Lecture F21 Mud: Airfoils – Overview
(23 respondents)

1. **Do the negative pressures that act in a forward direction provide thrust?**
   (1 student)
   Actually, yes. On some parts of the airfoil the pressures push or pull back (drag), an on some they pull or push forward (thrust). For an inviscid flow around an airfoil of any shape, the fore and aft forces cancel exactly, giving a net zero drag. In a real airfoil there is always a net aft drag force. ("Fore" and "aft" here is along the $\vec{V}_\infty$ direction, not along the chord line).

2. **What is an airfoil's "polar"?** (3 students)
   It's a plot of c_ℓ versus c_d, with α being a dummy parameter running along the curve. I'm not sure of the orgin of the word "polar" in this context.

3. **What do we interpret from the C_L vs C_D graph?** (1 student)
   I think I gave a number of examples in recitation and in the following lecture. You will probably get more practice with them next term.

4. **Why do the NACA 0015 and 4415 have the same lift?** (1 student)
   For a given α, the 4415 has more lift. I adjusted the 4415's α so its c_ℓ was the same as in the 0015 case.

   If two airplanes have the two different airfoils, but are otherwise identical and are flying at the same speed, then they will have the same C_L, but different α. So the same-C_L comparison is more relevant.

5. **Are there standard equations defining the airfoil?** (1 student)
   The NACA airfoils are defined with explicit formulas which have things like the camber and thickness as parameters. More modern airfoils do not have formulas, but rather are defined by a list of roughly 100 x, y points going around the airfoil perimeter. The airfoil shape is interpolated between the points if necessary.

6. **What is the significance of the points on the airfoil where $C_p = 0$?** (1 student)
   Nothing in particular. The C_p is positive at the nose, and negative along the sides. So it clearly has to go through zero somewhere in between.

7. **Why does the c_ℓ range and the V range shrink as the camber increases?** (5 students)
   Both $c_{\ell_{\min}}$ and $c_{\ell_{\max}}$ get shifted up as camber increases. So we can roughly write

   $$c_{\ell_{\min}} = (c_{\ell_{\min}})_0 + K \times \text{camber} \qquad , \qquad c_{\ell_{\max}} = (c_{\ell_{\max}})_0 + K \times \text{camber}$$

   with K some constant. The ratio

   $$\frac{c_{\ell_{\max}}}{c_{\ell_{\min}}} = \frac{(c_{\ell_{\max}})_0 + K \times \text{camber}}{(c_{\ell_{\min}})_0 + K \times \text{camber}}$$

   is large if camber $= 0$, but will tend to 1 as camber increases.

8. **Does the presence of the ground change things?** (1 student)
   Yes, but for the $c_\ell(\alpha)$ curve to change significantly, the airfoil has to be very close to the ground – roughly less than the chord length. This is unlikely in most cases. The overall <u>wing</u> is more affected by the ground. We will look at wings next term.

9. **No mud** (8 students)