Important Lift and Circulation Formulas PDF

Formulas
Examples
with Units

List of 16
Important Lift and Circulation Formulas

1) Angle of Attack for Circulation developed on Airfoil Formula

Evaluate Formula

Formula

$$\alpha = asin\left(\frac{\Gamma}{\pi \cdot U \cdot C}\right)$$

Example with Units

$$6.5069° = asin\left(\frac{62\,m^2/s}{3.1416 \cdot 81\,m/s \cdot 2.15\,m}\right)$$

2) Angle of Attack for Lift Coefficient on Airfoil Formula

Evaluate Formula

Formula

$$\alpha = asin\left(\frac{C_{L\,airfoil}}{2 \cdot \pi}\right)$$

Example with Units

$$6.5066° = asin\left(\frac{0.712}{2 \cdot 3.1416}\right)$$

3) Chord Length for Circulation developed on Airfoil Formula

Evaluate Formula

Formula

$$C = \frac{\Gamma}{\pi \cdot U \cdot \sin(\alpha)}$$

Example with Units

$$2.1523\,m = \frac{62\,m^2/s}{3.1416 \cdot 81\,m/s \cdot \sin(6.5°)}$$

4) Circulation developed on Airfoil Formula

Evaluate Formula

Formula

$$\Gamma = \pi \cdot U \cdot C \cdot \sin(\alpha)$$

Example with Units

$$61.9344\,m^2/s = 3.1416 \cdot 81\,m/s \cdot 2.15\,m \cdot \sin(6.5°)$$

5) Circulation for Single Stagnation Point Formula

Evaluate Formula

Formula

$$\Gamma_c = 4 \cdot \pi \cdot V_\infty \cdot R$$

Example with Units

$$243.1593\,m^2/s = 4 \cdot 3.1416 \cdot 21.5\,m/s \cdot 0.9\,m$$

6) Circulation in Location of Stagnation Points Formula

Evaluate Formula

Formula

$$\Gamma_c = -(\sin(\theta)) \cdot 4 \cdot \pi \cdot V_\infty \cdot R$$

Example with Units

$$243.1593\,m^2/s = -(\sin(270°)) \cdot 4 \cdot 3.1416 \cdot 21.5\,m/s \cdot 0.9\,m$$

7) Coefficient of Lift for Airfoil Formula

Evaluate Formula

Formula

$$C_{L\,airfoil} = 2 \cdot \pi \cdot \sin(\alpha)$$

Example with Units

$$0.7113 = 2 \cdot 3.1416 \cdot \sin(6.5°)$$

8) Lift coefficient for lift force in body moving on fluid Formula

Evaluate Formula

Formula

$$C_L = \frac{F_L'}{A_p \cdot 0.5 \cdot \rho \cdot \left(v^2\right)}$$

Example with Units

$$0.9445 = \frac{1100\,\text{N}}{1.88\,\text{m}^2 \cdot 0.5 \cdot 1.21\,\text{kg/m}^3 \cdot \left(32\,\text{m/s}^2\right)}$$

9) Lift Coefficient for Rotating Cylinder with Circulation Formula

Evaluate Formula

Formula

$$C' = \frac{\Gamma_c}{R \cdot V_\infty}$$

Example with Units

$$12.5581 = \frac{243\,\text{m}^2/\text{s}}{0.9\,\text{m} \cdot 21.5\,\text{m/s}}$$

10) Lift Coefficient for Rotating Cylinder with Tangential Speed Formula

Evaluate Formula

Formula

$$C' = \frac{2 \cdot \pi \cdot v_t}{V_\infty}$$

Example with Units

$$12.5664 = \frac{2 \cdot 3.1416 \cdot 43\,\text{m/s}}{21.5\,\text{m/s}}$$

11) Lift Force for Body moving in Fluid Formula

Evaluate Formula

Formula

$$F_L' = \frac{C_L \cdot A_p \cdot M_w \cdot \left(v^2\right)}{V_w \cdot 2}$$

Example with Units

$$1098.6935\,\text{N} = \frac{0.94 \cdot 1.88\,\text{m}^2 \cdot 3.4\,\text{kg} \cdot \left(32\,\text{m/s}^2\right)}{2.8\,\text{m}^3 \cdot 2}$$

12) Lift Force for body moving in Fluid of Certain Density Formula

Evaluate Formula

Formula

$$F_L = C_L \cdot A_p \cdot \rho \cdot \frac{v^2}{2}$$

Example with Units

$$1094.8157\,\text{N} = 0.94 \cdot 1.88\,\text{m}^2 \cdot 1.21\,\text{kg/m}^3 \cdot \frac{32\,\text{m/s}^2}{2}$$

13) Lift Force on Cylinder for Circulation Formula

Evaluate Formula

Formula

$$F_L = \rho \cdot I \cdot \Gamma_c \cdot V_\infty$$

Example with Units

$$53733.9825\,\text{N} = 1.21\,\text{kg/m}^3 \cdot 8.5\,\text{m} \cdot 243\,\text{m}^2/\text{s} \cdot 21.5\,\text{m/s}$$

14) Radius of Cylinder for Lift Coefficient in Rotating Cylinder with Circulation Formula

Evaluate Formula

Formula

$$R = \frac{\Gamma_c}{C' \cdot V_\infty}$$

Example with Units

$$0.9006\,\text{m} = \frac{243\,\text{m}^2/\text{s}}{12.55 \cdot 21.5\,\text{m/s}}$$

15) Tangential Velocity of Cylinder with Lift Coefficient Formula

Evaluate Formula

Formula

$$v_t = \frac{C' \cdot V_\infty}{2 \cdot \pi}$$

Example with Units

$$42.944\,\text{m/s} = \frac{12.55 \cdot 21.5\,\text{m/s}}{2 \cdot 3.1416}$$

16) Velocity of Airfoil for Circulation developed on Airfoil Formula

Evaluate Formula

Formula

$$U = \frac{\Gamma}{\pi \cdot C \cdot \sin(\alpha)}$$

Example with Units

$$81.0858\,\text{m/s} = \frac{62\,\text{m}^2/\text{s}}{3.1416 \cdot 2.15\,\text{m} \cdot \sin(6.5°)}$$

Variables used in list of Lift and Circulation Formulas above

- A_p Projected Area of Body *(Square Meter)*
- **C** Chord Length of Airfoil *(Meter)*
- $C_{L\ airfoil}$ Lift Coefficient for Airfoil
- C_L Lift Coefficient for Body in Fluid
- C' Lift Coefficient for Rotating Cylinder
- F_L Lift Force on Rotating Cylinder *(Newton)*
- F_L' Lift Force on Body in Fluid *(Newton)*
- **l** Length of Cylinder in Fluid Flow *(Meter)*
- M_w Mass of Flowing Fluid *(Kilogram)*
- **R** Radius of Rotating Cylinder *(Meter)*
- **U** Velocity of Airfoil *(Meter per Second)*
- **v** Velocity of Body or Fluid *(Meter per Second)*
- V_∞ Freestream Velocity of Fluid *(Meter per Second)*
- v_t Tangential Velocity of Cylinder in Fluid *(Meter per Second)*
- V_w Volume of Flowing Fluid *(Cubic Meter)*
- **α** Angle of Attack on Airfoil *(Degree)*
- **Γ** Circulation on Airfoil *(Square Meter per Second)*
- Γ_c Circulation Around Cylinder *(Square Meter per Second)*
- **θ** Angle at Stagnation Point *(Degree)*
- **ρ** Density of Fluid Circulating *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used in list of Lift and Circulation Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **asin**, asin(Number) *The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.*
- 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: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Volume** in Cubic Meter (m³) *Volume Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³) *Density Unit Conversion*
- Measurement: **Momentum Diffusivity** in Square Meter per Second (m²/s) *Momentum Diffusivity Unit Conversion*

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