

## 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  $\xi$ ,  $d\xi$  ...? 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  $\theta_o$ ?** (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 student)  
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)