University of Waterloo, Mechanical Engineering Name:

ME 351 Winter 2024 Do not write your ID on this side. Write your ID on the back side.

Tutorial 6: Dimensional Analysis and Similarity

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Instructions:

Submit your handwritten solution at the end of the seminar. Answer the question(s) below in either the space provided, or a separate sheet of paper. If you use extra pages, be sure to attach all pages to your submission. If you have questions, ask the teaching assistants for help.

Rules:

You are encouraged to work with your classmates, but everyone must submit their own solution. You are not permitted to directly copy another student's answers – each student must be able to explain their own solution. You can use online resources, but you are not permitted to use any solution manuals or AI tools (e.g., ChatGPT).

Question 1

Form groups of 2-6 students. *You must work with at least one other student.* What is the name of your group's engineering company?

Question 2

Your group members are employed as engineers at the above company, which offers experimental fluid mechanics services. Your company has the following facilities:

a. A wind tunnel, with a 2 m × 2 m × 4 m test section, and a maximum wind speed of 150 m/s.

b. A water tunnel, with a 1 m × 1 m × 10 m test section, and a maximum water speed of 8 m/s.

c. A machine shop, which can fabricate models for testing.

The teaching assistants work for Lewis Nath Motor Company (LNMC). The engineers at LNMC have designed a new type of electric vehicle, and have contracted your company to **estimate the drag force on LNMC's body design at a typical operating speed.** The TA's are busy engineers, and they only have time for two meetings. You are encouraged to search online for any other information.

Complete the "Experimental Testing Plan" and "Experimental Analysis Report" for the electric vehicle project.

a. Discuss with your group about what information is needed from the TA's.

b. Send one person from your group as a representative to have a meeting with the TA's. Your representative may ask up to 5 questions.

c. Complete the "Experimental Testing Plan" on the backside.

d. Complete the "Experimental Analysis Report" on the backside. The experimental drag coefficient which was measured in your experiment has been filled in for you.

e. If needed, you can send your representative back to have a second meeting with the TA's.

Name:		Grade:
ID:		

_____ EXPERIMENTAL TESTING PLAN

(Your company name)

1 Test facility

The test will occur in the following facility: _____

The fluid velocity in the test section should be set at: _____ m/s.

Supporting calculations for fluid velocity:

2 Test geometry

Dimensions (bounding box) of the test specimen ($L \times W \times H$):_____ (m × m × m)

Supporting calculations for test geometry dimensions:

_____ EXPERIMENTAL ANALYSIS REPORT

(Your company name)

1 Experimental Results

Experimental drag coefficient: $C_D =$ 0.4 (defined as $C_D = \frac{F_D}{\frac{1}{2}\rho U^2 A}$, where A is the frontal area).

2 Analysis: Incompressibility

The experimental Mach number is _____, and the design Mach number is _____.

Is this a concern? _____. Why or why not? _____.

3 Analysis: Predicted Design Performance

At a speed of _____ km/h, we predict LNMC's body design will experience a drag force of _____ N.

Supporting calculations for drag force calculation: