Final: Incompressible, Laminar Flow over a Rectangular Cavity

Investigation:

Forty five years ago, Mehta and Lavan* published a paper on the numerical investigation of flow over a rectangular cavity at low Reynolds numbers [1]. This relatively simple geometry provides tremendous insight into the physics of flow separation, an important flow feature in many applications. You are asked to develop a numerical 2D planar numerical model of these flows. Limit the scope of your investigation to the incompressible, laminar flow case. Use as a base case that defined by a unit aspect ratio (AR=0.5) and a Reynolds number (Re) of 100. Also consider the following cases: Re=1 and 2000 for AR=0.5, and AR=2.0 and 5.0 for Re=100. Note that while the assumption of steady flow is reasonable for the lower Re values, that may not be the case for Re=2000. To the extent possible, compare your results to those discussed in the paper by Mehta and Lavan [1]. Pay particular attention to the predicted flow structure (streamline pattern, eddies) and velocity profiles. It is expected that your report will use the various concepts that have been covered in class to substantiate the your arguments and establish the validity of your results.

Report: Prepare a report (no more than 4 pages in ASME's two-colum article format, templates are available on-line) describing your work and including:

1. A short description of the problem
2. A description of your approach
3. A discussion of the results, including answers to the questions listed above. Provide all necessary relevant information.
4. Plots – Provide the plots necessary to demonstrate that you obtained numerical solutions of the problems as well as to substantiate your arguments and support your discussion and conclusion.
5. Conclusion.

The Report (single file, PDF format only) and your source code (`.py, .m, .f90, .cpp,` ... uploaded as a separate file together with non-standard libraries needed for compiling if relevant, please zip these files if there is more than one) are due on **December 19, 2014 at 11:55pm** and must be submitted electronically using the class SmartSite. There will be no extension.

IMPORTANT NOTE

This is a "take home" exam. You are expected to work alone and not to communicate with anyone about this assignment except the instructor.

References

[1] U. B. Mehta and Zalman Lavan. *Journal of Applied Mechanics*, 36(4):897–901, 12 1969.

*Click here to access Ref. [1] on the publisher's website