

Unified Quiz 5F

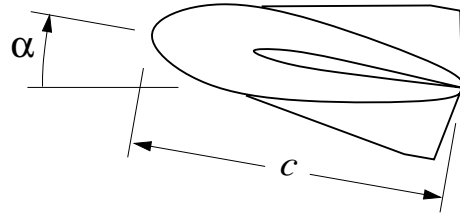
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- Put your name on each page of the exam.
- Read all questions carefully.
- Do all work for each problem on the two pages provided.
- Show intermediate results.
- Explain your work --- don't just write equations.
- Partial credit will be given, but only when the intermediate results and explanations are clear.
- Please be neat. It will be easier to identify correct or partially correct responses when the response is neat.
- Show appropriate units with your final answers.
- Calculators and a 2-sided sheet of paper are allowed
- Box your final answers.

Exam Scoring

| | |
|--------------|--|
| #1 (30 %) | |
| #2 (40%) | |
| #3 (30 %) | |
| Total | |

1. (30 %) A proposed winged blimp design flies at some angle of attack α , and uses both aerodynamic lift and aerostatic lift (buoyancy) to generate its total lift force L . The blimp has a given shape, but its length c is as yet undecided.



- a) In addition to the given α and c , list all the remaining physical parameters which significantly influence L .

$$g(L, \alpha, c, \dots) = 0$$

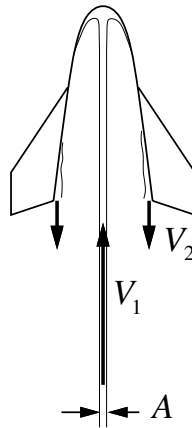
- b) Determine a set of nondimensional parameters (or Pi products) which describe this situation.
- c) Identify the nondimensional parameter which determines whether or not the aerodynamic force is significant compared to the buoyancy force.

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Problem #1 (continued)

2. (40 %) A toy rocket traveling at steady speed is propelled by a thin water jet with velocity V_1 and cross-sectional area A directed into the rocket's open bottom end. The water then pours out of the bottom at speed V_2 . These velocities are as seen by an observer moving alongside the rocket.



- Draw a suitable control volume for analyzing this flow situation. Determine the mass and momentum flows for your chosen control volume.
- What is the vertical thrust force imparted by the water? You may neglect the effect of gravity on the water velocities.

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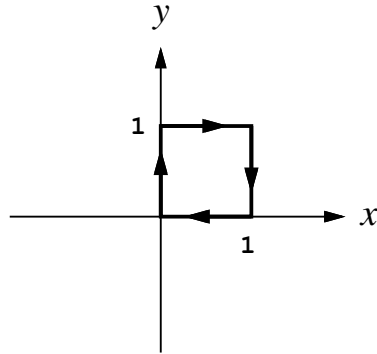
Name _____

Problem #2 (continued)

3. (30 %) A 2-D velocity field is given by

$$u(x, y) = x \quad , \quad v(x, y) = -y$$

- a) Determine and sketch the streamline pattern.
- b) Determine the circulation around the unit-square curve shown (Note: This is curve is not a streamline of this flow)



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Problem #3 (continued)