Vehicle Dynamics homework 2

1- Force system coefficients.

Consider a front-wheel-steering car with the following characteristics and determine the force system coefficients C_r, C_β , C_δ , D_r , D_β, and D_δ .

$C_{\alpha fL} = C_{\alpha fR} = 500N/\ deg$
$C_{\alpha rL} = C_{\alpha rR} = 460N/\ deg$
$m = 1245\ kg$
$I_z = 1328\ kgm2$
$a_1 = 110\ cm$
$a_2 = 132\ cm$
$v_x = 30m/\ s$

2- Force system and two-wheel model of a car.

Consider a front-wheel-steering car with the following characteristics $C_{\alpha rL} = C_{\alpha rR} = C_{\alpha fL} = C_{\alpha fR} = 500N/\ deg$

$a_1 = 110\ cm$
$a_2 = 132\ cm$
$m = 1205\ kg$
$I_z = 1300\ kgm^2$

Determine the force system that applies on the two-wheel model of the car.

$F_y = C_r\ r + C_\beta\ \beta + C_\delta\ \delta$
$M_z = D_r\ r + D_\beta\ \beta + D_\delta\ \delta$

Then, write the equations of motion of the car as

$F_x = mv\dot{}_x - mr\ v_y$
$Fy = mv\dot{}y + mr\ vx$
$Mz = r\dot{}\ Iz$

3- Equations of motion for a front-wheel-steering car.

Consider a front-wheel-steering car with the following characteristics

$C_{\alpha rL} = C_{\alpha rR} = C_{\alpha fL} = C_{\alpha fR} = 500N/\ deg$

$a_1 = 110\ cm$ $a_2 = 132\ cm$ $m = 1245\ kg$ $I_z = 1328\ kgm2$ $v_x = 40m/\ s$

Develop the equations of motion

$\dot{q} = [A]\ q + u$

4- Steady state response parameters.

Consider a car with the following characteristics

$C_{\alpha fL} = C_{\alpha fR} = 500N/\ deg$
$C_{\alpha rL} = C_{\alpha rR} = 520N/\ deg$
$m = 1245\ kg$
$I_z = 1328\ kgm2$
$a_1 = 110\ cm$
$a_2 = 132\ cm$
$v_x = 40m/\ s$

and determine the steady-state curvature response S_κ, sideslip response S_β , yaw rate response, S_r, and lateral acceleration response S_a.

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5- Critical speed of a car.

Consider a car with the characteristics

$C_{\alpha fL} = C_{\alpha fR} = 700N/\ deg$
$C_{\alpha rL} = C_{\alpha rR} = 520N/\ deg$
$m = 1245\ kg$
$I_z = 1328\ kgm2$
$a_1 = 118\ cm$
$a_2 = 122\ cm.$

(a) Determine if the car is understeer, neutral, or oversteer?
(b) In case of an oversteer situation, determine the neutral distance d_N and the critical speed v_c of the car.

6- Brake Temperature Rise

A brake has a normal braking torque of 2.8 kip.in and heat-dissipating cast-iron surfaces whose mass is 40 lbm. Suppose a load is brought to rest in 8.0 s from an initial angular speed
of 1600 rev/min using the normal braking torque; estimate the temperature rise of the heat dissipating surfaces.

7- Braking Distance

Consider a car with a mass of 1500kg which is moving in a straight line with a constant velocity of 200mph.

(a) Find the amount of work and energy that stops the car.
(b) Find the braking distance with the friction coefficient of $\mu=0.7$
(c) Find the total braking distance if the driver has a Reaction time of 1.5 seconds.
(d) Based of the figures you saw on the lectures, estimate the total braking distance if the road was wet.

8- Quarter car model

Consider a quarter car model. Determine its natural frequencies and mode shapes if

$m_s = 1085/4kg$
$m_u = 40kg$
$k_s = 10000N/m$
$k_u = 150000N/m$
$c_s = 800Ns/m$