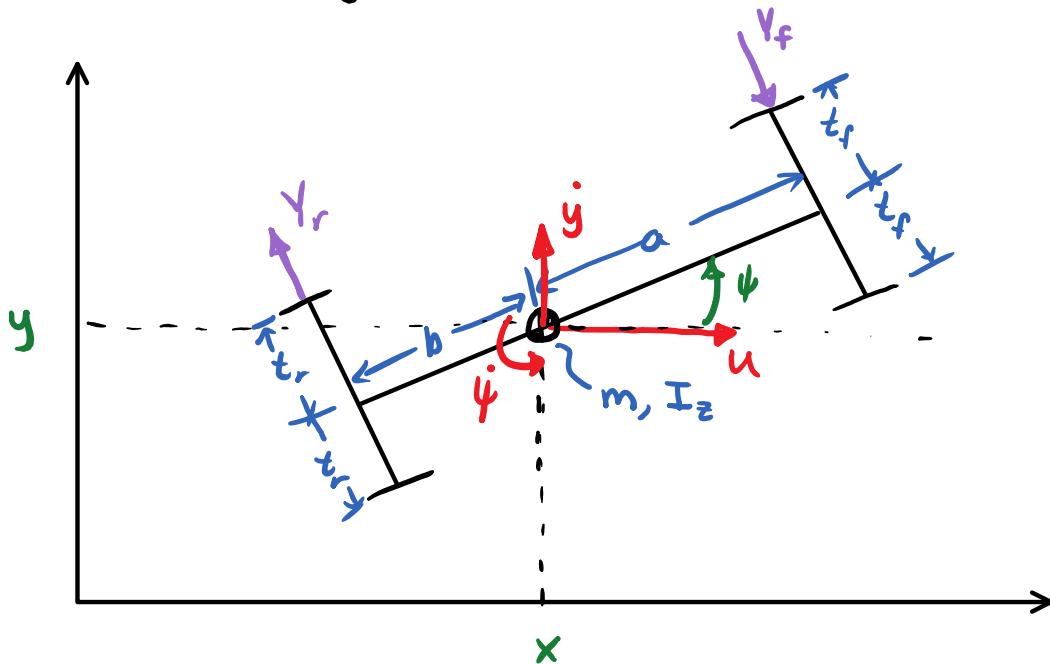


Ch. 6: Lateral Dynamics of Automobiles



Time varying vars

$y, \Psi, x, \gamma_r, v_f$

$x = Ut$

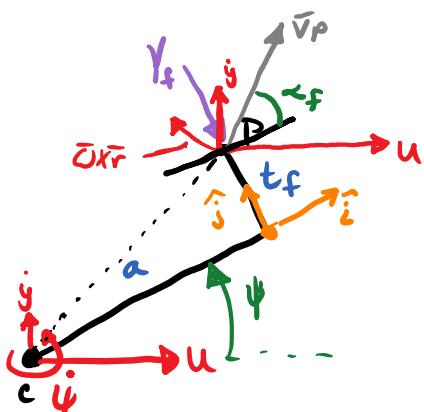
y, Ψ : generalized coordinates

Assumptions

- only planar motion (no roll, pitch, heave, etc.)
- constant forward speed, U
- single rigid body
- small angles and small motions about equilibrium state

Slip angles

left front



$$\bar{V}_p = \bar{V}_c + \bar{\omega} \times \bar{r}^c \rightarrow p$$

$$\hat{i}: U \cos \Psi + \dot{y} \sin \Psi - t_f \dot{\Psi} = U$$

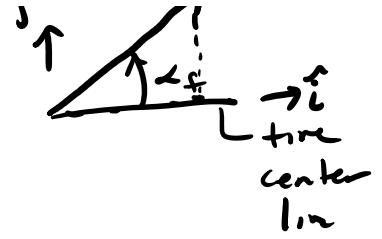
$$\hat{j}: -U \sin \Psi + \dot{y} \cos \Psi + a \dot{\Psi}$$

$$\tan \alpha_f = \frac{\bar{V}_p \cdot \hat{j}}{\bar{V}_p \cdot \hat{i}}, \quad \alpha_f = \frac{-U \dot{\Psi} + \dot{y} + a \dot{\Psi}}{U \hat{j}}$$

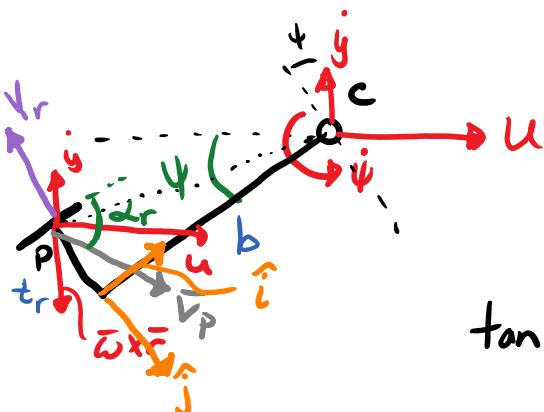


$$V_P \cdot \psi$$

$$\alpha_f = \frac{1}{u} \dot{y} + \frac{a}{u} \dot{\psi} - \psi$$



Rear Left



$$\hat{i}: U \cos \psi + j \sin \psi - t_r \dot{\psi}$$

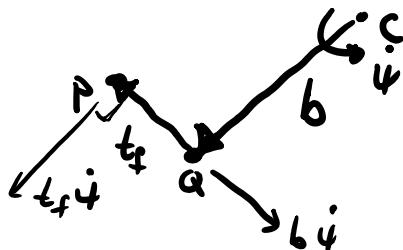
$$\hat{j}: U \sin \psi - j \cos \psi + b \dot{\psi}$$

$$\tan \alpha_r \approx \alpha_r$$

$$\alpha_r = \frac{U \psi - j + b \dot{\psi}}{U}$$

$$\bar{\omega} \times \bar{r}^{C \rightarrow P} = \bar{\omega} \times \bar{r}^{C \rightarrow Q} + \bar{\omega} \times \bar{r}^{Q \rightarrow P}$$

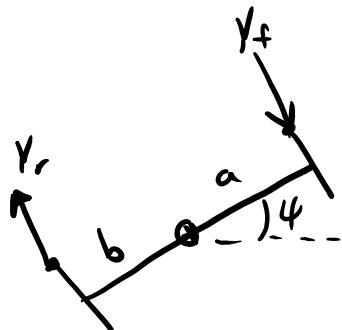
$$\alpha_r = \psi - \frac{1}{u} \dot{y} + \frac{b}{u} \dot{\psi}$$



Newton-Euler Equations

$$m \ddot{y} = \sum F_y = -V_f \cos \psi + V_r \cos \psi \\ = -V_f + V_r$$

$$I_z \ddot{\psi} = \sum M_z = -V_f a - V_r b$$



$$V_f = \frac{c_f}{u} \dot{y} + \frac{c_f a}{u} \dot{\psi} - c_f \psi = c_f \alpha_f$$

$$V_r = -\frac{c_r}{u} \dot{y} + \frac{c_r b}{u} \dot{\psi} + c_r \psi = c_r \alpha_r$$