

red: positive

blue: negative

Mid term

Average: 83/100

Median: 84/100

STD: 10

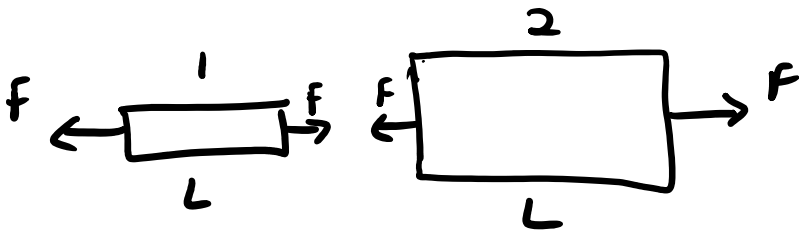
Max: 99

Min: 65

P1: 63% correct on average

$$\delta = \frac{FL}{AE} \quad \sigma = \frac{F}{A} \quad \epsilon = \frac{\delta}{L}$$

$$\sigma = E\epsilon$$



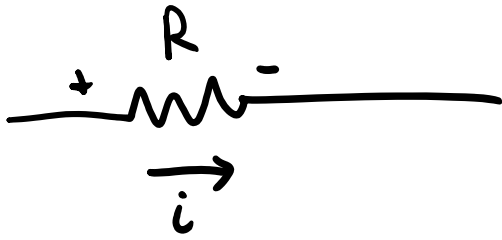
$$\delta = \delta_1 + \delta_2 = \frac{LF}{\pi r_1^2 E} + \frac{LF}{\pi r_2^2 E}$$

$$\delta = \left(\frac{1}{r_1^2} + \frac{1}{r_2^2} \right) \frac{L}{\pi E} F$$

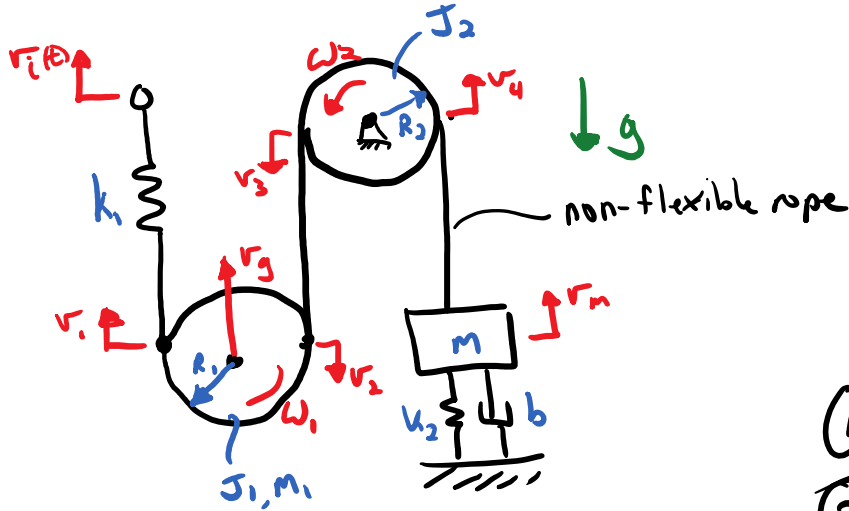
displacement & force

$$\frac{F}{\nu} \rightarrow C: \left(\frac{1}{r_1^2} + \frac{1}{r_2^2} \right) \frac{L}{\pi E}$$

$$q = Ce$$



Exercise



rope does not slip on discs

$$v_g = \omega_1 R_1 - v_2$$

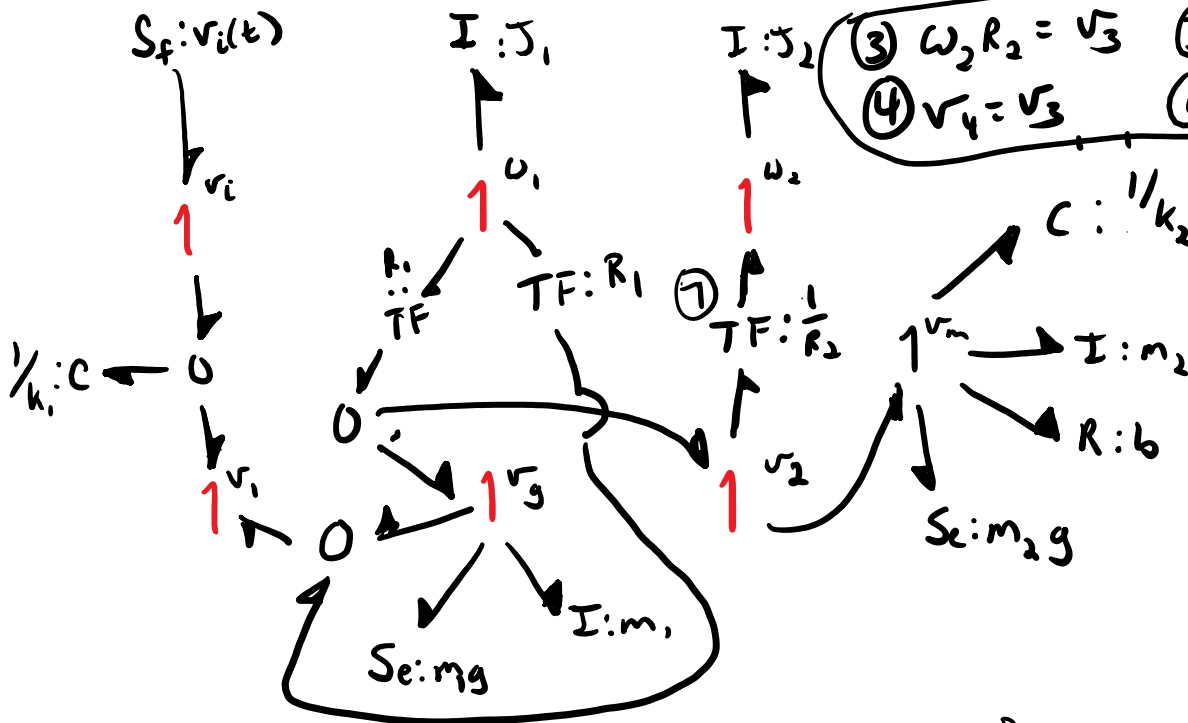
$$\textcircled{1} v_2 = -v_g + \omega_1 R_1$$

$$\textcircled{2} v_1 = v_g + \omega_1 R_1$$

$$\textcircled{3} \omega_2 R_2 = v_3 \quad \textcircled{5} v_3 = v_2$$

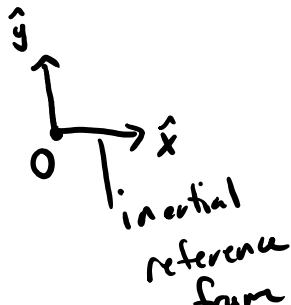
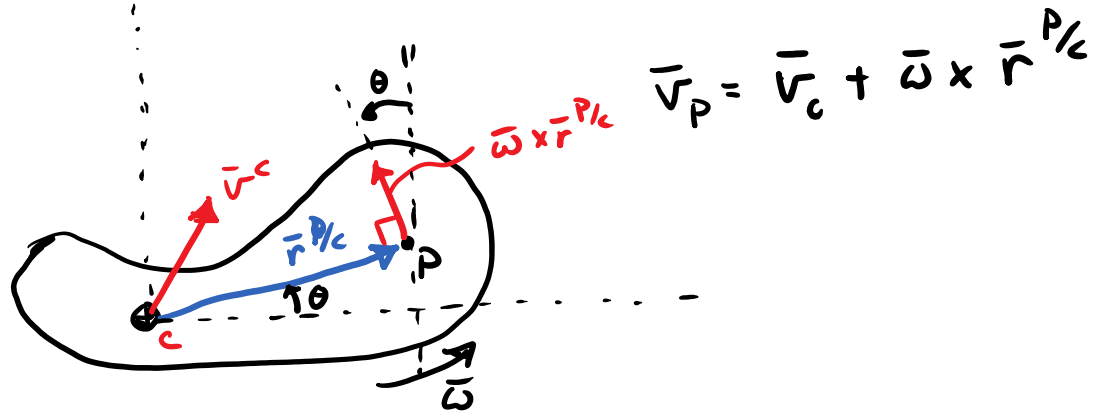
$$\textcircled{4} v_4 = v_3 \quad \textcircled{6} v_m = v_4$$

$$\textcircled{7} v_2 = \omega_2 R_2$$

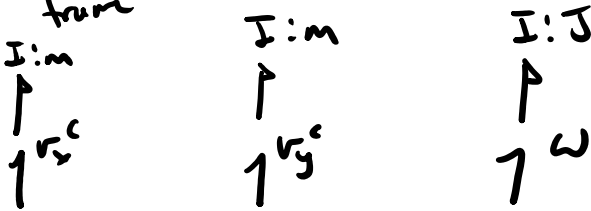


$$v_2 = -v_g + \omega_1 R_1 \Rightarrow \begin{matrix} 1 v_2 \\ \leftarrow 0 \end{matrix} \begin{matrix} R_1 \\ \text{TF} \end{matrix} \begin{matrix} 1 \omega_1 \\ \leftarrow 0 \end{matrix}$$

Planar Motion of a Rigid Body



$$\left. \begin{aligned} \bar{v}_x^P &= \bar{v}_x^C - \omega r \sin \theta \hat{x} \\ \bar{v}_y^P &= \bar{v}_y^C + \omega r \cos \theta \hat{y} \end{aligned} \right\} r = |\bar{r}^{P/C}|$$



Scalar values of the mass center velocity and angular

assume small ^{angular} motion ω is small and θ is small

$$\sin \theta \approx \theta \quad \cos \theta \approx 1 \quad \omega \cdot \omega \approx 0$$

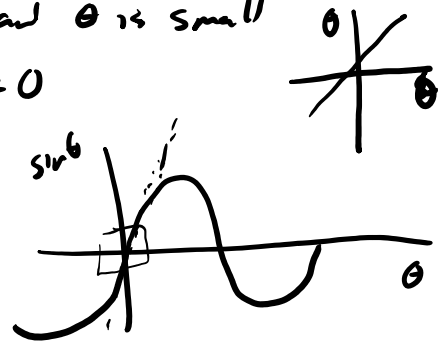
$$\bar{v}_x^P = \bar{v}_x^C - \omega r \theta \approx 0$$

$$\bar{v}_y^P = \bar{v}_y^C + \omega r$$

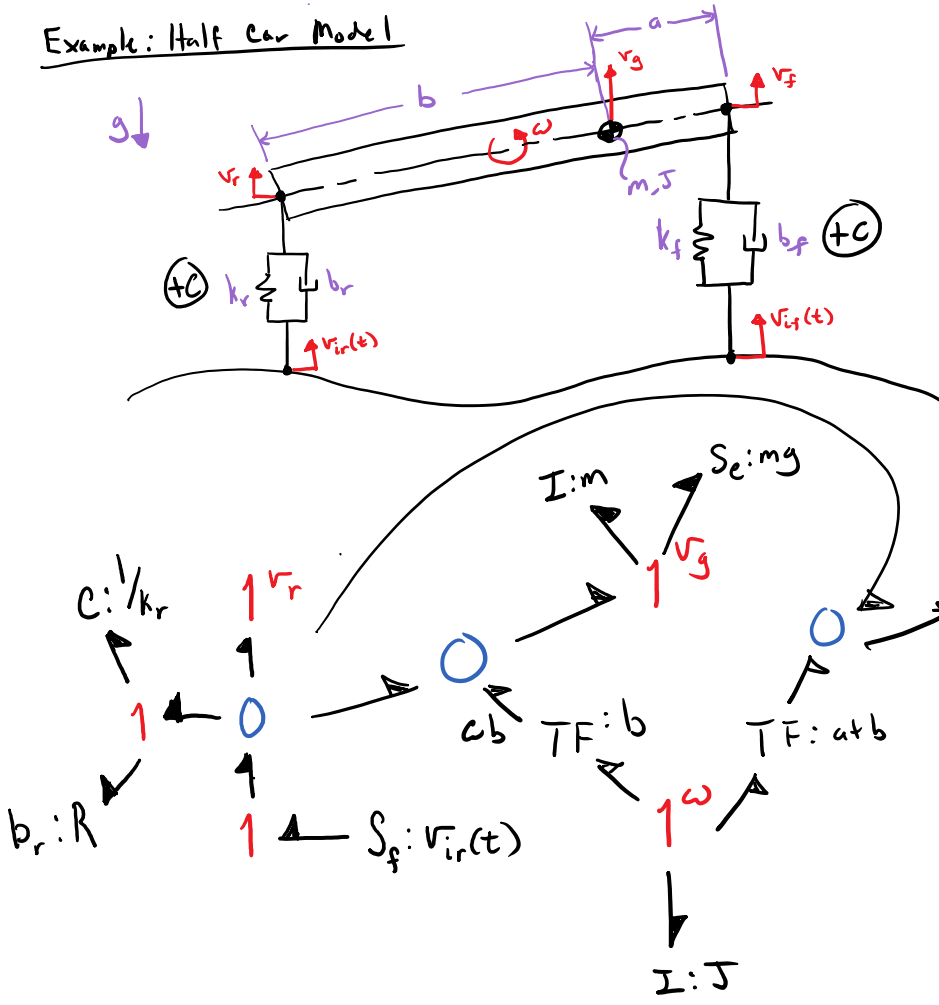
$$\begin{aligned} v_x^P &= v_x^C \\ v_y^P &= v_y^C + \omega r \end{aligned}$$

linear relationship

for velocities of two points on a rigid body



Example: Half Car Model



Assumptions

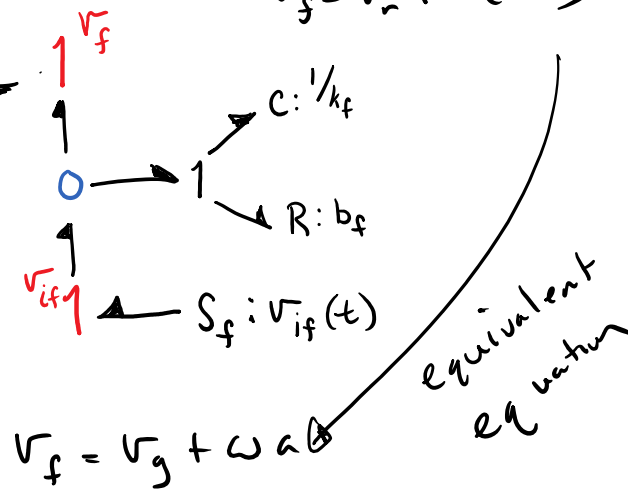
- small rotation of car body
- ignore longitudinal dynamics
- suspension: k, b lumps shocks & tires

$$v_x^p = v_x^c$$

$$v_y^p = v_y^c + \omega r$$

$$v_g = v_r + \omega b \quad (1)$$

$$v_f = v_r + \omega(a+b) \quad (2)$$



equivalent equation