Computer Project 1: Explicit Incompressible Euler Solver
Handed out 13th September; Due by 26th September

Write a computer program to solve the incompressible Euler equations using explicit, finite-volume techniques. You are required to test your code on flow past a bump geometry which will be provided to you. Consider the following free-stream conditions:

$$p = 1 \text{ atm}; u_\infty = 20 \text{ m/s}; v_\infty = 0 \text{ m/s}$$

You are supposed to use the artificial compressibility approach to time-march your solution and attain a steady-state solution. You can use a first order explicit time integration scheme to advance your solution. You can choose $\beta = 20$ m/s for your computations.

- Your code should construct the flux at the interfaces using an advection based upwinding scheme (discussed in class).
- You would need to add artificial dissipation (pressure based) to your mass flux of the form $\alpha\frac{\triangle p}{2\lambda_{max}}$ where $\triangle p$ can be chosen as $p_i - p_{i+1}$ (for flux at $i+\frac{1}{2}$ face) and λ_{max} is the maximum wave speed normal to the face. Compute your solution for $\alpha = 0.5$ and $\alpha = 1.0$. The mass flux at the $i+\frac{1}{2}$ face is thus given by:

$$\dot{m}|^{+}_{i+\frac{1}{2}} = \left(\rho U|^{+}_{i} + \alpha\frac{p_i - p_{i+1}}{2\lambda_{max}}\right) A_{i+\frac{1}{2}}$$
$$\dot{m}|^{-}_{i+\frac{1}{2}} = \left(\rho U|^{-}_{i+1} + \alpha\frac{p_i - p_{i+1}}{2\lambda_{max}}\right) A_{i+\frac{1}{2}}$$
$$\dot{m}|_{i+\frac{1}{2}} = \dot{m}|^{+}_{i+\frac{1}{2}} + \dot{m}|^{-}_{i+\frac{1}{2}}$$

  where,

$$U|_i = \vec{v}_i \cdot \hat{n}_{i+\frac{1}{2}}$$
$$U|_{i+1} = \vec{v}_{i+1} \cdot \hat{n}_{i+\frac{1}{2}}$$

  and $\hat{n}_{i+\frac{1}{2}}$ is the unit normal at face $i+\frac{1}{2}$.

- Your output should include contour plots (colour lines) of flow variables, velocity vector plots, convergence histories (log scale), line plots and anything else that helps in analysing the flow field. Please try to use data interpolated to grid points for plotting.

You need to present your report in a technical paper format. In your report

- Provide some description/explanation for any plot you present in the write up. You should not just post a figure without commenting on it.
- For the two different dissipation values compare the convergence histories and general flow features.
- Write your report in the format of a technical paper. At the end of your report include the code as an Appendix item. In your title page please write your names and roll numbers.
- Please submit a pdf copy of your report with the following naming convention: AS5330-Group-xx-Project-1.pdf where xx refers to your group number.
- **I would expect each group to write their own code. No sharing of code is acceptable between groups and absolutely no collaboration on the reports is permitted. This can result in getting a U grade in this course.**