CarSim Problems
Cornering Analysis

A car has the following properties:

	Front	Rear
Axle loads	5395.5 N	3825.9 N
Roll center height	70 mm	110 mm
Track width	1.39 m	1.375 m
Auxiliary roll stiffness	205 N-m/deg	184 N-m/deg
Suspension type	Independent	Independent
Suspension spring rate (per side)	15 N/mm	15 N/mm
Effective* lateral separation of springs	1.39 m	1.375 m
CG Height	448.6 mm	
Wheelbase	2.37 m	

Tire cornering coefficient:

Load	1500	2200	3700	5000	(N)
Coefficient	.35	.291	.234	.204	(N/N/deg)

a) What is the understeer gradient due to tire cornering stiffness?

b) Determine the total roll stiffness of both the front and rear suspensions taking into account the auxiliary roll stiffnesses.

c) What is the roll rate of the sprung mass?

d) What are the inside and outside tire loads on each axle at 0.25 g's lat. accel.?

e) What is the understeer gradient due to tire cornering stiffness at these loads?

f) Go to CarSim and duplicate the 0.25 g turning condition. Then compare the simulation results to your calculations by filling in the following table and print out the plots:

	Calculated		Simulated		
	Inside	Outside	Inside	Outside	Error
Tire Loads (Front)	_____	_____	_____	_____	
Tire Loads (Rear)	_____	_____	_____	_____	
Roll Rate	_____deg/g		_____deg/g		_____
Understeer gradient (at SW)			_____ deg/g		
Understeer (at roadwheel)	_____ deg/g		_____ deg/g		_____

* The effective lateral separation is determined by the type of suspension. With an independent suspension the effective separation is the same as the track width, because the springs are integrated into a linkage producing the stated suspension spring rate at the wheel center.

CarSim Exercise
Cornering at 0.25 g

1) The data given in the problem matches that for the Small Car in CarSim. Go to the *Handling Test: Big Car: Flat*. Click New, enter your name in the Category and make the following changes on the Run Control screen.

a) Go to the vehicle link and select Small Car: Baseline

b) Under Speed/Acceleration, make up a new data set labeled Delayed Ramp to 0.25g. Do this by entering a table with the values 0, 5: 20, 5: 60, 69.6: 80, 69.6. This will give you a simulation consisting of 20 seconds of low speed (close to zero g's) then take the car up to 0.25 g for the condition being analyzed.

c) Set the simulation time to 80 seconds.

d) Choose plots to show: Steer SW vs Ay; Fz Vertical Forces (Car) (All); and Roll – Sprung Masses.

2) Go to the Steering System, make up a Zero Compliance table and install that on both the front and rear steering systems.

3) Go to front and rear suspension screens (Suspension: Independent Suspensions), set all of the compliance coefficients to zero and choose No Toe and No Camber. Remember to install these suspensions on your vehicle. You have now prepared a vehicle that has no understeer influences except the tires.

4) We need to alter the tire cornering stiffness data as well because it doesn't go down to small enough loads. Go to the Vehicle: Assembly screen and select the Left Front Tire. On the tire screen (Tire: MSC Model) select the Lateral Force data link. Click New for the Tire: Lateral Force Table and give it your favorite name. We need a table that goes only to about 6 degrees, so you can delete the lines starting with slip angle values above 6 degrees. Now insert a new set of data for 1500 N vertical load with the lateral force values as follows:

1.2 (deg), 630 (N)	
2.9	1305
4.4	1716
6.0	1800

When you return to the Tire page, click New, name your tire and then once back to the Vehicle Assembly screen, select that tire for all four wheel positions.

5) Now run the simulation and look at the plots to get the data you need.

a) Get the individual tire loads off of the Fz – vertical force plots at the point where the vehicle has reached equilibrium in the turn.

b) Obtain the roll rate from the plot. You have the roll rate for 0.25 g, so you will have to convert it to degrees per g. Why do you think it is larger than what you calculated in the homework – I.e., what is not taken into account in the calculations that shows up on the plot?

c) You can find the understeer gradient at the Steering Wheel at the plot (I.e., how many degrees per g would the steering wheel change if you extrapolated the plot?) To get the understeer gradient at the roadwheels like you calculated, you have to divide the steering wheel gradient by the steering ratio.

6) Fill out the table of data requested, and print the screen showing your plots.