MECH 4420 Homework #2
(Due Friday 9/5/2025 in class)

1) Braking:

a) Suppose you are traveling at 70mph on I85 and you notice an unexpected road block. If your reaction time is 0.5s (time to see the road block to foot on the pedal to buildup of brake pressure on brake pads!), how long do you travel before the car starts to decelerate? If braking follows immediately at 0.8g, how far will you have traveled from the time you saw the road block until your stop? What if only 0.4g is possible due to road conditions?

b) Now suppose you are following another vehicle. What distance must you maintain to keep from rear-ending the other vehicle if the difference in braking capability is 0.9g to 0.8g (assume a 0.5 second time reaction time again). What about 1.6g (i.e. the car in front hits another vehicle) to 0.8 g?

c) Assuming a 3500 pound car with a frontal area of about 2 $m^2$ driving on flat terrain (I85), what braking force is required to decelerate the vehicle at 0.8 g. Simulate the car braking at this force after 0.5 second delay from a speed of 70 mph and compare the stopping distance to what was predicted in part a. Now add air-drag and rolling resistance (Cd=0.3 and frr=0.01), which is acting during the 0.5 second delay, and compare the stopping distance (show plots of position and velocity).

d) Let's say that your car has a cg height of 0.5m, a wheelbase of 2.5m and a 50-50 weight balance between the front and rear. If the tire/road interface has a peak friction coefficient of 0.8, you have no ABS system and you want to avoid locking the wheels, what peak deceleration can you achieve if you have ideal proportioning? If you have no proportioning?

2) Download the braking data from the website. Assume the effective radius of the wheel is 0.35 m.

a) For the first set of data, plot the GPS Velocity and Tire Velocity ("hold on") on the top half of a page ("subplot(2,1,1)"). Plot tire slip vs time on the bottom half of the page ("subplot(2,1,2)"). Any ideas what the "blip" in the data is due to?

b) For the second set of data, plot tire slip vs. time. Then plot the tire force vs. tire slip (mass of the car in 1500 kg). Estimate the tire's longitudinal stiffness.

Note the matlab command "orient" is useful to expand the size of a plot (especially subplots) for printing. Also make sure all plots have axis labels (and legends if needed).

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>>subplot(2,1,1)
>> plot(t,x)
>>sublot(2,1,2)
>>plot(t,y)
>>orient tall
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