AAE 519 Prof. Schneider, Fall 2009
Problem Set 6
Handed Out: Friday, 23 October
Due: Friday, 6 November
This is a two-week double-credit problem set

Study the similarity solution for the compressible flat plate boundary layer. Use the code that was emailed to you to solve the similarity solution equations for the laminar compressible boundary layer on a flat plate. See also the file `compbleqns.pdf` for some analytical analysis.

1. Plot profiles of some of the physical parameters for some cases of interest to you. Discuss.

2. Modify the code to compute the Reynolds analogy, here taken as

$$\frac{C_f}{C_H}\frac{h_e}{h_{aw}-h_w} = 2Pr\frac{f''(0)}{g'(0)}.$$

   Here, C_H is the Stanton number, as in Anderson eqn. 6.65. Plot this ratio, and also C_f/C_H, for some cases of interest. Discuss how the Reynolds analogy works out differently for the low speed Falkner-Skan flow, as compared to the compressible flat plate flow. Compare the results to Anderson, 2nd ed., Fig. 6.14.

3. Modify the code to print out the nondimensional total temperature as a function of the height above the wall. For Prandtl number 0.72 and 1.0, compare to the Crocco-Busemann relations (both first and second). Recall that the Crocco-Busemann relations are exact for $Pr =$ 1. Discuss. How good is the Crocco-Busemann approximation for air?

Present your results as a brief report.

(over)

Possible extensions, for extra credit, are as follows. Results should be described in the form of a brief report, to be turned in no later than 30 Nov. 2009. The codes should be emailed as an attachment.

1. Plot the profiles as a function of $(y/x)\sqrt{Re_x}$, as in Anderson, HHTG, 2e, Fig. 6.7.
2. Plot the flat-plate skin-friction coefficients, as in Anderson, Fig. 6.11.
3. Plot the flat-plate Stanton numbers, as in Anderson Fig. 6.12.
4. Compare the exact recovery factors to the simple Blasius-based theory, as in Anderson Fig. 6.13.
5. Adapt the code to solve for stagnation-point flow, as in Anderson 2e section 6.5.2.