

Vehicle

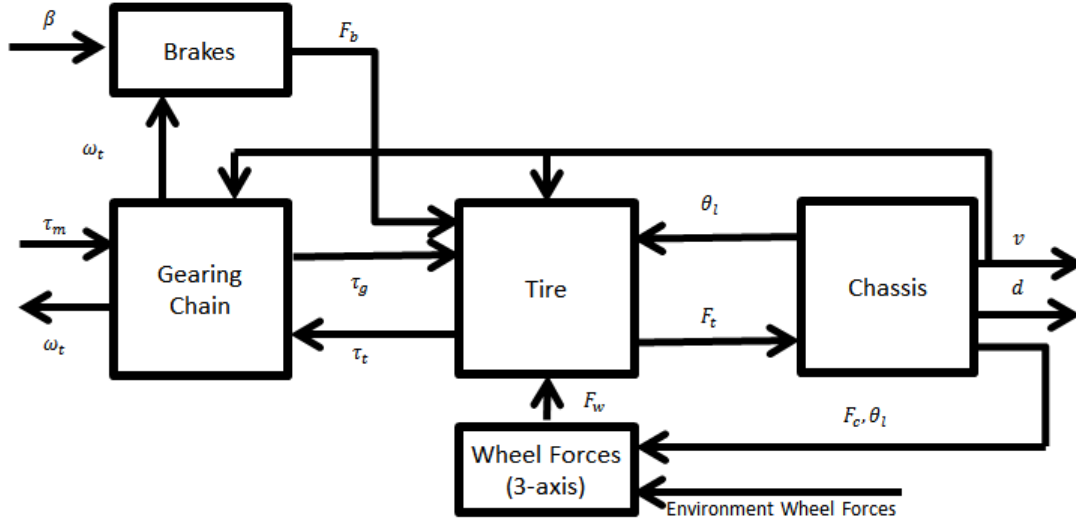


Figure 1: Vehicle Diagram

Vehicle

Gearing/Chain

$$\dot{\omega}_t = \frac{\tau_m - \tau_t}{J_m + J_g + J_t} \quad (1)$$

$$\tau_g = \frac{\tau_m \eta(\omega_t)}{R_g} \quad (2)$$

Brakes

$$F_b = \mu_b w_t \beta \quad (3)$$

Tire

Rolling Resistance

$$K_t = \begin{cases} 0.0085 + \frac{0.18}{p_t} + \frac{1.59 \cdot 10^{-6}}{p_t} & : v_{kph} \leq 165(km/h) \\ \frac{0.18}{p_t} + \frac{2.91 \cdot 10^{-6}}{p_t} & : v_{kph} > 165(km/h) \end{cases} \quad (4)$$

Wheel Slip

$$\kappa = \frac{v - \omega_t r_t}{v} \quad (5)$$

$$\mu_{t,gnd} = D_\kappa \sin(C_\kappa \arctan[B_\kappa \kappa - E_\kappa(B_\kappa \kappa - \arctan B_\kappa \kappa)]) \quad (6)$$

Load and Torque

$$\tau_t = \tau_g - \frac{F_{w,long}}{r_t} - \frac{F_b}{r_b} - K_t F_{w,n} v_{kph}^2 \quad (7)$$

Traction Limiting

$$F_{max} = \mu_{t,gnd} F_{w,n} \quad (8)$$

$$F = \tau r_t \quad (9)$$

$$F_t = \begin{cases} F & : -F_{max} \leq F \leq F_{max} \\ F_{max} & : -F_{max} > F > F_{max} \end{cases} \quad (10)$$

The tire coefficient ($\mu_{t,gnd}$) is modeled using the "Magic Formula" as shown below. Where D_κ is the maximum tire coefficient of the tire.

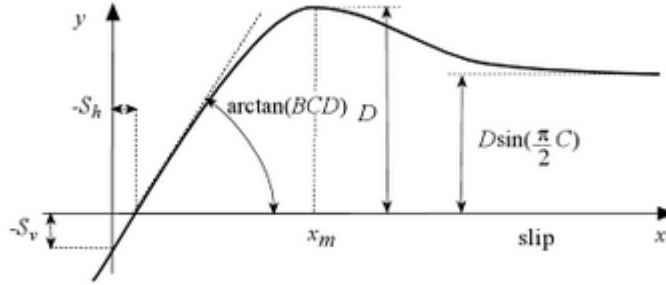


Figure 2: Magic Formula

Wheel Forces

$$F_{\omega,long} = F_{c,long} \quad (11)$$

$$F_{\omega,n} = F_{c,n} \quad (12)$$

Chassis

$$F_a = \frac{1}{2}\rho(d)C_dAv^2 \quad (13)$$

$$F_{c, long} = F_a + gm \sin(\theta_r(d)) \quad (14)$$

$$F_{c, n} = mg \cos(\theta_r(d)) \quad (15)$$

$$\dot{v} = mF_t \quad (16)$$

Environment

$$given : h(d) \quad (17)$$

$$\theta_r = \frac{d}{dd}h(d) \quad (18)$$

$$T_a mb(d) = T_0 - Lh(d) \quad (19)$$

$$P(d) = P_0 \left(1 - \frac{Lh(d)}{T_0}\right)^{\frac{gM}{RL}} \quad (20)$$

$$\rho(d) = \frac{PM}{1000RT} \quad (21)$$