

1. Consider flow over a flat plate with zero pressure gradient. Blasius found that by definition of following variables (He used  $\alpha = 1$ ):

$$\psi(x, y) = \sqrt{\alpha \nu x U} f(\eta) \quad \text{and} \quad \eta = y \sqrt{\frac{U}{\alpha \nu x}}$$

the boundary layer equations reduce to

$$f''' + \frac{\alpha}{2} f f'' = 0$$

with the following boundary conditions:

$$f = f' = 0 \quad \text{at} \quad \eta = 0$$

$$f' = 1 \quad \text{as} \quad \eta \rightarrow \infty$$

**Required:**

- (a) Write a computer program to solve the Blasius equation using the Keller-Box scheme. Carry out the computations for two values of step size  $\Delta\eta=0.5$  and  $\Delta\eta = 0.1$ , and the stretching grid mentioned in the class. For each case, apply the outer boundary condition at a distance from the wall such that  $\eta_{\max} = 12.0$ .
- (b) Make a table of quantities  $f$ ,  $f'$ , and  $f''$  for all the  $\eta$  locations for each case.
- (c) Plot the velocity profile in the form of  $u/U$  vs  $y\sqrt{U/\alpha\nu x}$  for each case.
- (d) Compute  $C_f Re_x^{1/2}$  for each case.
- (e) Prepare a report describing your program and discussing your results.