ME-AUE 4600/6600 (Fall 2022) – Homework
Assignment #7

Reference: Chapter 18 (Milliken, Race Car Vehicle Dynamics),
Chapter 17 (Milliken, RCVD) for Roll Center Construction,
Chapter 16 (Milliken, RCVD) for Roll Rates
Chapter 15 (Rajamani, Vehicle Dynamics, and Control) for Roll Dynamics

Due Date: 11/29/22, midnight

Problem 1

A vehicle with a 9 ft wheelbase and 4.5 ft front and rear tracks is placed on scales. The measured wheel loads are:

LF = 850 lb RF = 825 lb
LR = 725 lb RR = 750 lb

A. Find the x and y locations of the car's center of gravity, measured from the rear axle and left side of the vehicle, respectively.
B. What is the diagonal weight, D, for this vehicle?

Problem 2

A 20 kN car with 1.6 m front and rear tracks has CG at the center of the trackwidth.

a. If the car can corner at 0.9g, how high must the CG be to cause untripped rollover?
b. What is the total load transfer if the CG height is half of the rollover height?
c. The suspension springs in the rear are 25% stiffer than the ones in the front. Where (front or rear) would you add an anti-roll and what torsional stiffness would the roll bar need to provide for the lateral load transfer to be evenly distributed between front and rear?
d. Now, if the vehicle has 3m wheelbase, 58% front weight, 52% left weight and 25 N of diagonal weight; then calculate the static wheel loads.

Problem 3

Let's revisit the simulation problem with load transfer (and the nonlinear tire model) from the last homework assignment. Now, we want to perform the simulation while accounting for a more sophisticated model of the roll dynamics in load transfer. The maneuvers shall remain the same from the previous homework assignment. Provide the relevant plots for maneuver 1 (step input) and maneuver 2 (fishhook maneuver) for the following conditions:

A. Steady state roll: at each point in time, calculate the steady-state roll angle (assuming that there are no transients) and the resulting load transfer including roll (see lecture notes)
B. Dynamic roll: introduce 2 new states for roll angle and roll velocity to augment the state-space system and utilize the second order roll dynamics as discussed in class to calculate these states at each point in time. Incorporate the actual (dynamic) roll angle with transients in your load transfer calculations.
C. Compare your solutions from Parts A and B.

Additional Parameters:

Front roll center height:	0.33 ft
Rear roll center height:	0.5 ft
Total roll stiffness:	50000 Nm/rad
Roll damping:	3500 Nm-s/rad
Roll plane inertia:	700 kg-m^2
Roll Stiffness distribution:	58% front