AE 625 -Particle Methods in Fluid Flow Simulation
Assignment 5: Report

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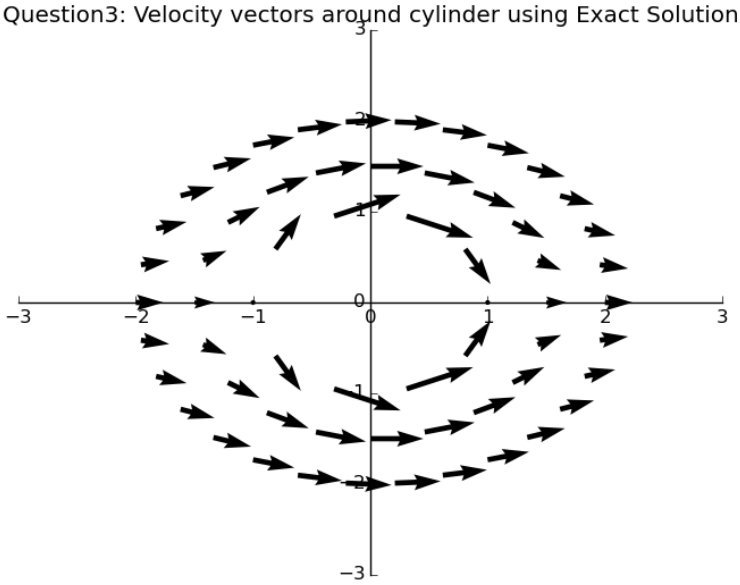

Figure 1: Velocity Distribution around Cylinder from Exact Solution

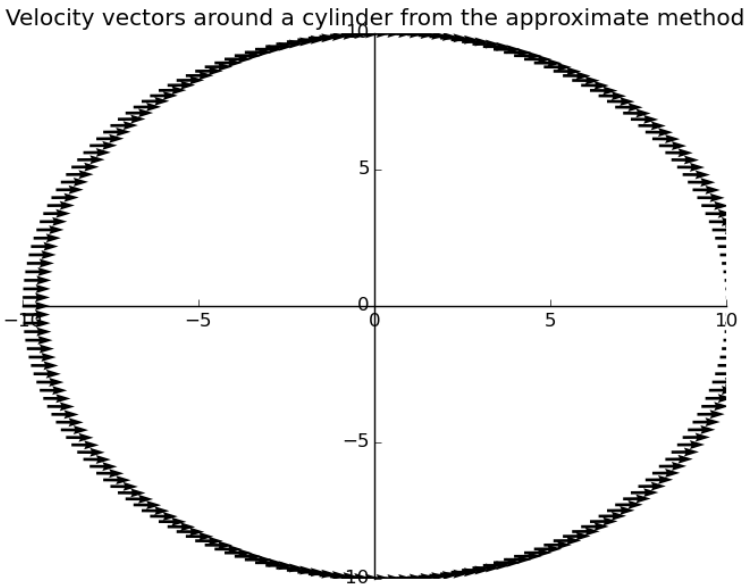

Figure 2: Velocity Distribution around Cylinder from Panel Method Approximation

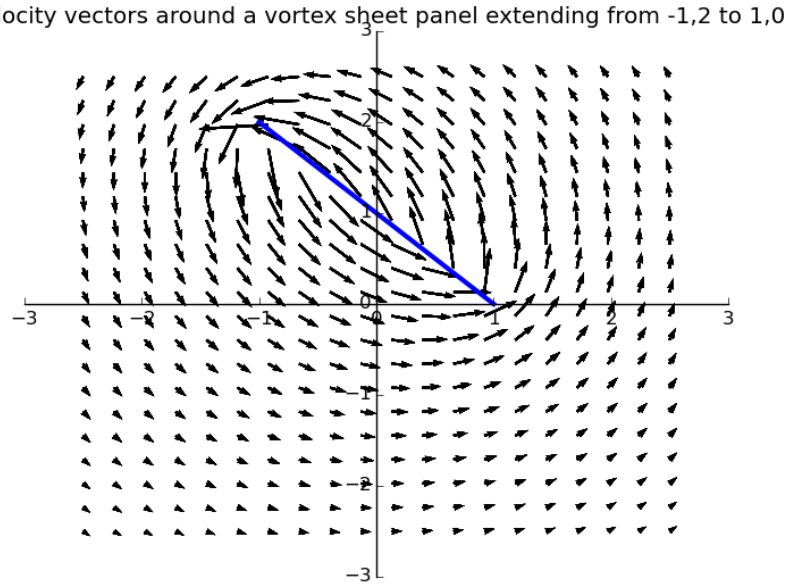

Figure 3: Velocity Distribution around Panel inclined at 45 degrees and length = 2.0

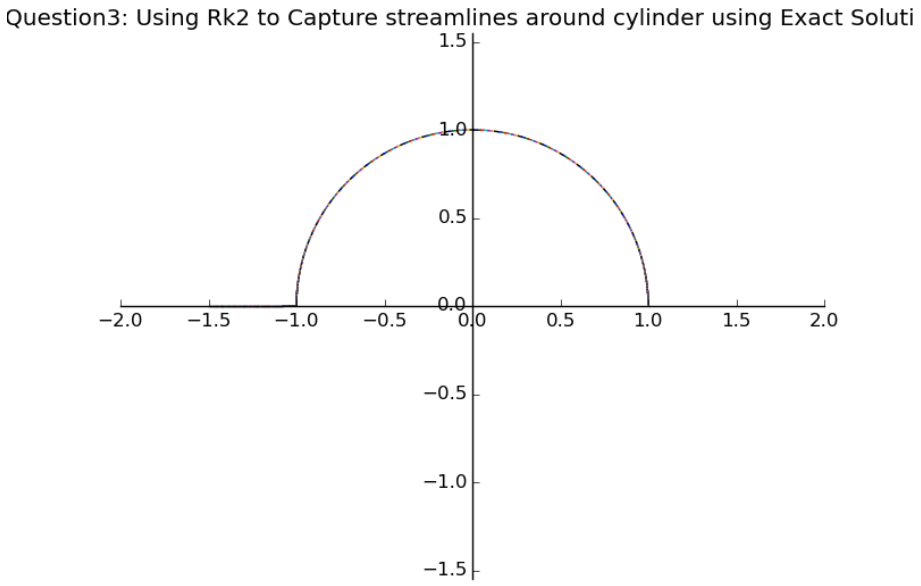

Figure 4: Streamline around Cylinder With Free stream velocity = 1.0

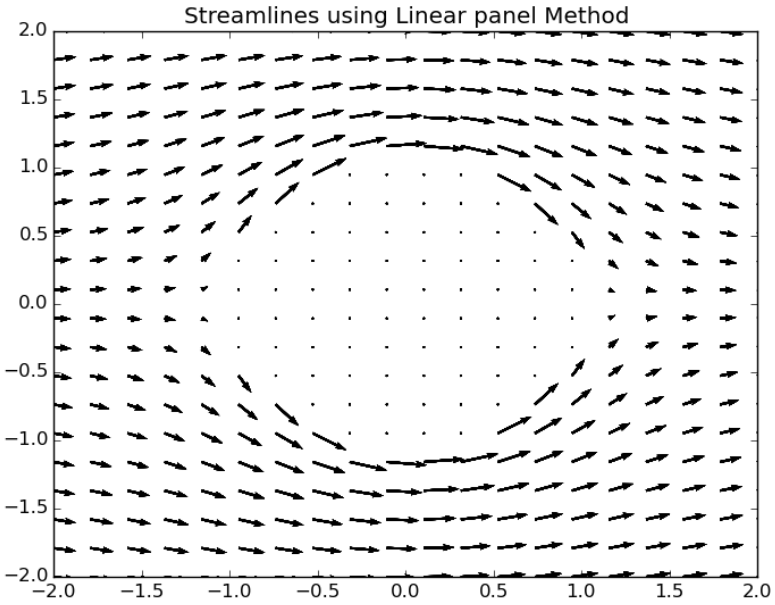

Figure 5: Streamlines around Cylinder using linear panel method with Free stream velocity = 1.0

Question1

Consider a ring of points (say 200) at a radius R outside the cylinder (i.e. R¿1), vary R and plot the average error in the value of the velocity magnitued with the exact solution.

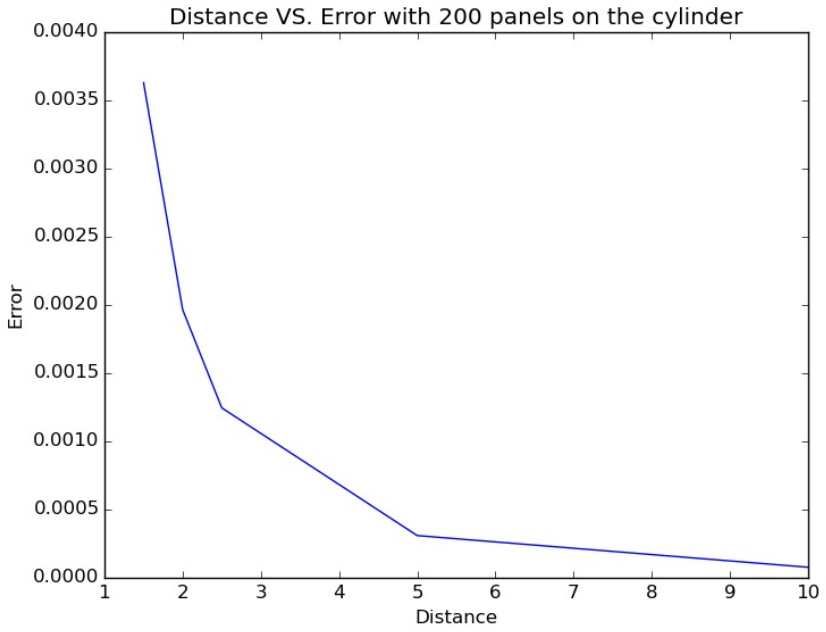

Figure 6: Error(relative average) Vs. Distance assuming 200 panels on the cylinder

Question 2

Do part 1 for different number of panels (say 20 to 100 or more).
Plots obtained for Panels 20,100,500:

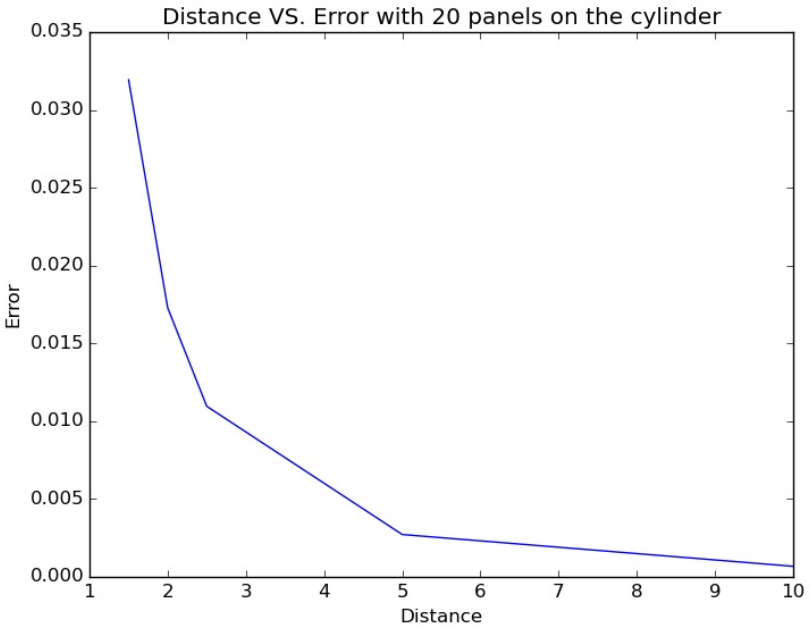

Figure 7: Error(relative average) Vs. Distance assuming 20 panels on the cylinder

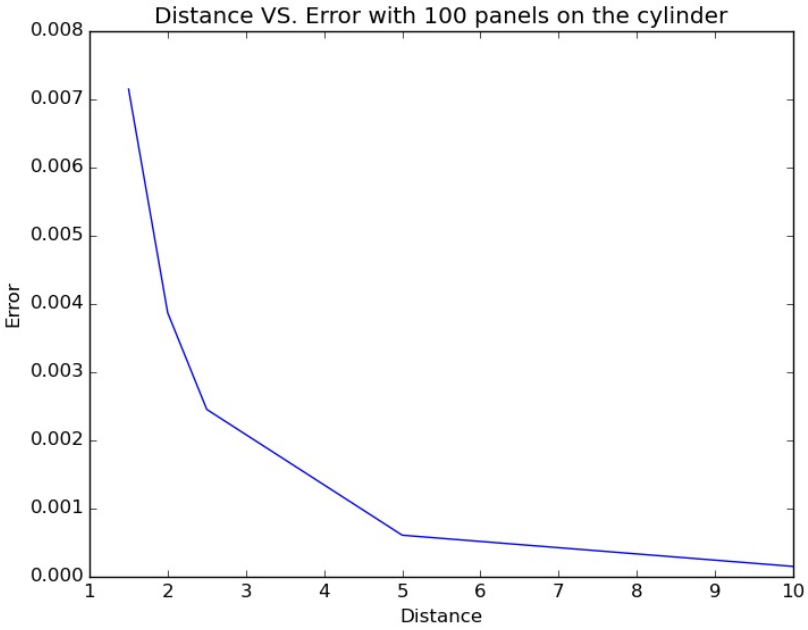

Figure 8: Error(relative average) Vs. Distance assuming 100 panels on the cylinder

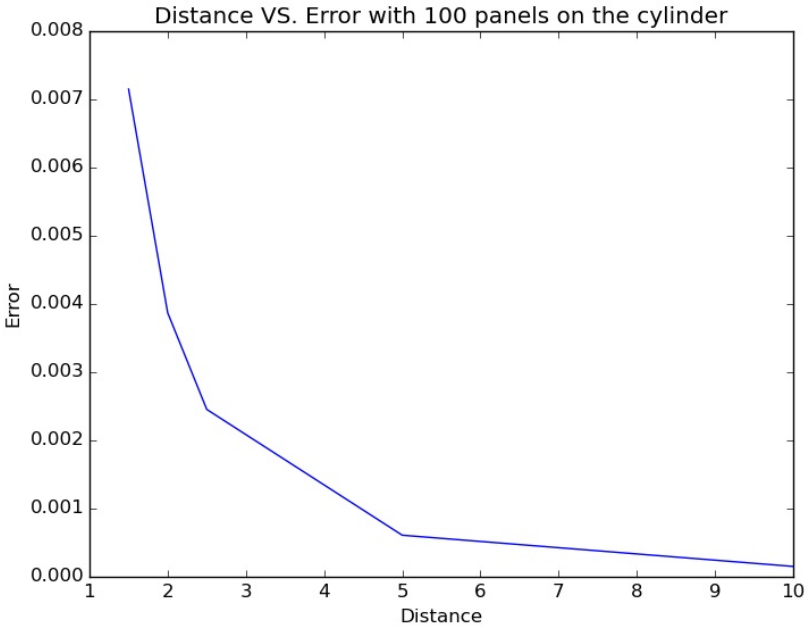

Figure 9: Error(relative average) Vs. Distance assuming 500 panels on the cylinder

Thus, it is clear that error decreases as the distance from the cylinder increases, since the effect of boundary condition decreases. Error also decreses as the number of panels increases.

Question 3

Consider the path of a single point vortex of strength 2 pi placed at a radius 1.5 units from the center of the cylinder of unit radius (without any free-stream). Integrate its path using the RK2 scheme. Also solve the same using the method of images and ensure that the paths are similar. Calculate the error.

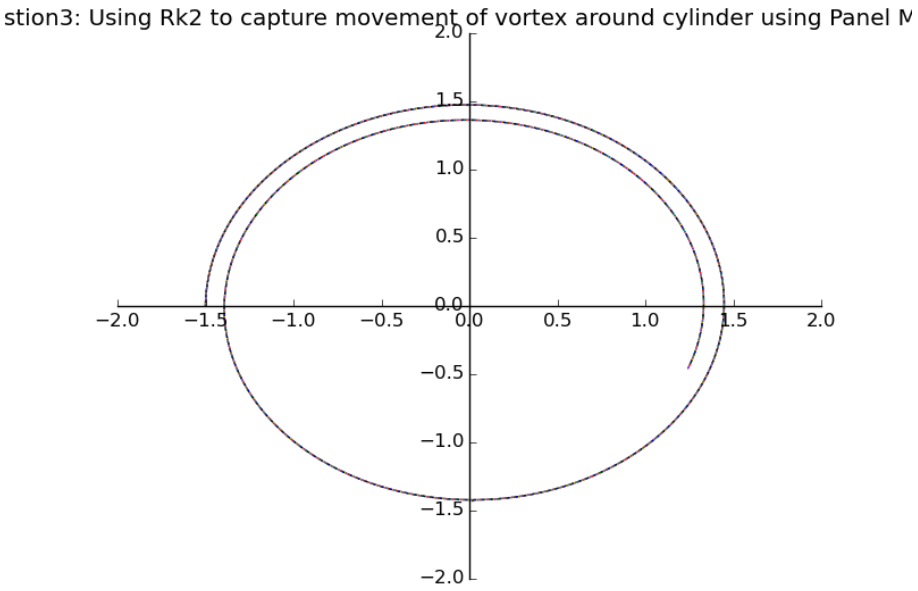

Figure 10: Path Traced by Vortex kept at (0,1.5) using Panel approximation solution in 5 sec

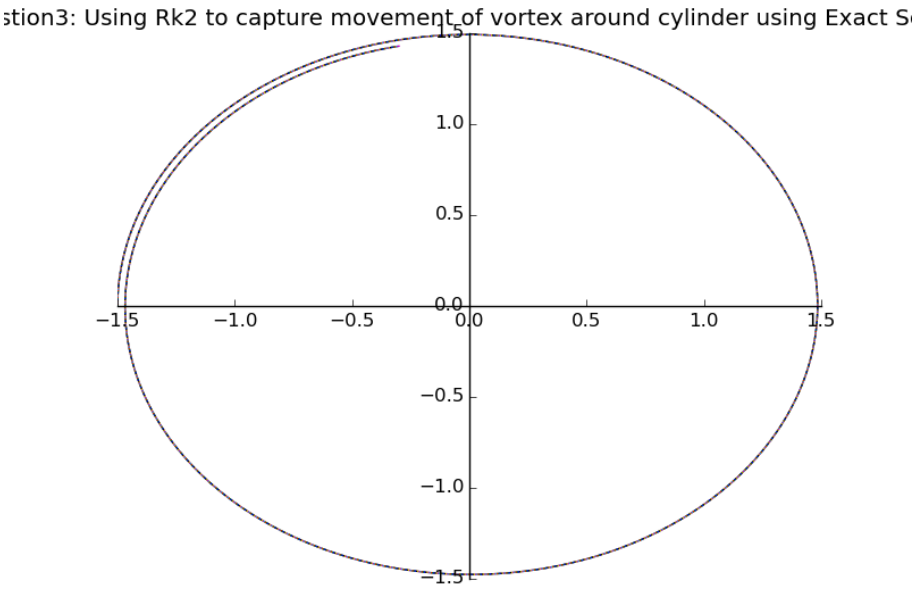

Figure 11: Path Traced by Vortex kept at (0,1.5) using exact solution in 5 sec

Absolute Error in the final position the vortex after 5 sec = 0.292746493 Error Increases as the time increases.