MAE560/460 Applied CFD, Fall 2022, Project 3 discussion

Task 1-4
See reference solutions for detail.

Task 1
Qualitatively, the behavior of the numerical solutions of the three cases is consistent with that shown in Video 3 in Lecture 20. The case with a vertically elongated ellipse has the highest amplitude and longest period. The one with a horizontally elongated ellipse has the smallest amplitude and shortest period.

Task 2
For this task, the 500k limit of number of nodes does not allow us to truly achieve grid convergence. As noted in class, the spirit of the exercise is to "do our best" within the constraint. Different choices of mesh do produce somewhat different values of lift and grad, particularly for the two cases with θ = 25° and 50°. Qualitatively, it is robust that lift force increases from θ = 0 to 25°, then drops back when θ reaches 50°. (This is when "stalling" occurs.) In contrast, drag force increases monotonically from θ = 0 to 50°.

Task 3
Similar to Task 2, we accept a range of values for the drag force and its two sub-components. It is however robust that (i) Run 2 has a higher total drag force and a higher value of *pressure component* of drag force, while (ii) Run 1 has a higher value of the *viscous component* of drag force. Also, for both runs, the pressure component is much larger than the viscous component, which is anticipated since *Re* >> 1 for the system. [Note: The *Reports* → *Forces* function in Fluent produces both drag force and drag coefficient. It appears that some students mistakenly reported drag coefficient, instead drag force, for the viscous component. The difference between drag force and coefficient was discussed in Lecture 23.]

Task 4
A satisfactory solution for this task should (i) use an obstacle with cross-sectional areas in both x- and y-direction comparable to their counterparts in the original "circle" in Task 1a, and (ii) demonstrate that the asymmetric obstacle generates a higher value of lift force compared to Task 1a.