MECH 4420
Homework #9
(Due Wednesday 12/10/2025)

To be performed in your teams. Turn in one report that lists the names of all team members and the vehicle(s) you looked at and the vehicle you analyzed (email me the completed spreadsheet).

The purpose of this assignment is to relate the discussion of linkage and steering kinematics to the characteristics of a real car. Each team should choose at least ***one*** vehicle (Bonus points for comparing two distinctly different vehicles). Provide basic information discussed below. Think about all the parameters you need to simulate the skid pad and how you would obtain them from what you see.

1. ***Suspension type***. What type of front suspension does the car have? Rear suspension? Do they have stabilizer bars? Bonus: Find roll centers for the suspension.

2. ***Steering kinematics***. Locate the ball joints where the tie rod connects to the wheel body and the inboard elements of the steering system (the rack, for instance). Is it a forward steer or rearward steer arrangement? Do these two ball joint points lie near the line to the instantaneous center?

3. ***Ride analysis***. Estimate the effective sprung mass as well as suspension stiffness and damping from experimental tests (Note: you should not use vehicle mass or curb weight but estimate all 3 parameters from dynamic test experiments). Estimate the tire stiffness as well. If you cannot do this using a jack, then you may assume it is 10 times the suspension stiffness. You may also assume the unsprung mass is one tenth of your estimated sprung mass.
    a. From your tests, determine the eigenvalues (as well as their natural frequency and damping ratios).and eigenvectors for you ¼ car model Compare the eigenvalues to the approximations given in class:

$$\omega_{body} \approx \sqrt{\frac{K_{eff}}{M_{body}}} \qquad \omega_{tire} \approx \sqrt{\frac{K_s + K_t}{m_{tire}}} \qquad K_{eff} = \frac{K_s K_t}{K_s + K_t} \text{ (ride rate)}$$

    b. Provide the step response of your ¼ car model using >>step(A,B,C,D)
    c. Provide the bode plot from road input to sprung and unsprung mass output
    d. Assuming the same values for the other axle (this is not usually true), provide the eigenvalues and eigenvectors for the ½ car model.