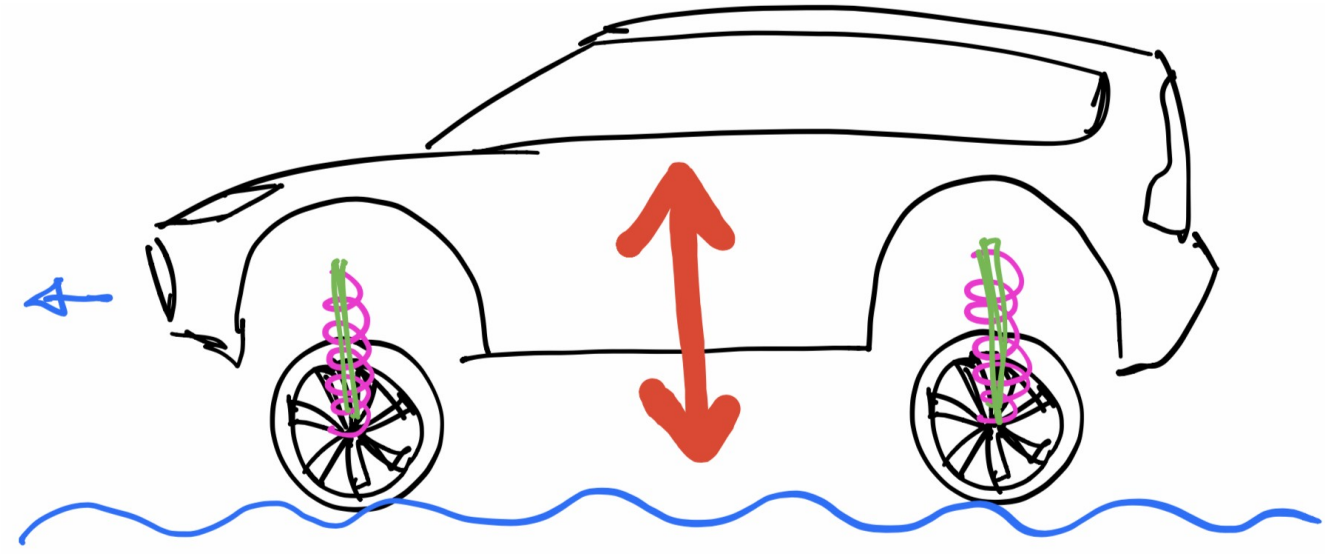
Project 5 [6 FP “Fluency Points”]

Base Motion: Tuning of Car Suspension Damping

Description:



You work for an automotive startup as an NVH (Noise, Vibration and Harshness) engineer. Your boss asked you to do some preliminary analysis of a new suspension system for a super secret passenger vehicle prototype.

The vehicle design is still in the highly conceptual phase, so “anything goes” at the moment. Your boss did tell you that this is a 4-seater EV having a “dry mass” ranging from 1,500 kg to 2,000 kg. Each wheel has a “coilover” spring having a stiffness ranging from 20,000 N/m (“soft spring”) to 100,000 N/m (“stiff spring”).

The goal here, according to your boss, is to **get a sense of the selection and tuning of the suspension system (spring + damper) in order to ensure passenger comfort when the vehicle is traveling on a bumpy road at various speeds**.

Specifically, you have been tasked with:

- Building a Google Sheet that
  - allows the user to easily specify vehicle and suspension system parameters, including vehicle mass, spring constant (stiffness), damping ratio, road bump (roughness) height, and the vehicle speed range to be considered
  - generates a plot of *max amplitude of vehicle bounce* vs. *vehicle speed*; this plot must automatically update with changes in any of the user-specified parameters
- Proposing a damping ratio value that will limit the max amplitude of bounce, at any speed, to 8 cm, if the road roughness height is 6 cm, and if the bumps are approximately sinusoidal in shape, with a bump spacing (λ) of 3 m.
- Concluding your analysis, noting any limitations, sources of errors and areas of

improvement
- Reflecting on your learning and journey of working on this project

Deliverable:

Present your work in a written technical memorandum (tech memo; PDF only) and a Google Sheet. The Google Sheet must be embedded (clickable hyperlink) in the tech memo PDF.

Rules and Formatting:

- This is an individual project, to be done by you and you alone
- The tech memo must be typed, except for sketches and equations where handwritten work may be included
- Content and file requirements
  - Your tech memo must contain the entirety of your work for this project, including vibration modeling and mathematical formulation, a plot from your Google Sheet, an embedded link to your Google Sheet, conclusion, and reflection
  - Your entire tech memo must be in portrait orientation and has a vertical page flow
  - Your Google Sheet must be publicly accessible, i.e., no permission required (see Appendix A below for how to set up your Google Sheet)
  - Your Google Sheet must not be edited after you have submitted it to Gradescope (your Google Sheet will show the last edit date to any viewer, so be sure not to modify it after submitting!)
- Google Sheet functionality requirements
  - Your spreadsheet must include instructions for the user
  - It must allow the user to quickly change values of the parameters described above
  - It must contain a plot that dynamically updates whenever an input value changes
  - It must have only one tab (or "sheet"); all input parameters (constants), data, and plot must be shown in the same tab/sheet

Submission:

Submit your tech memo PDF (containing a hyperlink to your Google Sheet) on Gradescope only. Submissions by email or other means will be disregarded.

Due on Nov 1, 2021 (Monday), at 11:59 pm CST.

Late submissions will be subject to the "half-life" reduction policy according to the syllabus.

Grading Rubric:

	Fluency			Scaling	Max Possible
	2	**1**	**0**		
Technical Rigor	Tech Memo: Assumptions are reasonable and not oversimplified; physics, math and data are accurate and convincing Google Sheet: Data are generated using spreadsheet formulas containing the correct equations; plot is accurate	Some obvious details missing	Farfetched, or missing most details	1	2
Professionalism	Tech Memo: Presentation of work is logical, legible, and easy to follow; format is well-structured; free from grammatical or typographical errors; a joy to read Google Sheet: Instructions for the user are clear, changing parameters is easy, plot is well formatted	Some obvious issues with coherence and/or format	Full of errors; hard to follow; illegible	1	2
Rationale, Justification, Reflection	Conclusions are insightful, thoughtful and transparent; goes beyond "pointing out the obvious"; reflection is thoughtful and authentic, and suggests future (self-)improvements	Insubstantial or vague	Missing altogether	1	2
				Max Possible:	6