

## AA543 - Homework #5

(due by 11pm PT on 3/16/2016; NOTE, on this assignment, late homeworks will not be accepted.)

### Problem:

Solve numerically the 2D Euler equations for the transonic flow over a NACA 0012 airfoil using the Jameson scheme (Jameson *et al.*, AIAA 1981).

Use the following conditions in your computations:

- angle of attack  $\alpha = 0$  deg;
- free-stream Mach number  $M_\infty = 0.85$ .

In summary do the following:

1. Write a computer program (and on paper the numerical algorithm) to solve the 2D Euler equations using Jameson scheme.

1. Read the computational grid coordinates generated in HW#3
  2. Prescribe the ICs
  3. Impose the BCs
  4. Solve the 2D Euler equations using Jameson scheme
  5. Run the code until reaching the steady state, i.e. the residual is smaller than a prescribed small tolerance
2. Plot the steady-state numerical solution with 2D color contours around the airfoils of velocity magnitude, pressure, Mach number, total enthalpy, and entropy, and the pressure coefficient

$$C_p = \frac{p - p_\infty}{\frac{1}{2}\rho_\infty U_\infty^2} \quad (1)$$

along the airfoil surface (6 figures total).

3. Discuss the results.

### Bonus points:

1. By looking at the numerical solution obtained above and identifying the shock-wave location, change the mesh resolution and/or the clustering properties of the computational grid to improve the solution. Plot the 2D contours of entropy and Mach number, and profile of  $C_p$  for the numerical solutions obtained using different grids.
2. Change the angle of attack to  $\alpha = 2$  deg and discuss the solution in comparison with that of  $\alpha = 0$  deg.

Notes:

- You are allowed to work in teams of two. If on a team, turn in one report with both names.
- Write on paper the algorithm that you have implemented in your computer code (handwriting or word processor).

- Include your computer codes as Appendices to your HW report.
- Hint for learning how to write technical report: present readable plots including labels, figure numbers and captions, do not place more than 2 plots in the same page, and use page space wisely.