Indian Institute of Space Science and Technology-Thiruvananthapuram

AE-225 Fluid Mechanics

Assignment-3

Topics: Potential flow and boundary layer equation

1. Solve the Falkner-Skan profile equation

$$\frac{d^3f}{d\eta^3} + \frac{(n+1)}{2} f \frac{d^2f}{d\eta^2} - n\left(\frac{df}{d\eta}\right)^2 + n = 0$$

using numerically for n = -0.0904, -0.654, 0, 1/9, 1/3, and 1 using boundary conditions

$$u = v = 0 \quad \text{at} \quad y = 0$$

$$u/u_\infty = 1 \quad \text{at} \quad y = \infty$$

and the RungeKutta scheme of numerical integration (ODE 45). Plot the results and compare with Blasius solution. What values of $f''(0)$ lead to successful profiles at these six values of n? Write an expression for boundary layer, displacement and momentum thickness for theses cases.

2. Illustrate the stream function (ψ) for a rotating cylinder flow using matlab.Choose a uniform flow of velocity 5 m/s in the positive x-direction with a dipole K and a vortex Γ located at (-1,1), that is, (x_k, y_k) = (-1,-1) and (x_Γ, y_Γ) = (-1,-1) , and give the strengths of each of these component flow fields the following values:K=5 and $\Gamma = 8\pi$. Represent the the cylinder with a thick black line. Use matlab command contour to represent the streamlines in color.