Basic Applications of Elementary Flows

1 Nonlifting flow over a cylinder

If we combine a uniform flow with a doublet, we get the stream function

$$\psi = V_{\infty}r \sin \theta - \frac{\kappa}{2\pi} \frac{\sin \theta}{r} = V_{\infty}r \sin \theta \left(1 - \frac{\kappa}{2\pi V_{\infty}r^2}\right) = V_{\infty}r \sin \theta \left(1 - \frac{R^2}{r^2}\right),$$
 (1.1)

where $R^2 = \frac{1}{2\pi V_{-}}$. This is also the stream function for a flow over a cylinder/circle with radius

$$R = \sqrt{\frac{\kappa}{2\pi V_{\infty}}}.$$
 (1.2)

The velocity field can be found by using the stream function, and is given by

$$V_r = V_\infty \cos \theta \left(1 - \frac{R^2}{r^2}\right), \quad V_\theta = -V_\infty \sin \theta \left(1 + \frac{R^2}{r^2}\right).$$
 (1.3)

Note that if r = R, then $V_r = 0$, satisfying the wall boundary condition. At the wall also $V_\theta = -2V_\infty \sin \theta$. This means that the pressure coefficient over the cylinder is given by

$$C_p = 1 - \left(\frac{V}{V_{\infty}}\right)^2 = 1 - 4 \sin^2 \theta,$$
 (1.4)

2 Nonlifting flow over a sphere

Let's combine a uniform 3-dimensional flow with a 3-dimensional doublet. Let's define R as

$$R = \sqrt[3]{\frac{\mu}{2\pi V_{\infty}}}.$$
 (2.1)

Using the combined stream function, it can be shown that the velocity field is given by

$$V_r = -V_{\infty} \cos \theta \left(1 - \frac{R^3}{r^3}\right), \quad V_{\theta} = V_{\infty} \sin \theta \left(1 + \frac{R^3}{r^3}\right), \quad V_{\phi} = 0.$$
 (2.2)

At the wall, the velocity is $V_{\theta} = \frac{3}{2}V_{\infty}\sin\theta$. This means that the pressure coefficient over the sphere is given by

$$C_p = 1 - \left(\frac{V}{V_{\infty}}\right)^2 = 1 - \frac{9}{4}\sin^2\theta.$$
 (2.3)

3 Lifting flow over a cylinder

Let's combine a nonlifting flow over a cylinder with a vortex of strength Γ . This results in a lifting flow over a cylinder. The resulting stream function is

$$\psi = (V_{\infty}r \sin \theta) \left(1 - \frac{R^2}{r^2}\right) + \frac{\Gamma}{2\pi} \ln \frac{r}{R}. \qquad (3.1)$$

From the stream function we can derive the velocity field, which is given by

$$V_r = V_\infty \cos \theta \left(1 - \frac{R^2}{r^2}\right), \quad V_\theta = -V_\infty \sin \theta \left(1 + \frac{R^2}{r^2}\right) - \frac{\Gamma}{2\pi r}.$$
 (3.2)

Elementary Basic With Applications

M Tight

Elementary Basic With Applications:

Elementary BASIC with Applications Mario V. Farina,1970 Essential Mathematics for Games and Interactive Applications James M. Van Verth,Lars M. Bishop,2008-05-19 Essential Mathematics for Games and Interactive Applications 2nd edition presents the core mathematics necessary for sophisticated 3D graphics and interactive physical simulations The book begins with linear algebra and matrix multiplication and expands on this foundation to cover such topics as color and lighting interpolation animation and basic game physics Essential Mathematics focuses on the issues of 3D game development important to programmers and includes optimization guidance throughout The new edition Windows code will now use Visual Studio NET There will also be DirectX support provided along with OpenGL due to its cross platform nature Programmers will find more concrete examples included in this edition as well as additional information on tuning optimization and robustness The book has a companion CD ROM with exercises and a test bank for the academic secondary market and for main market code examples built around a shared code base including a math library covering all the topics presented in the book a core vector matrix math engine and libraries to support basic 3D rendering and interaction

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