Transition and Separation

Lecture 11

ME EN 412
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Outline

Transition

https://www.youtube.com/embed/XOL12KeDiOg

How can we predict transition?

Flat plate:

$$Re_x = 2 \times 10^5 \text{ - } 3 \times 10^6$$

Michel's criteria (for airfoils in incompressible flow):

$$Re_\theta > 1.174 \left(1 + \frac{22,400}{Re_x} Re_x^{0.46}\right)$$

Linear Stability Theory

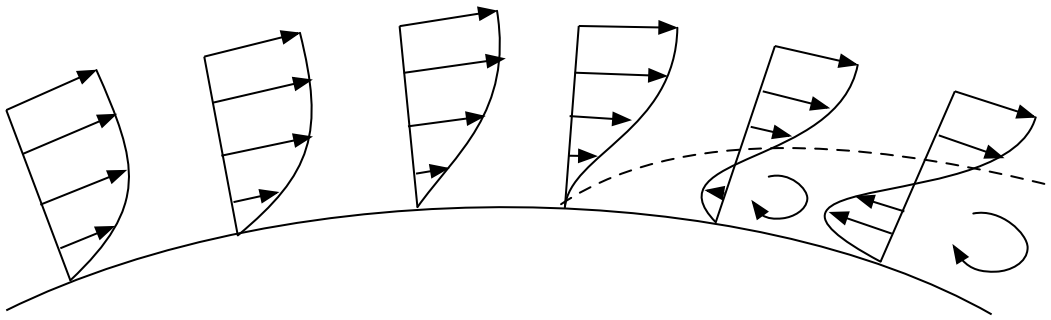
$$e^n$$

3D transition

What factors can we change to affect transition?

Separation

Favorable and Adverse Pressure Gradients



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Tennis Balls

If you hit a tennis ball with underspin it experiences a lifting force and thus a flatter trajectory. Why?

What if I told you that a smoother ball would behave in the opposite manner (an underspin would cause a downward force)?

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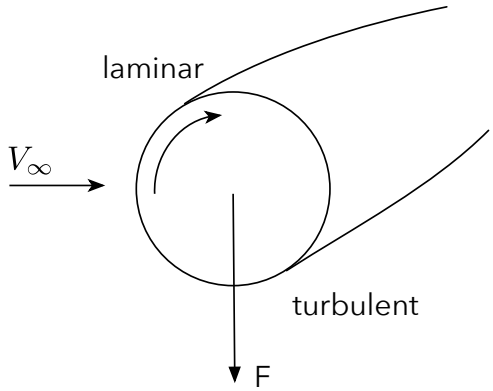
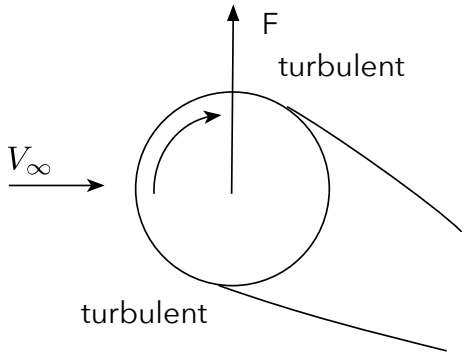
Photo by T. J. Mueller from "An Album of Fluid Motion"



$Re < Re_{crit}$



$Re > Re_{crit}$