MECH 481/581 – Exercise 1: Aerodynamic Toolbox

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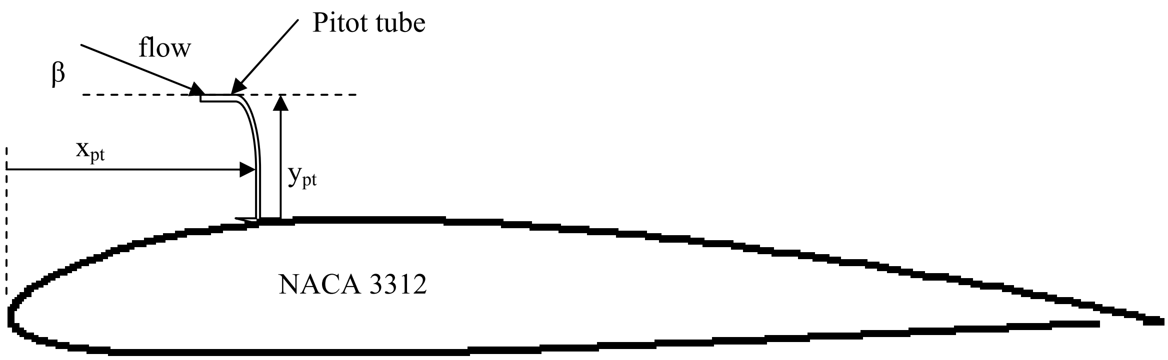
1 Problem

Imagine you are charged with the task of mounting a pitot tube on the upper surface of a two dimensional wing section. The wing section is NACA 3312.[1] The pitot tube[2] is made from stainless steel and has an outer diameter of 6mm and an inner diameter of 4mm. Assuming the pitot tube is accurate for incident flow angles $\beta = \pm 4°$, design a probe for this application by determining the height (y_{pt}) and the chord-wise position (x_{pt}).



For this case, assume that this portion of the wing does not generate lift and that the angle of attack does not change. Assume irrotational, incompressible flow.

2 Format

Work in your teams on this problem. Use the tools that we have developed/discussed in class including potential flow and force coefficients. Once you have completed your analysis, prepare a summary that supports your position and shows that you have considered all aspects of this problem. Your summary must be limited to a single side of a sheet of 8.5"x11" paper and all text must be 16pt font or larger. Other teams will view your summary and you will lose marks for unsubstantiated claims or if you failed to analyze important elements. Concentrate on outlining what you were trying to determine/calculate, how you did it, and what you found – do not include calculation details unless you feel they are essential to understanding your approach.

Have your one-page summary ready for class on Wednesday, September 28, with your team number clearly marked.

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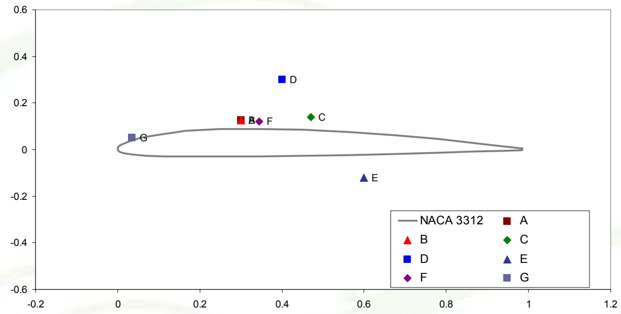
[1] We will discuss airfoil sections later but for now you can find the x-y coordinates for the NACA 3312 from many online sources including http://www.pagendarm.de/trapp/programming/java/profiles/NACA4.html

[2] For those who do not know what a pitot tube is, it basically just measures total (stagnation) pressure. Please see your text or http://www.efunda.com/designstandards/sensors/pitot_tubes/pitot_tubes_intro.cfm for more information. (Note that the web reference also describes a pitot-static tube which measures dynamic pressure; a pitot tube does not have the static pressure holes and therefore measures total pressure.)



"In short, to solve this problem fully, students had to:

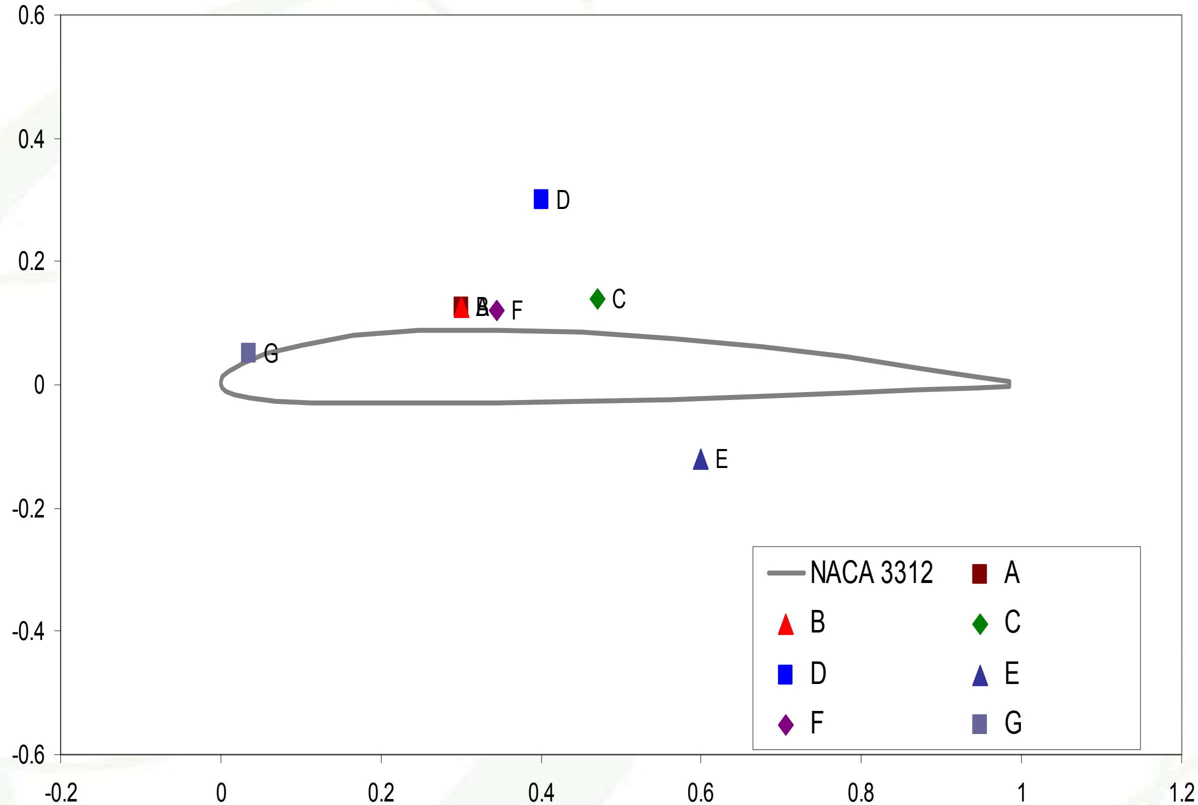
- determine the velocity field around the wing (this required quite involved numerical analysis in the topic of potential flow)

- identify a region in the flow field with flow speed and direction that met requirements stated or implied in the problem

- use the potential flow results to compute the drag force on the pitot tube to ensure stiffness and strength were sufficient

- ensure the pitot tube was sufficiently far away from the boundary layer (viscous flow effect region) on the wing

This exercise tied together the three major course elements to that point (potential flow, boundary layers, and force coefficients) and introduced them to the next major element (airfoils)."



Reporting

- Numerical Position
- One page summary- principles and approach and not calculations (16 pt font or bigger)