Lecture F2 Mud: Thin Airfoil Theory – Symmetric Airfoil
(respondents)

1. How thin does the airfoil have to be for this to apply? (1 student)
   It depends what you’re after. If you just want overall $c_\ell$ and $c_m$, TAT is remarkably
   accurate even for not-so-thin airfoils. For accurate detailed surface $C_p(x)$ distributions,
   the airfoil must be quite thin. In the PS’s you will investigate this.

2. What do you mean by “real flow and vortex-sheet model are equivalent”? (1 student)
   They are equivalent when the model duplicates the velocity field $\vec{V}(x,z)$ of the real
   flow.

3. What’s $\xi$, $d\xi \ldots$? Same as vorticity? What’s $x - \xi$? (5 students)
   $\xi$ is a location along the $x$-axis where the $d\xi$-piece of the vortex sheet is. The sheet
   strength at that location is $\gamma(\xi)$, and the circulation around the piece is $d\Gamma = \gamma d\xi$.
   $x$ is a different location, where the velocity $w(x)$ is being computed. The difference
   $x - \xi$ is just the distance between the sheet-piece location and the velocity-calculation
   location. Note: Here, $\xi$ is not vorticity (there’s not enough Greek letters to go around).

4. What’s $\theta_s$? (2 students)
   The $\theta$-coordinate location corresponding to $x$. The other location corresponding to $\xi$
   is denoted just by $\theta$, without any subscript.

5. Why does the vortex sheet only give a z-component on the airfoil? (1 student)
   By geometry. A vortex’s velocity is always in the tangential direction. So each piece
   of the sheet has velocities along the sheet which point either straight up or straight
   down. Nothing horizontal.

6. How did you get the integral formula for $w(x)$? (1 student)
   From superposition of all the infinitesimal vortices of strength $\gamma d\xi$ which constitute
   the sheet. See the vortex-sheet stuff from last term.

7. Is $c_\ell$ always $2\pi\alpha$ for any airfoil? (1 student)
   True for any thin symmetric airfoil. You will examine not-so-thin airfoils in the first
   PS.

8. Lower vortex sheet on 1st page figure looks like it increases the velocity. (1 student)
   The sheet vortex strength directions are drawn as they typically appear. Upper surface
   is typically clockwise ($\gamma_u > 0$), lower surface is counterclockwise ($\gamma_\ell < 0$). For upward
   lift, $\gamma_u$ is greater in magnitude, so $\gamma = \gamma_u + \gamma_\ell$ ends up positive.

9. What’s the Kutta condition again? (1 student)
   The fact that the fluid flows smoothly off the trailing edge, without curling around.
   To represent this real situation, the vortex-sheet model must have zero sheet strength
   at the trailing edge point: $\gamma(x = c) = 0$, or $\gamma(\theta = \pi) = 0$.

10. Equation for $\vec{V} = \vec{V}_\infty + w\hat{k}$ was not the same as in notes? (1 student)
    I think I wrote it wrong on the board. It’s correct in the notes.
11. **Can you do some examples?** (2 students)  
In the current PS, the next PS, and maybe in recitations.

12. **Math was too confusing.** (9 students)  
Try to keep the overall concepts clear. I’ll have an overall concept summary in F3 lecture. Hopefully that will help.

13. **Why are the axes labeled \( \gamma/2\alpha V_\infty \) and \( x/c \)?** (1 student)  
It’s the most universal way to plot the result. Specifically, it’s a plot of the simple function \((1 + \cos \theta)/\sin \theta\) versus \(x/c(\theta)\), with \(\theta\) a free parameter.

14. **Is there a good way to review important previous material?** (1 student)  
I don’t know a better way than to dig back and review it. I’ll try to make specific suggestions when appropriate.

15. **Explain the PRS. What are the arrows?** (1 student)  
Tough to do here without a board. Maybe in recitation.

16. **How do we use Xfoil in our home PC’s? How do we use it in the Pset?** (1 student)  
You can download xfoil.exe from http://raphael.mit.edu/xfoil. I suggest following the sample session commands. It becomes fairly natural with a bit of practice.

17. **No mud** (12 students)