ME107 Spring 2018: ROLL CAR

ASSIGNMENT:

Using Design of Experiments, design a model characterizing the roll car on the track in the basement of Hesse. At the end of the 6-week section, you should be able to plug in the required variables to your team's model and predict the behavior of the roll car.

The format for assignments was chosen because the Planning and Preliminary report will contribute towards the final report. The goal is that your group will get and respond to feedback and end up with a high quality final report.

OUTPUTS:

You should design your model to output the following values:

- Position along the track as a function of time
- Velocity as a function of time
- Acceleration as a function of time
- Number of complete passes car will undergo before failing to climb the center hill

Once the roll car fails to climb over the hill in the center of the track, you can consider that run over. I am only interested in the data up to that point.

DESIGN VARIABLES:

To construct your predictive model, you will need to study at least three values for each of the design variables. This way you can encapsulate the entire ranges of values for each parameter in the regressive model. Based on your understanding of how each parameter impacts the car's performance, you should use any extra time to gather more data for your model. The parameter with the biggest impact should probably get the most attention.

Your model should include the following variables:

- Drop Height
- Mass
- Radius of Gyration (typically defined as $r_g^2 = \frac{Moment\ of\ Inertia}{Mass}$)

Are there any other changes you can think of that might improve or diminish the performance of the roll car? Discuss those in your report.

FORMATTING RESTRICTIONS

- Each report will use the included template for MS Word. If your group prefers to use an alternative (e.g. Latex, Google Docs, or w/e) that is fine as long as you can produce

reports which look “almost the same” to the MS Word template and produce a file as a .doc, .docx or .pdf.
- Reports will be submitted electronically via Bcourses.
- Page length restrictions are included for each report format. The page counts will not be measured unless it is clear that there is a violation - try to be clear and concise.

SUBMISSION INSTRUCTIONS

Planning and Preliminary reports will be due **at the start of the lab section (Berkeley time, 10 minutes after the listed start)**. Final Reports will be due the **Sunday 11:59pm** after presentations and should be submitted electronically. Late reports will be penalized.

REQUIREMENTS: GENERAL FOR ALL REPORTS

- Abstract correctly summarizing the report and written in passive voice
- Writing style adequate (titles not at the end of pages, sections identified, proper spacing between text and images, etc.)
- All figures included in the report should be cited and discussed in the text
- References should be cited in the document
- Comments from previous version addressed, except in planning report

CONTENT: PLANNING REPORT

(max 3 pgs. Block text Excluding Title page, References, Appendices, figures)

1. Title Page
2. Abstract
3. Introduction
4. Experimental Description
    - Discussion of measurement devices and their resolution (don’t forget length measurements)
    - Roll Track sensor sampling rate
    - Method for converting measured voltage to relevant data
5. Experimental Plan – Testing matrix, Data Management
    - Discuss your plan to analyze at least a 2x2x2 matrix for your design variables (recommend adding at least one center point beyond the 2x2x2 “box”)
    - Each combination of variables needs to be tested at least 4-5 times to assure you have sufficient understanding of the error
    - Address what you believe to be the most significant variable (or variables) and how you plan to expand on your initial 2x2x2 matrix to better characterize that/those variable(s)
6. Division of labor & Planning
    - This isn’t binding, but is to show that you have thought about how to divide and conquer the work

- Who has done what? Who will be doing what in the next few weeks?
- If someone missed lab, how did they make up for their absence in contributing to the group work?

CONTENT: INTERMEDIATE REPORT

(max 8 pgs. Excluding Title page, References, Appendices, Figures, list of changes)

1. Title page
2. Abstract
3. Introduction
4. Experimental Description
   - In addition to what you had before, include a discussion of the test matrix now that you have executed it (completely or otherwise)
5. Preliminary Results
   - You may not be completely finished collecting data or analyzing it, but deliver as much as you can to show that you are on track to finish by the final report's deadline.
   - See Final Report content for charts and figures required by the end of the half-semester.
   - You will need to show some charts and figures in this report.
6. Discussion (preliminary)
   - Relevant equations need to be discussed in either this section or the introduction
   - Analysis physically interpreting your initial results
7. Error Analysis
   - Any figures in the results should have completed error analysis
8. List of changes addressing concerns from planning report
9. Division of Labor
   - Describe division of labor for this report and proposed division of labor up to the Final Report
   - This isn't binding, but is to show that you have thought about how to divide and conquer the work.

CONTENT: FINAL REPORT

(max 10 pgs. Excluding Title page, References, Appendices, Figures, list of changes)

1. Title page
2. Abstract
3. Introduction
4. Experimental Description
   - In addition to what you had before, include a discussion of the test matrix now that you have executed it completely
5. Results

- You should include figures displaying the effect of each input variable on the outputs. It is up to you to present your data as concisely as possible in a non-cluttered format.
    - Effect of Mass on Position, Velocity and Acceleration vs. Time.
    - Effect of Moment of Inertia on Position, Velocity and Acceleration vs. Time.
    - Effect of Drop Height on Position, Velocity and Acceleration vs. Time.
- Curves should include some comparison to the ideal/physics-based model (you'll discuss discrepancies in your analysis)
- Table of completed passes for your 27 configurations.
    - You should also show which variable affects how many passes the car will complete. What can you calculate to know how many passes the car will complete? What affects this?

6. Data Processing and Discussion
    - Discuss how you got your final results from the raw data.
    - Do your results make sense? Why/why not?
    - Discuss the size of your error. Is it reasonable? What might have caused the error?
    - Model (can be its own section as you see fit)
        - Prediction model for number of passes and position, velocity, and acceleration vs. time based on empirical data measured and interpolation.
        - Describe inputs, outputs, and mathematical model.
7. Conclusion
8. Describe division of labor throughout laboratory unit
9. Appendices
    - The following are MANDATORY, but you may include others in addition.
        - Error Analysis
        - Data (can be as a table or list of files (e.g. csv, dat, etc.) files submitted with report
        - Commented Computer Code (e.g. matlab files, python files, Jupyter Notebooks, etc.) Computer code used to plot the results does not need to be included

LAB PROGRAM (CYCLE 1):

Week 1	(45 min) Introduction to roll car track and description of expected outcomes (65 min) Getting to know the set up.
Week 2	(50 min) Statistical analysis review (10 min) Discussion of sampling rates (50 min) Data collection
Week 3	- *Planning report due at the beginning of lab* (30 min) Interpolation and model building review (80 min) Data Collection
Week 4	(110 min) Data Collection
Week 5	- *Intermediate report due at the beginning of lab*

	(110 min) Data Collection
Week 6	(30 min) Presentations (30 min) Verification of predictions (50 min) Finish remaining tests for final report to remove outliers
Week 7 (no lab)	- *Final report due*

LAB PROGRAM (CYCLE 2):

Week 1	(60 min) Introduction to roll car track and description of expected outcomes (50 min) Getting to know the set up.
Week 2	(20 min) Statistical analysis review (90 min) Data collection
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Week 3	- *Planning report due at the beginning of lab* (30 min) Regression and model building review (80 min) Data Collection
Week 4	(110 min) Data Collection
Week 5	- *Intermediate report due at the beginning of lab* (110 min) Data Collection
Week 6	(30 min) Presentations (30 min) Verification of predictions (50 min) Finish remaining tests for final report to remove outliers
Week 7 (no lab)	- *Final report due*