Computer Project: Assessment of Cylinders in Cross Flows

Name:

Date:

Scoring:

|  |  |  |  |
| --- | --- | --- | --- |
| ***Section*** | **Component** | **Score** | **Out of** |
| ***Abstract*** |  |  |  |
|  | Writing |  | 5 |
| ***Analysis*** |  |  |  |
|  | Part a |  | 5 |
|  | Part b |  | 5 |
|  | Part c |  | 10 |
|  | Part d (write up) |  | 5 |
|  | Part d (code) |  | 10 |
| ***Results*** |  |  |  |
|  | Part a |  | 10 |
|  | Part b (write up) |  | 5 |
|  | Part b (coding) |  | 10 |
|  | Part c (write up) |  | 5 |
|  | Part c (coding) |  | 10 |
|  | Part d (write up) |  | 5 |
|  | Part d (coding) |  | 10 |
| ***Summary*** |  |  |  |
|  | Writing |  | 5 |
|  |  |  |  |
| ***Total*** |  |  | **100** |

# Abstract/Introduction

1 paragraph summary of what you did and what the results were.

# Analysis

Report the following in this section in a written form:

1. Determine an equation for the stream function and velocity potential function (report the original equations and discuss how you get there).
2. Determine the value of the stream function defining the body (report the original equations and discuss how you get there).
3. Determine the stagnation point as a function of K (report the original equations and discuss how you get there).
4. Plot contour plots of the stream function and velocity-potential function for values of K/(UR)=0.0, 1.0, 2.0, and 3.0 (check against Fig. 8.14 in book)
   1. Discuss results, i.e., what does each of these results mean and what are the main differences.
   2. Be sure to reference code in Appendix A.
   3. Discuss when this is valid.
5. K/(UR)=0.0
6. K/(UR)=1.0
7. K/(UR)=2.0
8. K/(UR)=3.0

Figure 1: Contour plots of the stream function and velocity-potential function

# Results

The goal of the results is to evaluate the previous analyses in terms of flow variables and extend it to viscous flow. For parts a-d, perform and report the assessments. Be sure to comment on what the results mean.

1. Discuss the number of points *N* on the surface used. Why did you choose that number versus a smaller or larger number for N?
2. for K/(Ua)=0 and 1.0, plot:
   1. Velocity magnitude on the surface, , as a function of x/R.
   2. Pressure on surface as a function of x/R.
3. for K/(Ua)=0 and 1.0, provide table of
   1. Drag
   2. Lift
4. Viscous Estimation:
   1. Estimate the separation location on the upper and lower surfaces (for K/(Ua)=0, 1.0). We will estimate this as the first point where pressure is decreasing on the surface, i.e., dP/ds>0.
   2. Recalculate the drag coefficient (for K/(Ua)=0). This time assume that pressure aft of the separation point remains unchanged from the point at separation.
   3. How does this model scale with Re? How does the result compare to data?
5. Velocity magnitude on the surface, , as a function of x/R.
6. Pressure on surface as a function of x/R.

Figure 2: Contour plots of the stream function and velocity-potential function

Table 1: Table of inviscid forces

|  |  |  |
| --- | --- | --- |
| **K/(Ua)** | **Lift Coefficient** | **Drag Coefficient** |
| 0.0 |  |  |
| 1.0 |  |  |

Table 2: Table of separation angles

|  |  |  |
| --- | --- | --- |
| **K/(Ua)** | **Upper surface separation location** | **Lower Surface Separation location** |
| 0.0 |  |  |
| 1.0 |  |  |

Table 3: Table of Viscous Drag force

|  |  |  |
| --- | --- | --- |
| **K/(Ua)** | **Predicted Drag Coefficient** | **High-Re Drag Coefficient** |
| 0.0 |  | 1.2 (as given in Table 7.2) |

# Summary

Summarize what you did, what you found, and what you think can be improved.

# Appendix 1: Copy of code plotting potential flow solutions.

Paste in code used for plotting potential flow (sample for a single value of K)

# Appendix 2: Copy of code calculating the surface velocity, pressure, and lift and drag coefficients

Paste in code used for plotting potential flow (sample for a single value of K)

# Appendix 3: Copy of code calculating drag with separation

Paste in code used for plotting potential flow (sample for a single value of K)