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| **Name** | **Team Number** |
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AAE 251: Introduction to Aerospace Design

Assignment 2—Subsonic Wind Tunnels and

Space Environment

**Due Tuesday 29 January, 10:00 am on Blackboard**

**Instructions**

*Write or type your answers into the appropriate boxes. Make sure you submit a single PDF on Blackboard. Your homework will be a handy study guide.*

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| --- | --- | --- |
| Problem Number | Points Possible | Points Earned |
| Problem 1 | 8 |  |
| Problem 2 | 12 |  |
| Problem 3 | 10 |  |
| Problem 4 | 5 |  |
| Total | 35 |  |

**Problem 1:**

The Coefficient of Pressure is expressed as:

where is the local pressure, is the freestream pressure, and the denominator gives the free stream dynamic pressure. Suppose you own a low speed GA aircraft which measures airspeed using a pitot tube mounted at the leading edge of its wing. Find a reasonable maximum cruise speed for a typical GA aircraft and assume it is the same for your aircraft. Develop an expression to show how the pressure measured by the pitot tube varies with the aircraft’s airspeed at sea level conditions. Plot your result for the velocity range you found (0 < < ) using Matlab and paste your code and figure into your solution. Looking back at your solution and the expression given above, can you say what would be the at the leading edge of your aircraft? How does it vary with airspeed?

Answer:

Answer:

**Problem 2:**

You want to operate a low-speed subsonic wind tunnel so that the flow in the test section has a velocity of. You are given the following details about the wind tunnel:

* It is an arrangement of a nozzle and a constant area test section. The flow at the exit of the test section dumps out to the surrounding atmosphere, where atmospheric pressure is . A settling chamber or reservoir provides the inlet pressure to the nozzle.
* The contraction ratio of the nozzle is 10:1.

Assuming incompressible flow at standard sea-level density answer the following showing all the equations and steps required:

1. Sketch the wind tunnel with the appropriate pressures, areas, and velocities indicated. Label the different parts of the wind tunnel.
2. Calculate the pressure at the inlet of the nozzle.
3. By how much should you increase this inlet pressure to achieve in the test section of this wind tunnel?
4. Comment on the magnitude of this increase in pressure relative to the increase in test-section velocity.

Answer:

Answer:

**Problem 3:**

We are testing a 1:10 scale model of a wing in a subsonic tunnel. The actual wing spans 15 m and its average chord is 0.8 m. We are operating at sea level. We would like to estimate the drag at 160 km/hr, but our wind tunnel does not go that fast. We do have the following data available from a previous test.

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| --- | --- |
| **Speed (m/s)** | **Drag (N)** |
| 14.9 | 0.31 |
| 18.1 | 0.44 |
| 21.6 | 0.61 |
| 25.2 | 0.8 |
| 29.3 | 1.08 |
| 32 | 1.3 |
| 34.2 | 1.46 |
| 36.9 | 1.7 |
| 39 | 1.9 |

Drag, as we will see in class, can be expressed as follows:

where is the air density, is the free stream velocity, is the drag coefficient, and *S* is the area. You will need to do two things to estimate the drag at 160 km/hr: (1) establish whether you have a reasonable basis for extrapolation (i.e., do we have *dynamic similarity*?), and (2) if extrapolation is indeed reasonable, solve for the drag at this velocity. Your answer must include a properly formatted Matlab code and plot, showing the variation in experimentally obtained drag coefficient with Reynolds number.

Answer:

Answer:

**Problem 4:**

Complete your space hazards summary that you began in class on Tuesday and scan it in with your homework.