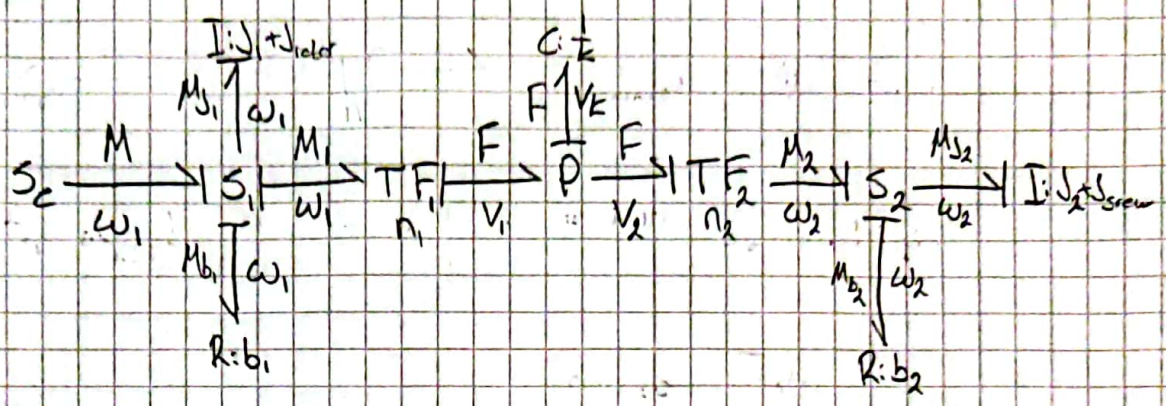
Lab 2 Casper Larsson

2.1 Belt transmission:



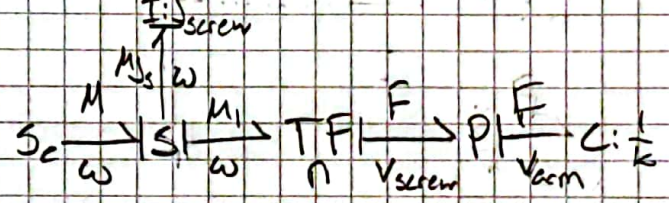
$n_1 = r_1 \Rightarrow \quad v_1 = \omega_1 r_1$

$F = \frac{1}{r_1} M_1$

$n_2 = \frac{1}{r_2} \Rightarrow \quad \omega_2 = \frac{1}{r_2} v_2$

$M_2 = F r_2$

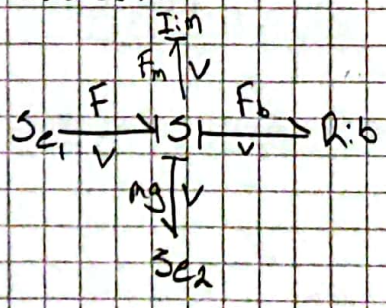
Screw transmission:



$n = \frac{0.0254}{2\pi} \approx 4.04 \cdot 10^{-3} \Rightarrow \quad v_{screw} = 4.04 \cdot 10^{-3} \omega$

$F = \frac{1}{4.04 \cdot 10^{-3}} M_1$

Robot arm:



2.2 $J_1 = \frac{\pi}{2} r^4 h \rho = \begin{cases} r = 10mm = 0.01m \\ h = 10mm = 0.01m \end{cases} \quad \rho = 2.7 \cdot 10^3 kg/m^3 \Big\} = 4.24... \cdot 10^{-7} \approx 4.2 \cdot 10^{-7} kgm^2$

$b_1 = 2 \cdot 10^{-6}$ Nms/rad

$J_2 = \frac{\pi}{2} r^4 h \rho = \begin{cases} r = 40mm = 0.04m \\ h = 16mm = 0.016m \end{cases} \quad \rho = 2.7 \cdot 10^3 kg/m^3 \Big\} = 1.62... \cdot 10^{-4} = 1.6 \cdot 10^{-4} kgm^2$

$b_2 = 5 \cdot 10^{-5}$ Nms/rad

$F = k_{belt} \Delta x \Leftrightarrow k_{belt} = \frac{F}{\Delta x} = \begin{cases} F = 200N \\ \Delta x = 0.004 \cdot 750mm = 0.003m \end{cases} \Big\} = \frac{200}{0.003} \approx 66\,667 N/m$

$J_{screw} = J_{unit} \cdot length = 5.2 \cdot 10^{-5} \cdot \frac{0.45359}{16} \cdot 9.81 N \cdot sec^2 \cdot 1m =$

$= 5.2 \cdot 10^{-5} \cdot \frac{0.45359}{16} \cdot 9.81 \approx 1.4 \cdot 10^{-5} kgm^2$

$k_{screw} = 75000$ N

$m_{arm} = 5.5 kg$

$b_{arm} = 25$ Ns/m

$F_g = m_{arm} g = 5.5 \cdot 9.81 = 53.955$ N

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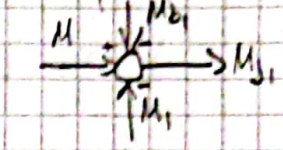
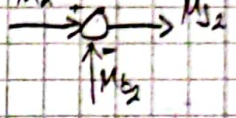
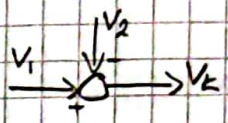
Simulink:

Belbi:

S_c: $u = M$

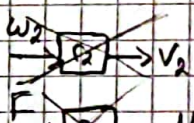
S_1: $M - M_{J_1} - M_1 - M_{b_1} = 0 \Leftrightarrow M_{J_1} = M - M_1 - M_{b_1} \Rightarrow$ 

S_2: $M_2 - M_{b_2} - M_{J_2} = 0 \Leftrightarrow M_{J_2} = M_2 - M_{b_2} \Rightarrow$ 

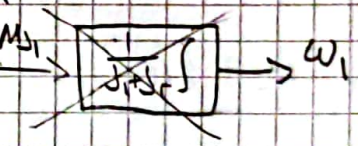
P: $V_1 - V_k - V_2 = 0 \Leftrightarrow V_k = V_1 - V_2 \Rightarrow$ 

TF$_1$: $V_1 = \omega_1 r_1 \Rightarrow$ 

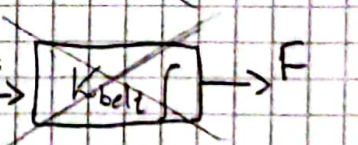
$F = \frac{1}{r_1} M_1 \Rightarrow$ 

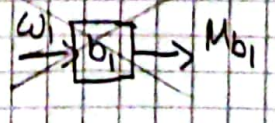
TF$_2$: $\omega_2 = \frac{1}{r_2} V_2 \Rightarrow$ 

$M_2 = F r_2 \Rightarrow$ 

I: $J_1 + J_c$: $\omega_1 = \frac{1}{J_1 + J_c} \int M_{J_1}(t)\,dt \Rightarrow$ 

I: $J_2 + J_s$: $\omega_2 = \frac{1}{J_2 + J_s} \int M_{J_2}(t)\,dt \Rightarrow$ 

C: $\frac{1}{K_{belt}}$: $F = K_{belt} \int V_k(t)\,dt \Rightarrow$ 

R: b_1: $M_{b_1} = b_1 \omega_1 \Rightarrow$ 

R: b_2: $M_{b_2} = b_2 \omega_2 \Rightarrow$ 

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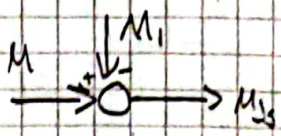
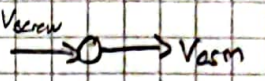
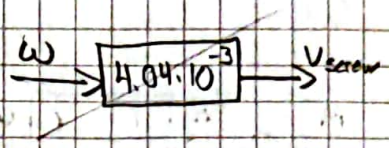
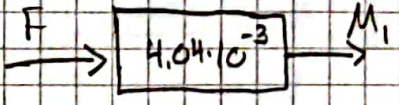
Screw:

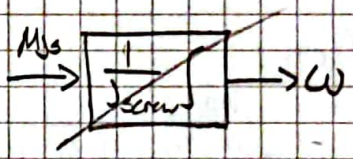
Se: $u = M$

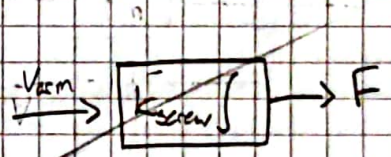
S: $M - M_{js} - M_1 = 0 \Leftrightarrow M_{js} = M - M_1 \Rightarrow$ 

P: $v_{screw} - v_{arm} = 0 \Leftrightarrow v_{arm} = v_{screw} \Rightarrow$ 

TF: $v_{screw} = 4.04 \cdot 10^{-3} \omega \Rightarrow$ 

$F = \frac{1}{4.04 \cdot 10^{-3}} M_1 \Rightarrow$ 

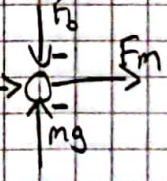
I: J_{screw}: $\omega = \frac{1}{J_{screw}} \int M_{js}(t) dt \Rightarrow$ 

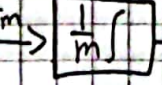
C: $\frac{1}{k_{screw}}$: $F = k_{screw} \int v_{arm}(t) dt \Rightarrow$ 

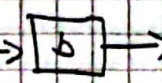
Arm:

$S_{e_1}: u_1 = F$

$S_{e_2}: u_2 = mg$

S: $F - F_m - F_b - mg = 0 \Leftrightarrow F_m = F - F_b - mg \Rightarrow$ 

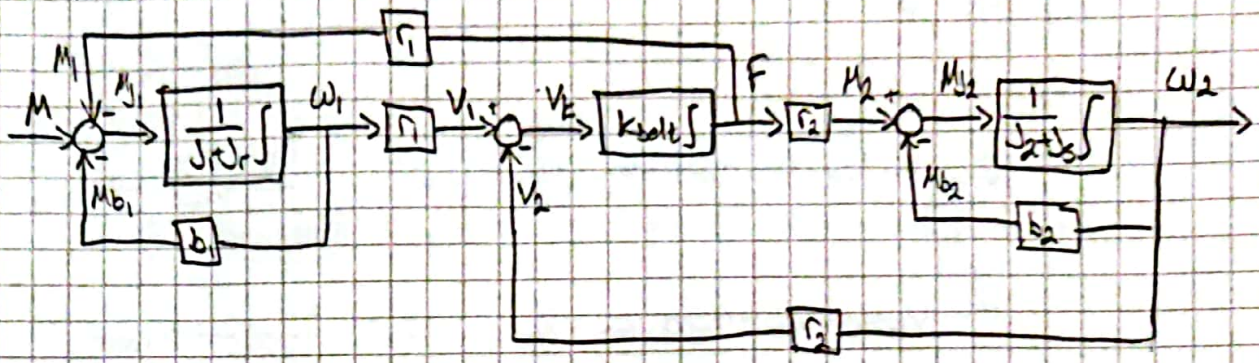
I: m: $v = \frac{1}{m} \int F_m(t) dt \Rightarrow$ 

R: b: $F_b = bv \Rightarrow$ 

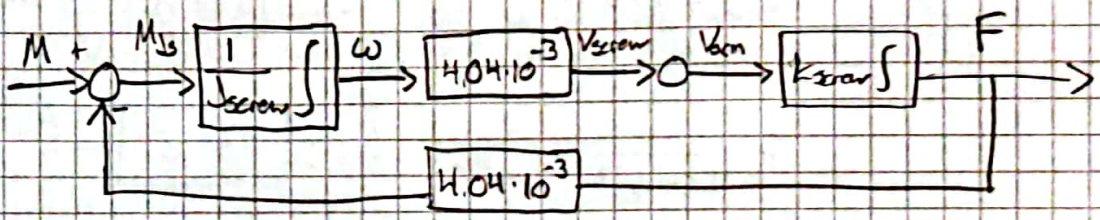
2.3

Block diagram:

Belt:



Screw:



Arm: