Equations

$\sum \vec{\tau} = I \vec{\alpha}$ $\qquad \vec{\tau} = \vec{r} \times \vec{F}$

motor

$\tau_m - \tau_f = I \vec{\alpha}$

$\vec{\tau} = \vec{r} \times F$

$\sum \vec{\tau} = I_1 \alpha_1$

$I_2 \alpha_2$

$r \times F$

Goal: $\tau_m \rightarrow a$

$\sum \vec{\tau} = I_1 \alpha_1 + I_2 \alpha_2 + r \times F$

motor

$\tau_m - \tau_f - r_1 P_1 = I \alpha_1$ $\qquad |\vec{P_1}| = |\vec{P_2}|$

wheels

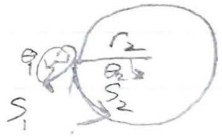
$r_2 P_2 - r_w F = I_2 \alpha_2$

$\sum \vec{F} = m \vec{a}$

$s = r\theta$ $\qquad$ Gear ratio

$v = rw$

$a = r\alpha$



train

$F - \mu mg = ma$

$S_1 = S_2$ $\qquad \gamma = \frac{r_2}{r_1}$

$r_1 \theta_1 = r_2 \theta_2$ $\qquad \alpha_1 = \gamma \alpha_2$

$v_0 \quad r_1 \omega_1 = r_2 \omega_2$ $\qquad a = r_w \alpha_w \quad \alpha_2$

$r_1 \alpha_1 = r_2 \alpha_2$ $\qquad$ can now relate all αs to a

$\alpha_1 = \frac{r_2}{r_1} \alpha_2$

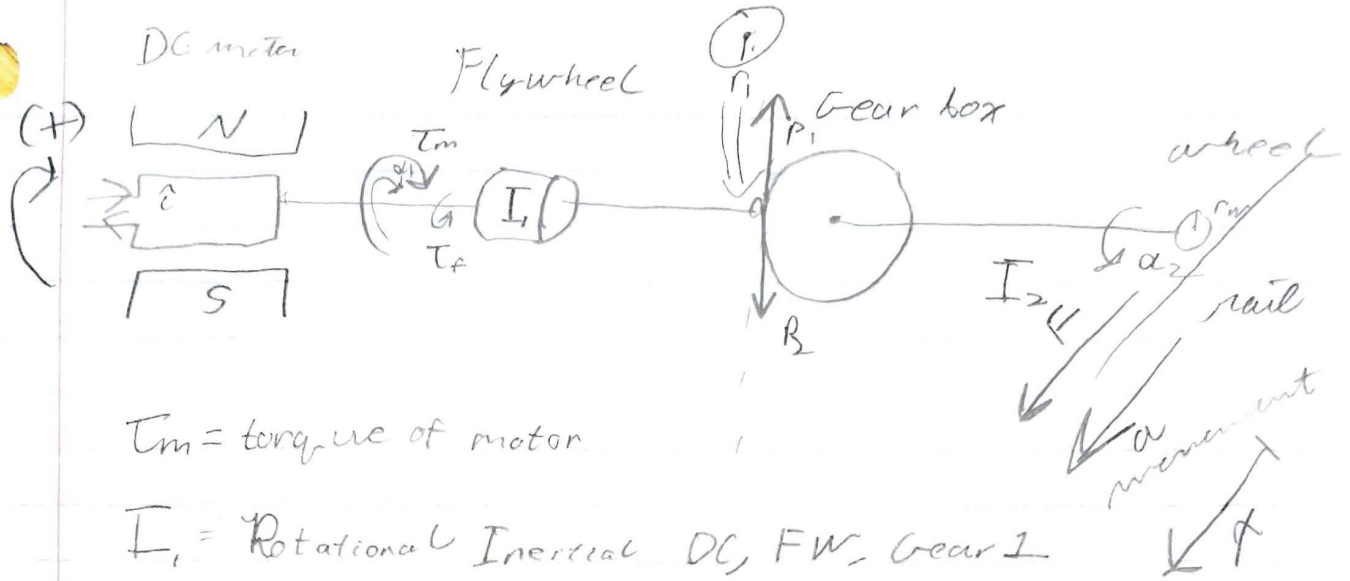
solve for a torque equation looks like

$\tau_m - \tau_f - \square = \bigcirc \frac{a}{r_w}$

stuff $\qquad I_{eq}$

units of I

Symmetric



τ_m = torque of motor

I_1 = Rotational Inertial DC, FW, Gear 1

τ_f = frictional torque = $k v$

I_2 = Rotational inertia of wheel

$|\vec{P_1}| = |\vec{P_2}|$ = normal force (eventually cancels out)