

T_m = torque of motor

Rotational inertia: DC motor, flywheel, gear 1

T_f = frictional torque = $k(v)$

I_z = Rotational inertia, gearbox and wheel.

$|P_1| = |P_2|$ = normal force

Force exerted by wheel on track equal to frictional force.

Motor: $T_m - T_f - r_1 P_1 = I_1 d_1$

Wheels: $r_2 P_2 - r_w F = I_2 a_2$

Train: $F - \mu mg = ma$

Gear ratio:

$S_1 = S_2$

$r_1 \theta = r_2 \theta$

v: $r_1 \omega_1 = r_2 \omega_2$

$r_1 a_1 = r_2 a_2$

$\square_1 = r_2 / r_1 (a_1)$

$$\gamma = \frac{r_2^2}{r_1}$$

Full torque equation: $T_m - T_f - (\text{lump}) = (\text{lump } 2.0) \frac{a}{\omega}$