ASEN 3111 Computational Lab #2: Computation of Potential Flow

Lab Date: September 15, 2017
Due Date: September 22, 2017

Collaboration Policy:

Collaboration is permitted on the computational labs. You may discuss the means and methods for formulating and solving problems and even compare answers, but you are not free to copy someone else's work. *Copying material from any resource (including solutions manuals) and submitting it as one's own is considered plagiarism and is an Honor Code violation.*

Lab Reports Policy:

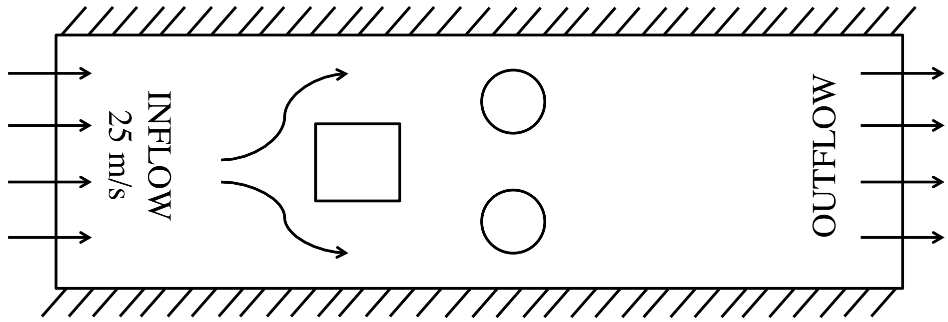
Computational lab reports must be written individually. If you have collaborated with others while writing your code, be sure to credit them in the Acknowledgements section. Computational lab reports should be submitted by 8:00 AM on the due date. Reports will not be accepted after the given due date.

Reflection Question:

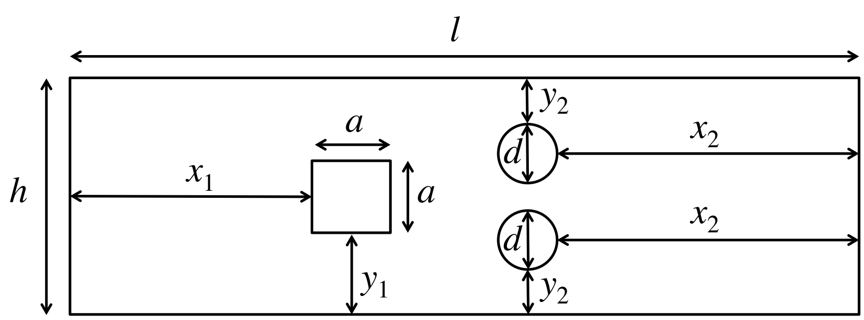
In this lab, there is one reflection question. Please answer this question in the Discussion portion of your lab report.

Problem Description:

Consider two-dimensional potential flow in a channel about a square cylinder and two circular cylinders as depicted in the figure below:



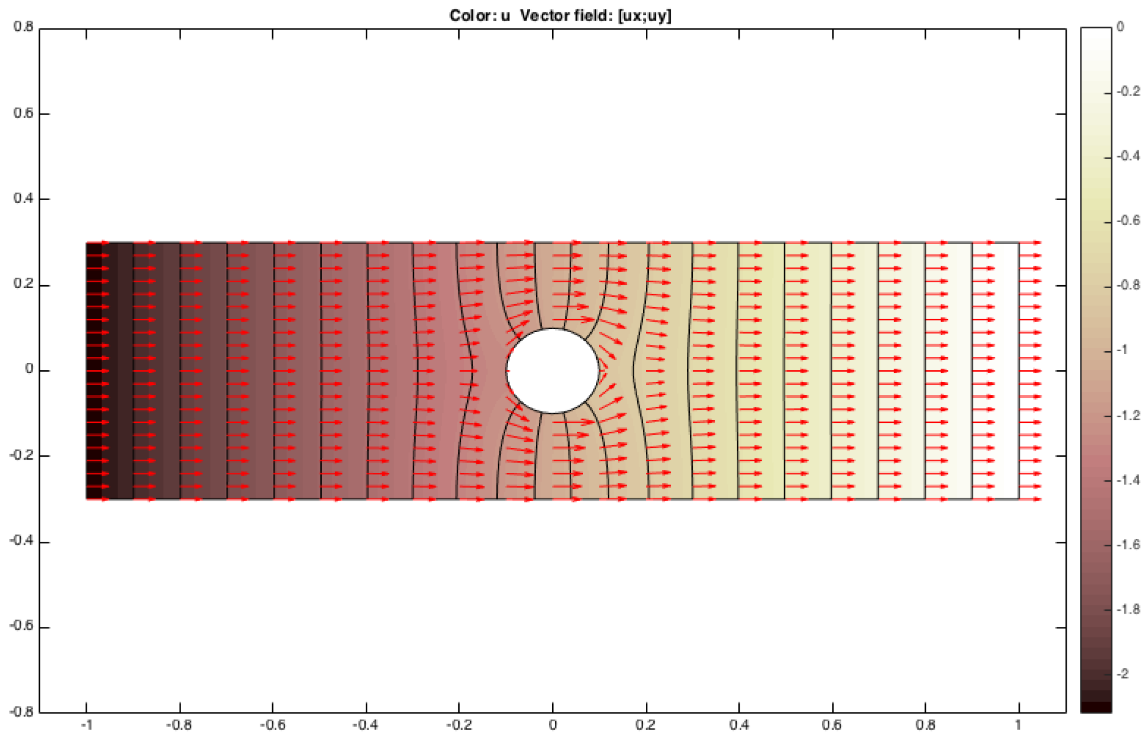
Geometric dimensions associated with the flow problem are depicted in the figure below:



$l = 20$ m	$x_1 = 6.5$ m
$h = 6$ m	$y_1 = 2$ m
$a = 2$ m	$x_2 = 7$ m
$d = 1.5$ m	$y_2 = 1$ m

For this flow problem, specify the appropriate boundary conditions and solve the resulting Laplace problem numerically using MATLAB's built-in PDE app. Remark on the selected choice of boundary conditions within the lab report. To run the PDE app, simply type `pdetool` at the MATLAB command line. A simple tutorial on the PDE app will be given during the lab session, and more information regarding the PDE app may be found within the online MathWorks documentation. In addition, information regarding the PDE app may be found within the lab document `Potential_Flow_Handout`, located on D2L.

Once the Laplace problem has been solved numerically, visualize the velocity potential, the equipotential lines, and the velocity vectors on the same plot. An example of such a plot in the context of flow over a cylinder is provided below for reference.



In a second figure, visualize the pressure field, the pressure contour lines, and the velocity vectors on the same plot assuming that the density of the fluid in the channel is 1 kg/m^3 and the pressure at the inlet is 1 MPa. *Hint:* To do so, you will need to use Bernoulli's equation.

Finally, in addition to solving the Laplace problem for a single mesh, conduct a study of the effect of mesh refinement on the resulting flow field accuracy. The assessment of accuracy may be *qualitative* in nature rather than *quantitative* (i.e., you may compare plots obtained using different meshes).

Reflection: Using your numerical results, predict the total drag due to pressure about the square cylinder, the two circular cylinders, and the top and bottom walls. You do not need to perform any computations to make such a prediction. Instead, you may simply observe the plots generated in this assignment to draw an inference. Is your prediction physically reasonable? If not, describe why the above simulation environment is unable to accurately predict drag.

Remark: Please submit the PDE app model along with the lab report. To save the model, simply click `File - Save As` within the PDE app.