∞ Freestream Density *(Kilogram per Cubic Meter)*
- ψ Stream Function *(Square Meter per Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **arccos**, arccos(Number)
  Inverse trigonometric cosine function
- Function: **arsin**, arsin(Number)
  Inverse trigonometric sine function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- 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 (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Surface Tension** in Newton per Meter (N/m)
  Surface Tension Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion
- Measurement: **Velocity Potential** in Square Meter per Second (m^2/s)
  Velocity Potential Unit Conversion

Check other formula lists

- **Flow and Lift Distribution Formulas**
- **Lift Distribution Formulas**

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