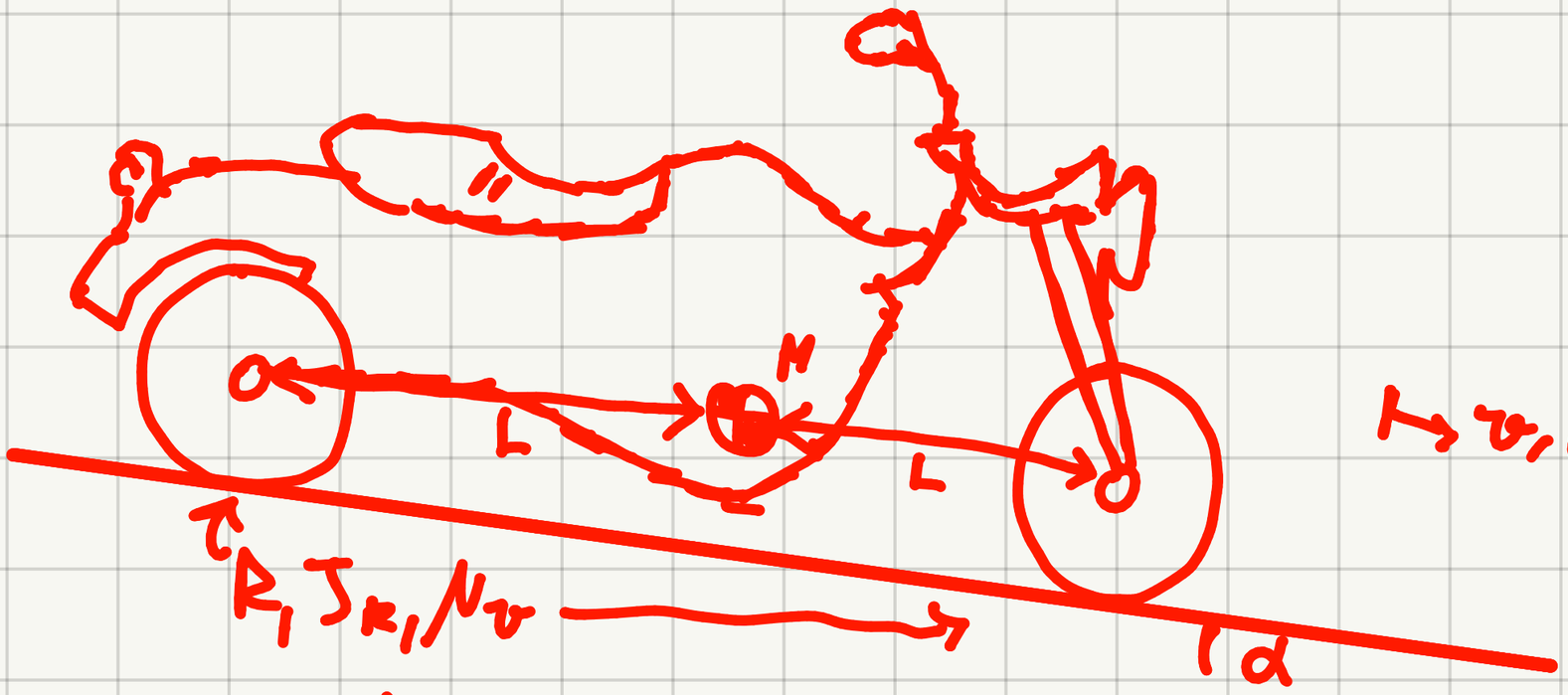
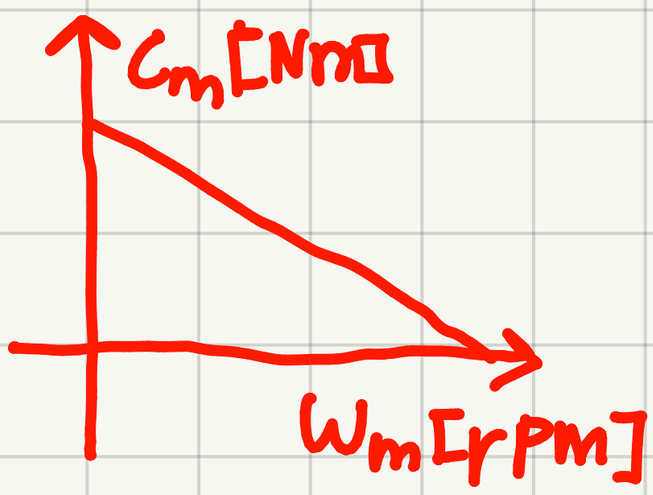


$\mapsto v, a$



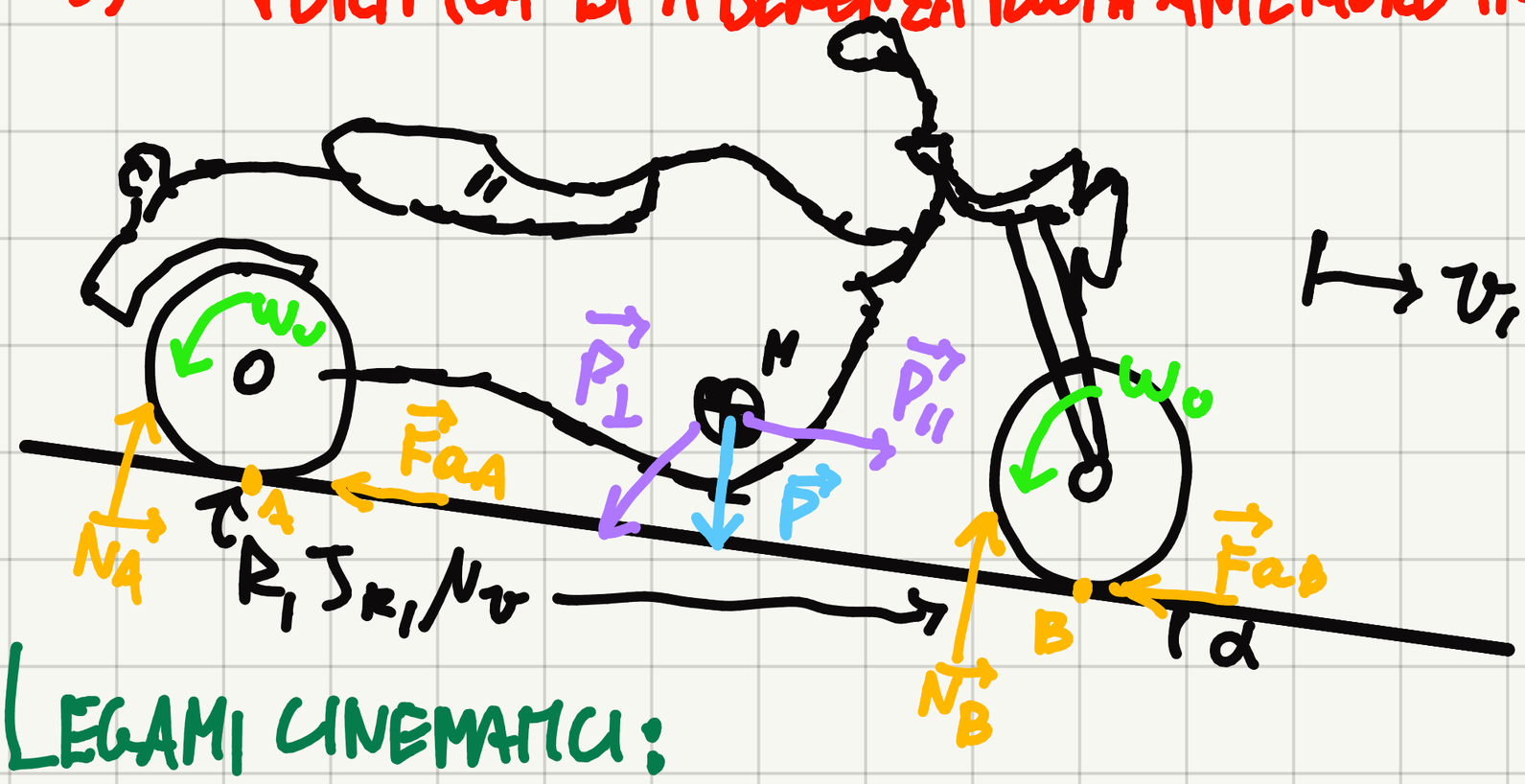
$C_{m_0} = 60Nm \quad \omega_s = 3000 rpm$

$M = 150Kg \quad R = 0,3m \quad L = 1m \quad J_R = 3 Kg m^2$ PERSONA $J_m = 0,5 Kg m^2 \quad \alpha = 10°$

$\tau = 0,05 \quad \eta_d = 0,9 \quad \eta_r = 0,8 \quad N_s = 1,8 \quad N_v = 0,02$

1) C_m, ω_m A REGIME? 2) $a = 1,5 m/s^2$ C_m?

3) VERIFICA DI ADERENZA RUOTA ANTERIORE IN 2



$\mapsto v, a$

$\Sigma \vec{F}_Y = 0$

$N_A + N_B - P_\perp = 0$

$N_A + N_B = Mg\cos\alpha$

LEGAMI CINEMATICI:

$\omega_v = \tau \omega_m \quad v = R\omega_v = \tau R \omega_m \quad \dot{\omega}_v = \tau \dot{\omega}_m \quad a^{(m)} = R\dot{\omega}_v = \tau R \dot{\omega}_m$

BILANCIO DI POTENZE) $P_1 + P_2 + P_T = 0$

$P_1 = \Sigma P^{(m)} - \frac{d}{dt} K^{(m)} = C_m \omega_m - J_m \dot{\omega}_m \omega_m$

$P_2 = \Sigma P^{(\omega)} - \frac{d}{dt} K^{(\omega)}$

- $\Sigma P^{(\omega)} = (P_{II}, v) - Fa_v = Mgv\sin(\alpha) - \mu_v N_A R\omega_v - \mu_v N_B R\omega_v =$

  $= MgR\tau(\sin(\alpha) - \mu_v \cos(\alpha))\omega_m = (3,39 Nm)\omega_m$

- $\frac{d}{dt} K = Mva^{(a)} + 2J_R \dot{\omega}_v \omega_v = M\tau^2 R^2 \dot{\omega}_m \omega_m + 2J_R \tau^2 \dot{\omega}_m \omega_m =$

  $= (1,048 Kg m^2)\dot{\omega}_m \omega_m$

$C_m\omega_m - J_m\dot{\omega}_m\omega_m + 3{,}39\omega_m - 0{,}048\dot{\omega}_m\omega_m + P_T = 0$

CASO 1) REGIME $\Rightarrow \frac{d}{dt}K = 0,\ \alpha = 0,\ \dot{\omega} = 0$ $\quad C_m, \omega_m$?

$C_m\omega_m + 3{,}39\omega_m + P_T = 0$

$P_1)$ $C_m\omega_m \gtrless 0$?

$P_2)$ $3{,}39\omega_m > 0 \Rightarrow$ MOTO RETROGRADO $\Rightarrow P_T = -(1-2z_p)\cdot 3{,}39\omega_m$

$C_m\omega_m + 3{,}39\omega_m - (1-2z_p)\cdot 3{,}39\omega_m = 0 \Rightarrow C_m = -2{,}712\,NM$

$C_{m_0} = 60\,NM \qquad \omega_s = 3000\,rpm \qquad \frac{rad}{s} = rpm\cdot\frac{2\pi}{60} \Rightarrow \omega_s = 314{,}16\,rad/s$

$0 = C_{m_0} - B\cdot\omega_s \Rightarrow B = 0{,}19\,\frac{NM}{rad/s}$

$C_m = 60 - 0{,}19\omega_m \Rightarrow \omega_m = 330\,rad/s$

CASO 2) $\alpha = 4{,}5\,m/s^2 \qquad C_m$?

$\alpha = r_{ING}\dot{\omega}_m \Rightarrow \dot{\omega}_m = 100\,rad/s^2$

$C_m\omega_m - J_m\dot{\omega}_m\omega_m + 3{,}39\omega_m - 0{,}048\dot{\omega}_m\omega_m + P_T = 0$

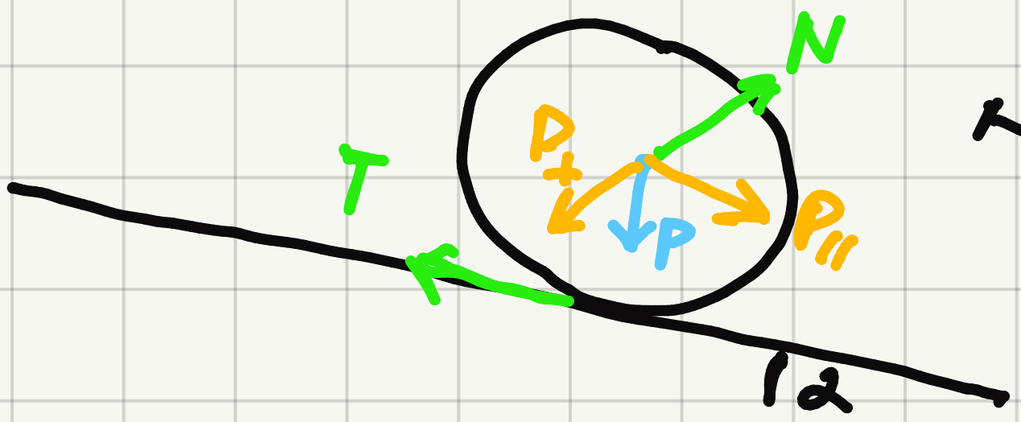
$P_2)$ $(3{,}39 - 0{,}048\cdot 100)\omega_m \gtrless 0 \Rightarrow$ MOTO DIRETTO

$P_T = -(1-2z_d)(C_m - J_m\dot{\omega}_m)\omega_m$

$C_m\omega_m - J_m\dot{\omega}_m\omega_m + 3{,}39\omega_m - 0{,}048\dot{\omega}_m\omega_m - (1-2z_d)(C_m - J_m\dot{\omega}_m)\omega_m = 0$

$\Rightarrow C_m = 5155\,NM \qquad P_2 = (5155 - 0{,}5\cdot 100)\omega_m > 0 \Rightarrow$ CONFERMA MOTO DIR.

VERIFICA DI ADERENZA RUOTA ANTERIORE



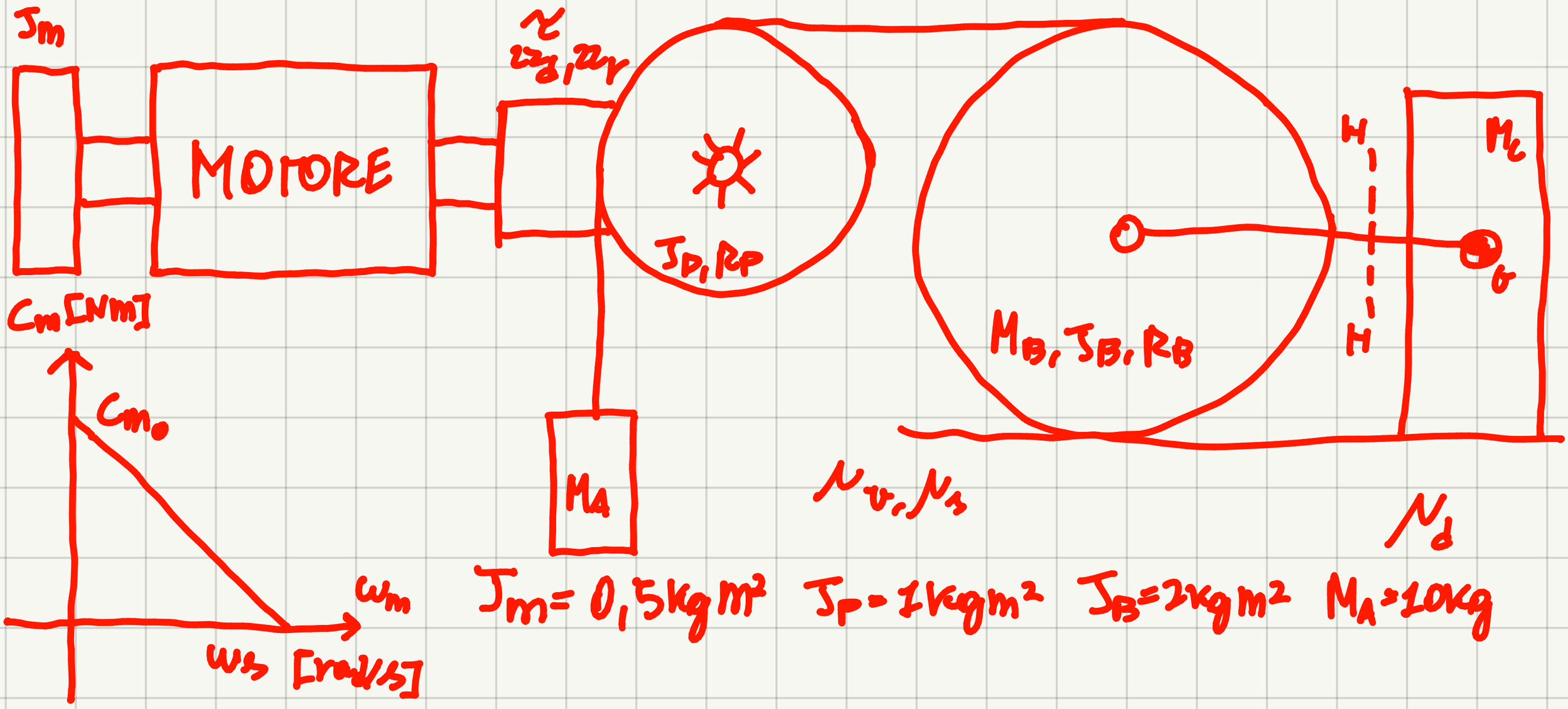
$\hookrightarrow v, a \qquad T \leq T_{attrito} = \mu_s N$

$\Sigma F_x = P_{//} - T = Ma \rightarrow T = Ma - P_{//}$

$\Sigma F_y = N - P_\perp = 0 \rightarrow N = Mg\cos(\alpha)$

$M(a - g\sin\alpha) \leq \mu_s Mg\cos\alpha \Rightarrow \quad a - g\sin\alpha \leq \mu_s g\cos\alpha$

$0{,}12 \leq 0{,}178$ ✓



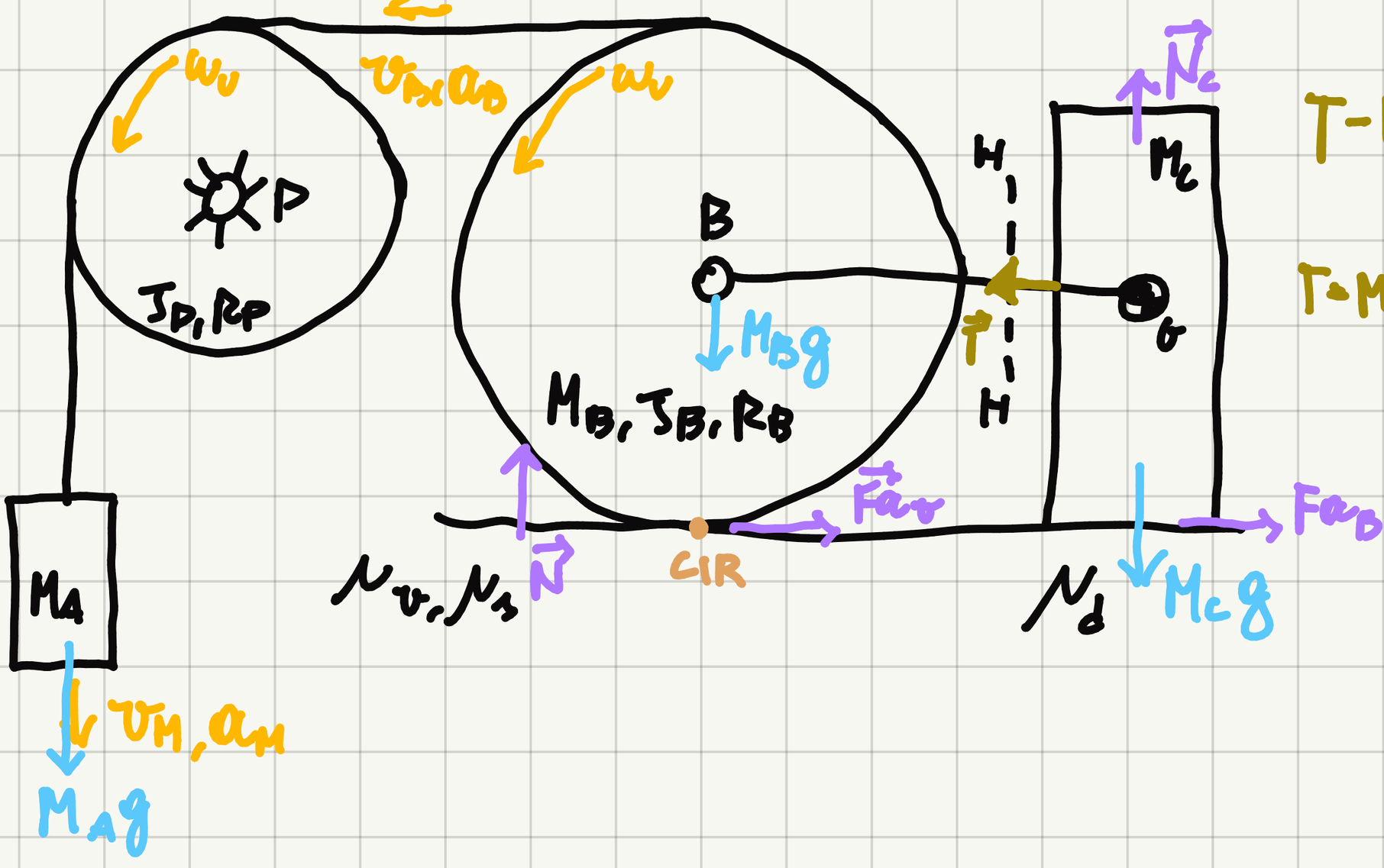
$J_m = 0{,}5\,kg\,m^2$ $J_P = 1\,kg\,m^2$ $J_B = 2\,kg\,m^2$ $M_A = 10\,kg$

$M_B = 8\,kg$ $M_C = 5\,kg$ $R_P = 1\,m$ $R_B = 2\,m$ $C_{m_0} = 25\,Nm$

$\omega_s = 250\,rad/s$ $\tau = \frac{1}{20}$ $\eta_d = 0{,}9$ $\eta_r = 0{,}8$ $\eta_s = 0{,}7$ $\eta_d = 0{,}5$ $\eta_v = 0{,}02$

M_A IN DISCESA ① REGIME $\Rightarrow C_m, \omega_m$? ② $a_{M_A} = 1{,}5\,m/s^2 \Rightarrow C_m$?

TIRO FUNE IN H---H? ADERENZA DISCO M_B?



$T - F_{ad} = M_C a_B$

$T = M_C (a_B + \eta_d g)$

LEGAMI CINEMATICI:

$$\omega_v = \tau \omega_m \rightarrow \dot{\omega}_v = \tau \dot{\omega}_m$$

$$v_M = v_P + \omega_v R_P = \tau R_P \omega_m \rightarrow a_M = \tau R_P \dot{\omega}_m$$

$$v_M = v_{/IR} + 2R_B\omega_B \Rightarrow \omega_B = \tau\frac{R_P}{2R_B}\omega_m \rightarrow \dot{\omega}_B = \tau\frac{R_P}{2R_B}\dot{\omega}_m$$

$$v_B = v_{/IR} + R_B\omega_B = \tau\frac{R_P}{2}\omega_m \Rightarrow a_B = \tau\frac{R_P}{2}\dot{\omega}_m$$

BILANCIO DI POTENZE) $P_1 + P_2 + P_T = 0$

$$P_1 = \Sigma P^{(m)} - \frac{d}{dt}K^{(m)} = C_m\omega_m - J_m\dot{\omega}_m\omega_m$$

$$P_2 = \Sigma P^{(\omega)} - \frac{d}{dt}K^{(\omega)}$$

- $\Sigma P^{(\omega)} = M_A g v_M + (0) + (-N_0 \overbrace{M_B g R_B \omega_m}^{N}) - F\alpha_B v_B$ $\quad \nearrow N_d N_c = N_d M_c g$

$= M_A g \tau R_P \omega_m - N_0 M_B g R_B \tau\frac{R_P}{2R_B}\omega_m - N_d M_c g \tau\frac{R_P}{2}\omega_m =$

$= \tau g R_P \left(M_A - \frac{N_0 M_B}{2} - \frac{N_d M_c}{2}\right)\omega_m = 4{,}25\omega_m$

- $\frac{d}{dt}K = M_A v_M a_M + J_P\dot{\omega}_0\omega_0 + M_B v_B a_B + J_B\dot{\omega}_B\omega_B + M_C v_B a_B =$

$= M_A\tau^2 R_P^2\dot{\omega}_m\omega_m + J_P\tau^2\dot{\omega}_m\omega_m + (M_B + M_C)\tau^2\frac{R_P^2}{4}\dot{\omega}_m\omega_m +$

$J_B\tau^2\left(\frac{R_P}{2R_B}\right)^2\dot{\omega}_m\omega_m = 0{,}036\dot{\omega}_m\omega_m$

$C_m\omega_m - J_m\dot{\omega}_m\omega_m + 4{,}25\omega_m - 0{,}036\dot{\omega}_m\omega_m + P_T = 0$

CASO 1) REGIME $\Rightarrow C_m, \omega_m$?

$C_m\omega_m + 4{,}25\omega_m + P_T = 0$

- $P_L = C_m\omega_m \gtrless 0$?
- $P_T = 4{,}25\omega_m > 0 \Rightarrow$ **MOTO RETROGRADO**

$P_T = -(1 - \Pi_r)\cdot 4{,}25\omega_m \Rightarrow C_m\omega_m + 4{,}25\omega_m - (1 - 2\Pi_r)\cdot 4{,}25\omega_m = 0$

$\Rightarrow C_m = -3{,}4\,Nm$

$C_m = C_{m0} + B\omega_m$ $\quad 0 = 25 + B\omega_s \Rightarrow B = -0,1 \frac{Nm}{rad/s}$

$\Rightarrow C_m = 25 - 0,1\omega_m$ $\quad \omega_m = 284\ rad/s$

CASO 2) $a = 1,5\ m/s^2 \Rightarrow C_m$?

$\dot{\omega}_m = 30\ rad/s^2$ $\quad C_m\omega_m - J_m\dot{\omega}_m\omega_m + 4,125\omega_m - 0,036\dot{\omega}_m\omega_m + P_T = 0$

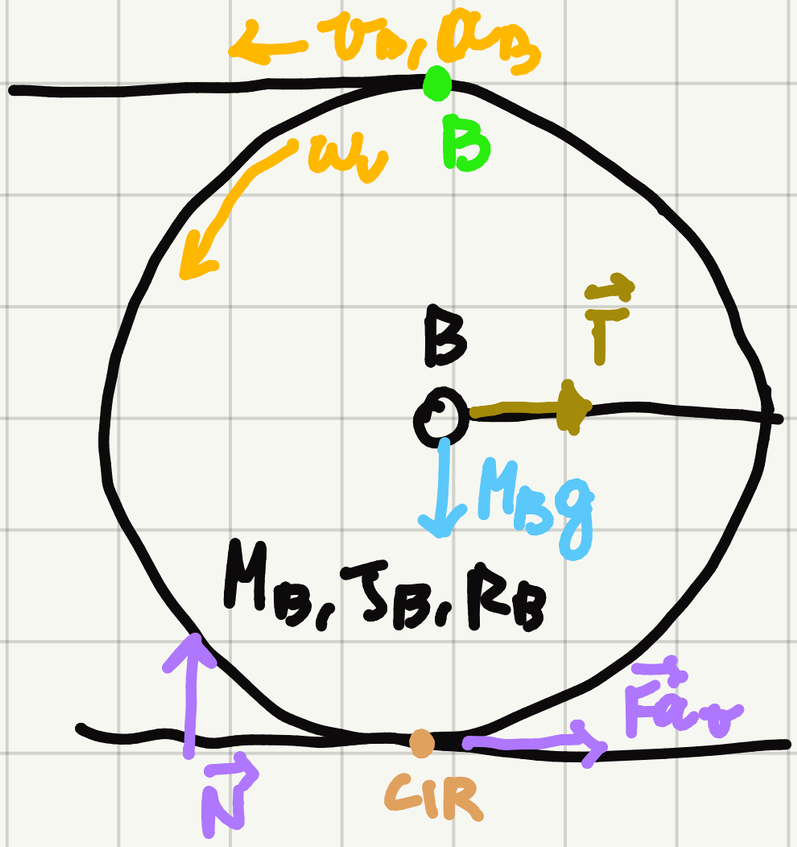
- $P_I = (C_m - 15)\omega_m \gtrless 0$?

- $P_I = (4,125 - 0,036 \cdot 30)\omega_m = 3,17\omega_m > 0 \Rightarrow$ MOTO RETROGRADO

$\Rightarrow C_m = 12,46\ Nm$

$P_T = -(1 - \eta_t) \cdot 3,17\omega_m$ $\quad (C_m - 15)\omega_m + 3,17\omega_m - (1 - \eta_t)3,17\omega_m$

$a_B = 0,75\ m/s^2 \Rightarrow T = 28,28\ N$



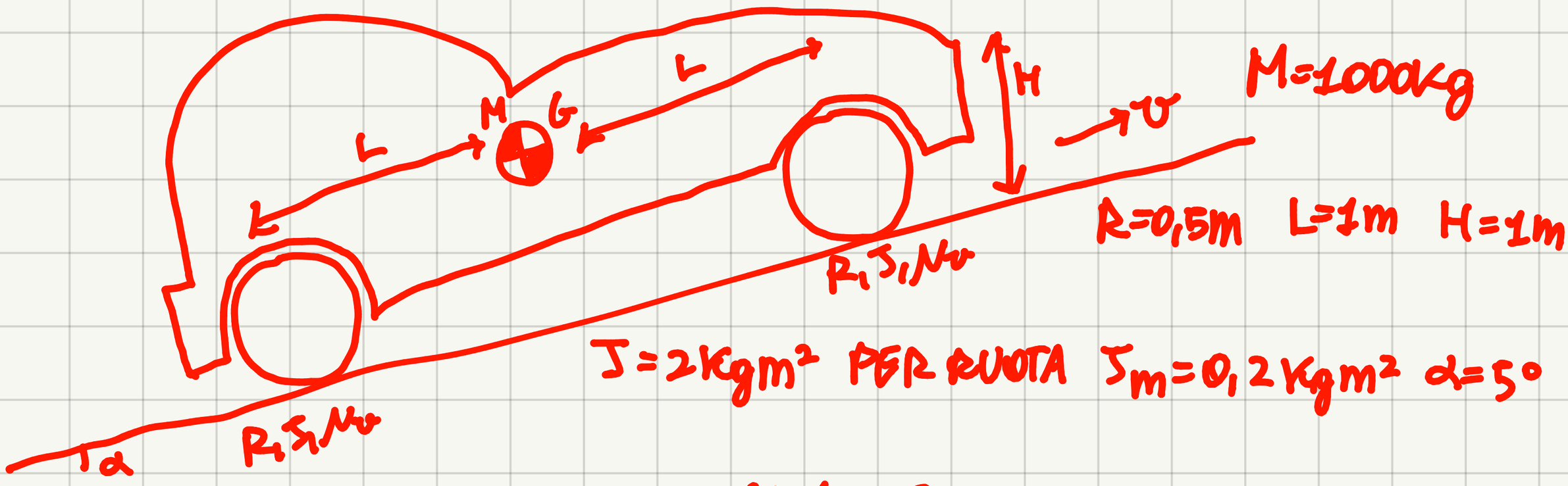
$\dot{\omega}_R = 0,375\ rad/s^2$

$M_B)$ $\quad -R_B T - F_{av} 2R_B + J_B\dot{\omega}_B - M_B a_B R_B -$

$-N_v M_B g R_B = 0$

$F_{av} = -17,74\ N$ $\quad F_{a\,lim} = N_s M_B g = 54,9\ N$

$\Rightarrow$ ADERENZA VERIFICATA

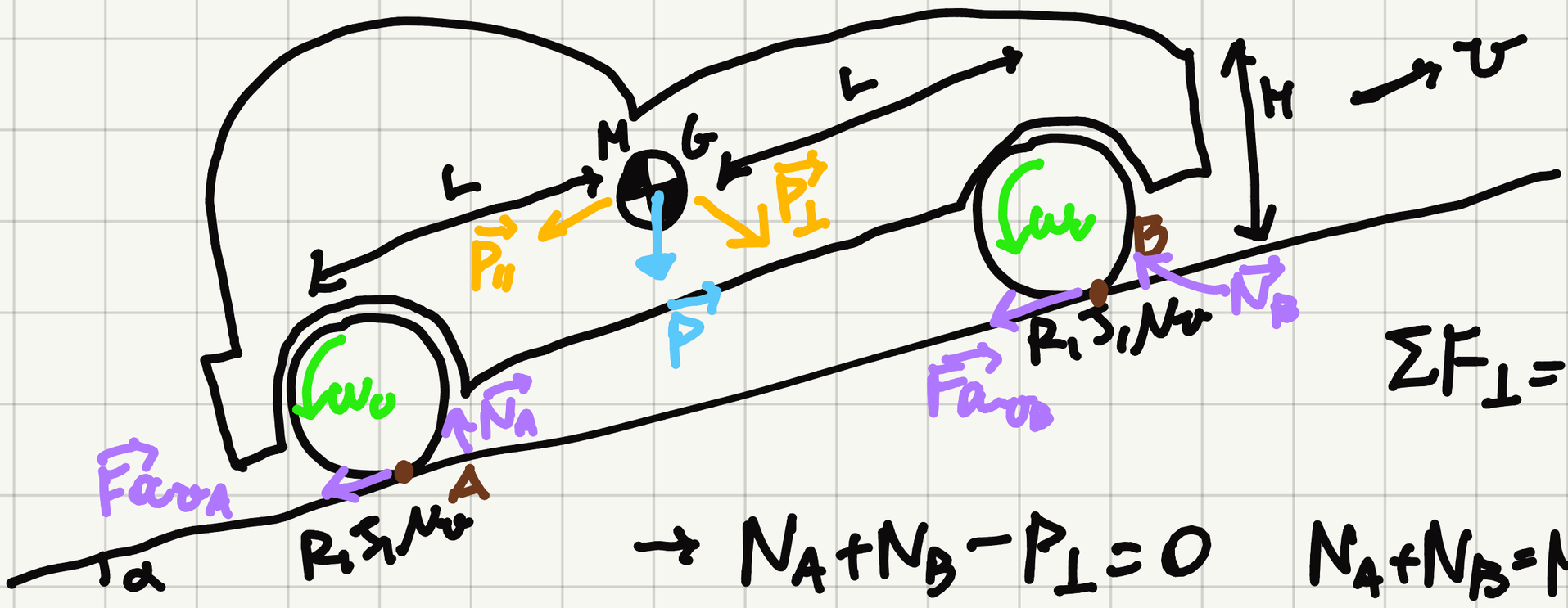


$J = 2\,Kgm^2$ PER RUOTA $J_m = 0,2\,Kgm^2$ $\alpha = 5°$

$C_{m0} = 300\,Nm$ $N_v = 0,05$ $N_s = 0,8$ $\tau = 1/10$ $\eta_d = 0,9$ $\eta_r = 0,7$

RUOTE POSTERIORI

① REGIME ⇒ C_m? ② SPUNTO ⇒ α? ③ $\alpha = -2M/s^2$ ⇒ C_m? ADERENZA



$\Sigma F_\perp = 0$

$\rightarrow N_A + N_B - P_\perp = 0 \quad N_A + N_B = Mg\cos\alpha$

LEGAMI CINEMATICI:

$$\omega_v = \tau\omega_m \rightarrow \dot{\omega}_v = \tau\dot{\omega}_m$$

$$v_G = v_{RUOTE} = R\omega_v = \tau R\omega_m \rightarrow a_G^{(c)} = \tau R\dot{\omega}_m$$

BILANCIO DI POTENZE) $P_1 + P_T + P_2 = 0$

$$P_1 = \Sigma P^{(m)} - \frac{d}{dt}K^{(m)} = C_m\omega_m - J_m\dot{\omega}_m\omega_m$$

$$P_2 = \Sigma P^{(w)} - \frac{d}{dt}K^{(w)}$$

- $\Sigma P^{(w)} = -P_{//}v_G - Fa_{v_B} - Fa_{v_A} = -Mg\sin\alpha\,\tau R\omega_m - N_v(N_A + N_B)R\omega_v =$

$= -\tau RMg(\sin\alpha + N_v\cos\alpha)\omega_m = -67,2\omega_m$

- $\frac{d}{dt}K = M v_G a_G^{(a)} + 4 J \dot{\omega}_v \omega_v = M \gamma^2 R^2 \dot{\omega}_m \omega_m + 4 \gamma^2 J \dot{\omega}_m \omega_m =$

$= \gamma^2 (MR^2 + 4J) \dot{\omega}_m \omega = 2{,}58\, \dot{\omega}_m \omega_m$

$C_m \omega_m - J_m \dot{\omega}_m \omega_m - 67{,}2\, \omega_m - 2{,}58\, \dot{\omega}_m \omega_m + P_T = 0$

CASO 1) REGIME $\Rightarrow C_m, \omega_m$?

$C_m \omega_m - 67{,}2 \omega_m + P_T = 0$

- $P_t = C_m \omega_m \gtrless 0$?
- $P_T = -67{,}2\, \omega_m > 0 \Rightarrow$ MOTO DIRETTO

$P_T = -(1 - \tau Z_d) C_m \omega_m$ $C_m \omega_m - 67{,}2 \omega_m - (1 - \tau Z_d) C_m \omega_m = 0 \Rightarrow C_m = 74{,}7\,Nm$

CASO 2) $C_m = C_{m0} \Rightarrow a$?

$C_m \omega_m - J_m \dot{\omega}_m \omega_m - 67{,}2\, \omega_m - 2{,}58\, \dot{\omega}_m \omega_m + P_T = 0$

P1) $C_{m0} \omega_m > 0 \Rightarrow$ MOTO DIRETTO

$C_{m0} \omega_m - J_m \dot{\omega}_m \omega_m - 67{,}2 \omega_m - 2{,}58 \dot{\omega}_m \omega_m - (1 - \tau Z_d)(C_{m0} \omega_m - J_m \dot{\omega}_m \omega_m) = 0$

$\rightarrow \dot{\omega}_m = 73{,}48\ rad/s^2 \Rightarrow a = \gamma R \dot{\omega}_m = 3{,}67\ m/s^2$

CASO 3) $a = -2\ m/s^2$ C_m?

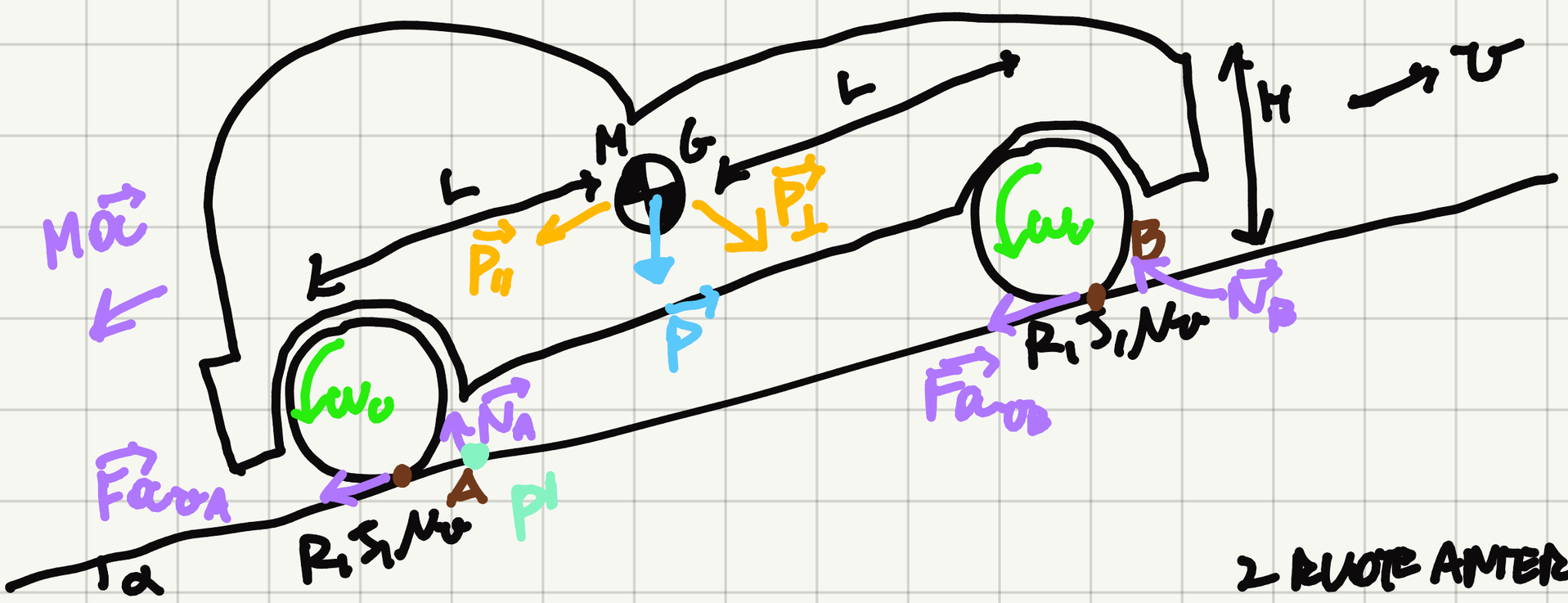
$\dot{\omega}_m = -40\ rad/s^2$

$C_m \omega_m - J_m \dot{\omega}_m \omega_m - 67{,}2\, \omega_m - 2{,}58\, \dot{\omega}_m \omega_m + P_T = 0$

- $(C_m - J_m \dot{\omega}_m) \omega_m \gtrless 0$?
- $(-67{,}2 - 2{,}58 \cdot (-40)) \omega_m = 36 \omega_m > 0 \Rightarrow$ MOTO RETROGRADO

$$P_f = -(1-2Z_f)\cdot 36\omega_m$$

$$C_m\omega_m - J_m\dot{\omega}_m\omega_m + 36\omega_m - (1-2Z_f)36\omega_m = 0 \rightarrow C_m = -33,2\,Nm$$



2 RUOTE ANTERIORI

$$M_{pi}) \quad -\tau^2 4J\dot{\omega}_m - MaH - MgH\sin\alpha + 2L(2N_B) - Fa_{vB} = 0$$

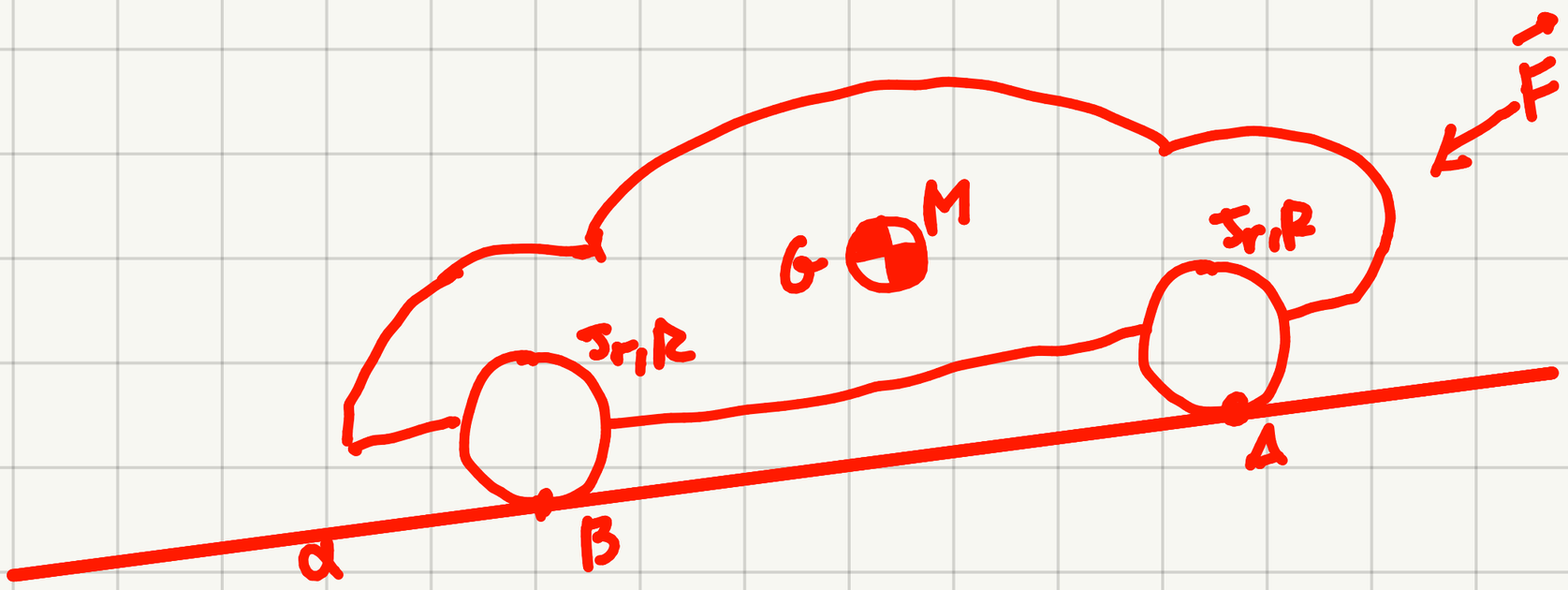
$$-\tau^2 4J\dot{\omega}_m - MaH - MgH\sin\alpha + 2L(2N_B) - Mg\cos\alpha(L - N_0R) = 0$$

$$\Rightarrow N_B = 2676\,N$$

$$M_c) \quad FaR + N_0NR - J\dot{\omega}_m = 0 \rightarrow Fa = 117\,N$$

$$Fa_{aim} = N_3N = 2140\,N$$

$Fa \leq Fa_{aim} \Rightarrow$ ADERENZA VERIFICATA



$\alpha = 5°$ $M = 1100\,kg$

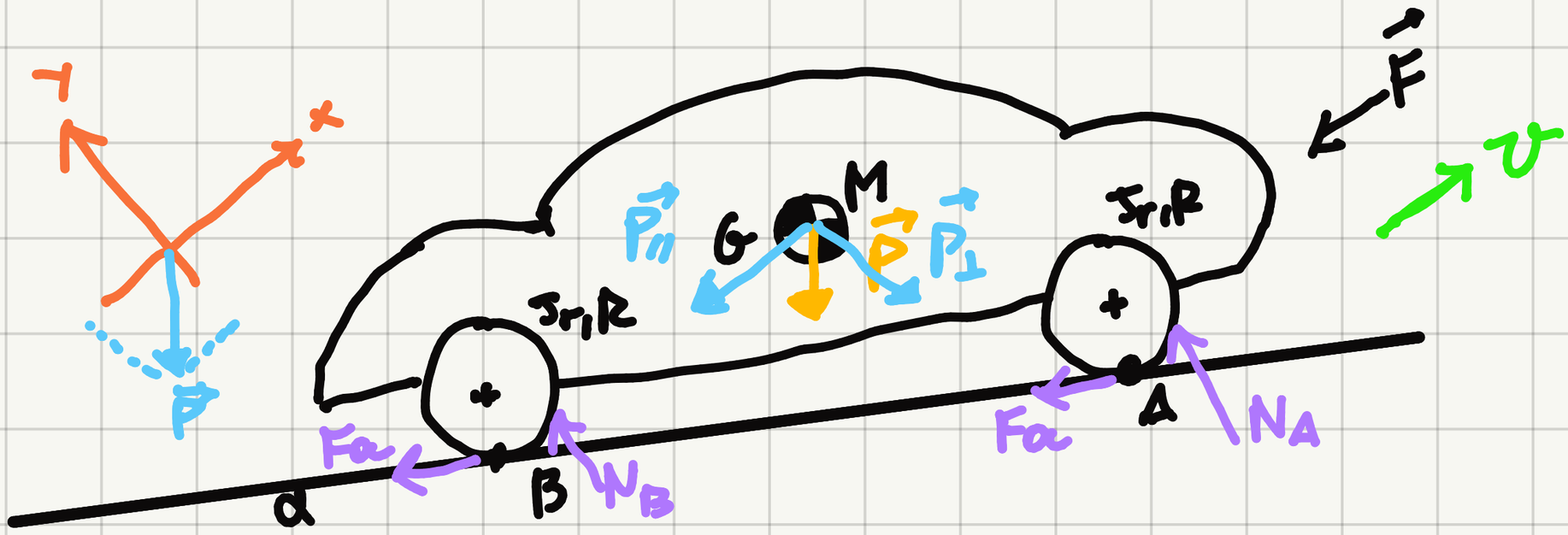
$J_m = 0,25\,kg\,m^2$

J_r → SINGOLA $J_r = 0,175\,kg\,m^2$

$R = 0,3\,m$ $F = 200\,N$ $\mu_v = 0,02$ $\tau = 1/6$ $\eta = 0,9$ $B = 150\,Nm$

$A = 0,02 \frac{Nm}{rad/s}$

- $C_m = 100\,Nm$ $\dot{\omega}_m$? · REGIME C_m? v?



LEGAMI CINEMATICI $F_{a1} = \mu_v N_A + \mu_v N_B = \mu_v (N_A + N_B) = \mu_v Mg\cos\alpha$

$\omega_r = \tau \omega_m$ $\dot{\omega}_r = \tau \dot{\omega}_m$ $v = v_r = v_{C/R} + R\omega_v = \tau R \omega_m$ $a = \tau R \dot{\omega}_m$

BILANCIO DI POTENZE) $P_1 + P_2 + P_T = 0$

$P_1 = \sum P^{(m)} - \frac{d}{dt} K^{(m)} = C_m \omega_m - J_m \dot{\omega}_m \omega_m$

$P_2 = \sum P^{(\omega)} - \frac{d}{dt} K^{(\omega)}$ $C_m \omega_m - J_m \dot{\omega}_m$

- $\sum P^{(\omega)} = (-P_{//} - F) v - F_{a1} \omega_v R = \tau R (-Mg\sin\alpha - F - \mu_v Mg\cos\alpha)\omega_m =$
$= -67,77\,\omega_m$
- $\frac{d}{dt} K = Mva + 4 J_r \dot{\omega}_v \omega_v = \tau^2 R^2 M \dot{\omega}_m \omega_m + 4\tau^2 J_r \dot{\omega}_m \omega_m =$
$= (\tau^2 R^2 M + 4\tau^2 J_r)\dot{\omega}_m \omega_m = 2,83\,\dot{\omega}_m \omega_m$

$C_m \omega_m - J_m \dot{\omega}_m \omega_m - 67,77\,\omega_m - 2,83\,\dot{\omega}_m \omega_m + P_T = 0$

CASO 1) $C_m = 100 Nm$ $\dot{\omega}_m$?

$$100\omega_m - J_m\dot{\omega}_m\omega_m - 67{,}77\omega_m - 2{,}83\dot{\omega}_m\omega_m + P_T = 0$$

$P_1 = (100 - 0{,}25\dot{\omega}_m)\omega_m \geq 0$? H_P MOTO DIRETTO

$P_2 = (-67{,}77 - 2{,}83\dot{\omega}_m)\omega_m \geq 0$? $P_T = -(1-\tau_2)(100 - 0{,}25\dot{\omega}_m)\omega_m$

$(100 - 0{,}25\dot{\omega}_m)\omega_m + (-67{,}77 - 2{,}83\dot{\omega}_m)\omega_m - (1-\tau_2)(100 - 0{,}25\dot{\omega}_m)\omega_m = 0$

$\Rightarrow \dot{\omega}_m = 7{,}27\ rad/s^2 \Rightarrow a = 0{,}36\ m/s^2$ $P_1 = 99{,}91\omega_m > 0$ ✓

CASO 2) REGIME $\rightarrow$ C_m, ω_m ?

$$C_m\omega_m - 67{,}77\omega_m + P_T = 0$$

$P_2 = C_m\omega_m \geq 0$?

$P_2 = -67{,}77\omega_m < 0 \Rightarrow$ MOTO DIRETTO $P_T = -(1-\tau_2)C_m\omega_m$

$C_m\omega_m - 67{,}77\omega_m - (1-\tau_2)C_m\omega_m = 0 \Rightarrow C_m = 75{,}3\ Nm$

$C_m = 150 - 0{,}02\omega_m \Rightarrow \omega_m = 3735\ rad/s \Rightarrow v = 186{,}75\ m/s$