

MECH 4420 Homework #7  
(Due Wednesday 12/2/2009 in class)

Below is data for the G35 Sedan (from one of the lab groups). What is the understeer gradient?

$$\begin{array}{lll} m = 1573 \text{ kg (unloaded)} & a = 1.311 \text{ m} & C_{af} = 933 \text{ N/rad/tire} \\ I_z = 3200 \text{ kgm}^2 & b = 1.539 \text{ m} & C_{ar} = 2175 \text{ N/rad/tire} \end{array}$$

1) In class we developed the model for slip angle and yaw rate given steer angle. Given the parameters above (for the G35), write a program to simulate the vehicle yaw rate and slip angle as a function of the steer angle and vehicle velocity.

- a) Using data collected at the track, provide clearly labeled plots of the simulated vs. experimental vehicle sideslip and tire sideslip angles (two pages at the most). Simulated and experimental plots should be on the same figure (use solid for experimental and dashed for simulated with a legend). Note any adjustments you had to make to tire parameters.

2) Simulate the G35 performing a step steer input that provides a final yaw rate of 50 deg/s. You can use “lsim” or “step” or your simulation for problem #1 to perform the simulation

- a) Write a formula to calculate the desired steer angle input.  
b) Simulate the Step Steer at 15 m/s (plot yaw rate and sideslip angle)  
c) Simulate the Step Steer at 30 m/s  
d) Swap the front and rear cornering stiffnesses and move the CG back 20 cm. What is the new understeer gradient? Repeat parts b and c. What happens? Why?

Turn in all 8 plots (clearly labeled) on one page (subplot(4,2,#)) and use “>>orient tall” Label the pole locations (including  $\omega_n$  and  $\zeta$ ) for each run.

3) Simulate the G35 doing a lane change maneuver. You can use the sine function below for the steer angle input or the steer angle input from the lab

$$\begin{array}{ll} \delta(t) = 0.2 \times \sin(2\pi \times (t - 0.5)) & 0.5 \leq t \leq 1.5 \\ \delta(t) = 0 & 0 \leq t \leq 0.5 \text{ and } 1.5 \leq t \leq 3 \end{array}$$

- a) Simulate the maneuver at 10 m/s and 20 m/s. Plot  $y$  for each speed on one page.  
b) Swap the front and rear cornering stiffnesses and move the CG back 20 cm. Repeat part a. What happens? Why?  
c) Scale the magnitude of the steer angle input until you get a 4 m-lane change at 10 m/s and 20 m/s. This will have to be done through trial and error (or by using the steer angle data from the track). Plot the steer angle, yaw rate and sideslip angle on one page and the heading angle and lateral position on another page. What was the magnitude of the steer angle?  
d) Compare simulated data with experimental data.