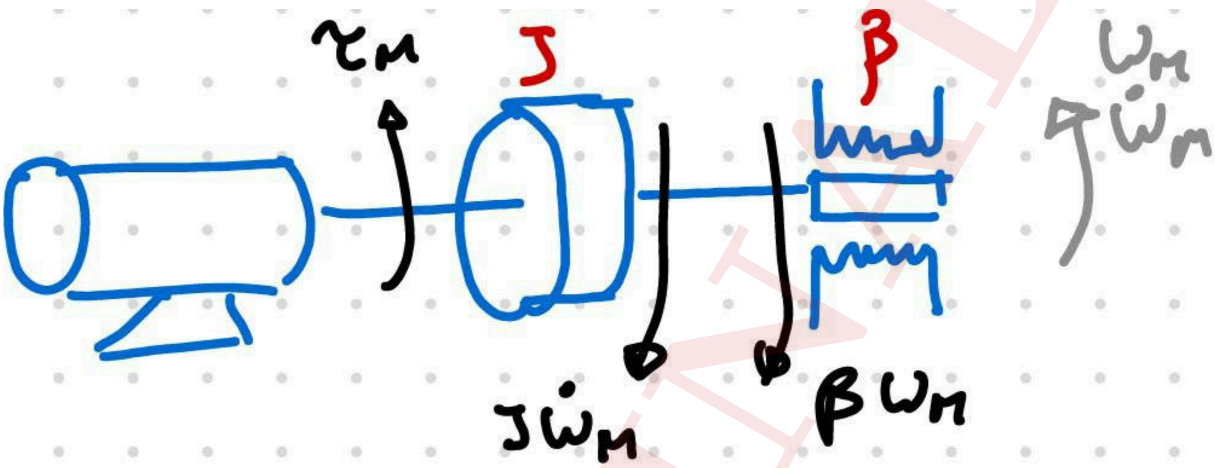
Lab 1: what to do now?

Congrats, you've just completed your first day in the lab. In those 5 hours (more like 4 and half to be honest...) we performed our fair share of experiments and it's now time to see what can we obtain from all the data.

1) Gray Box Model identification

(From the "quick sketch" photo I shared previously)



Where $J_{\text{tot}} = J_m + \frac{J_l}{r^2 \eta_g}$ and β is a generic parameter that contains in itself all additional mechanical losses due to friction (supposed linear to angular speed).

$$\tau_m = J\dot{\omega}_m + \beta\omega_m \tag{1.}$$

At steady state:

$$\tau_m = \beta\overline{\omega}_m \tag{2.}$$

$$\beta = \frac{\tau_{m(\omega_m)}}{\overline{\omega}_m} \tag{3.}$$

From the electrical circuit:

$$\tau_{m(\omega_m)} = \eta_m k I(\omega_m) \tag{4.}$$

$$I = \frac{V - E}{R} = \frac{V - k\omega_m}{R} \tag{5.}$$

$$\tau_{m(\omega_m)} = \eta_m k \frac{V - k\omega_m}{R} \tag{6.}$$

Once we know the speed at steady state it's possible to estimate the parameter β and plug it in the dynamic model.

2) Signal processing

We have two tasks:

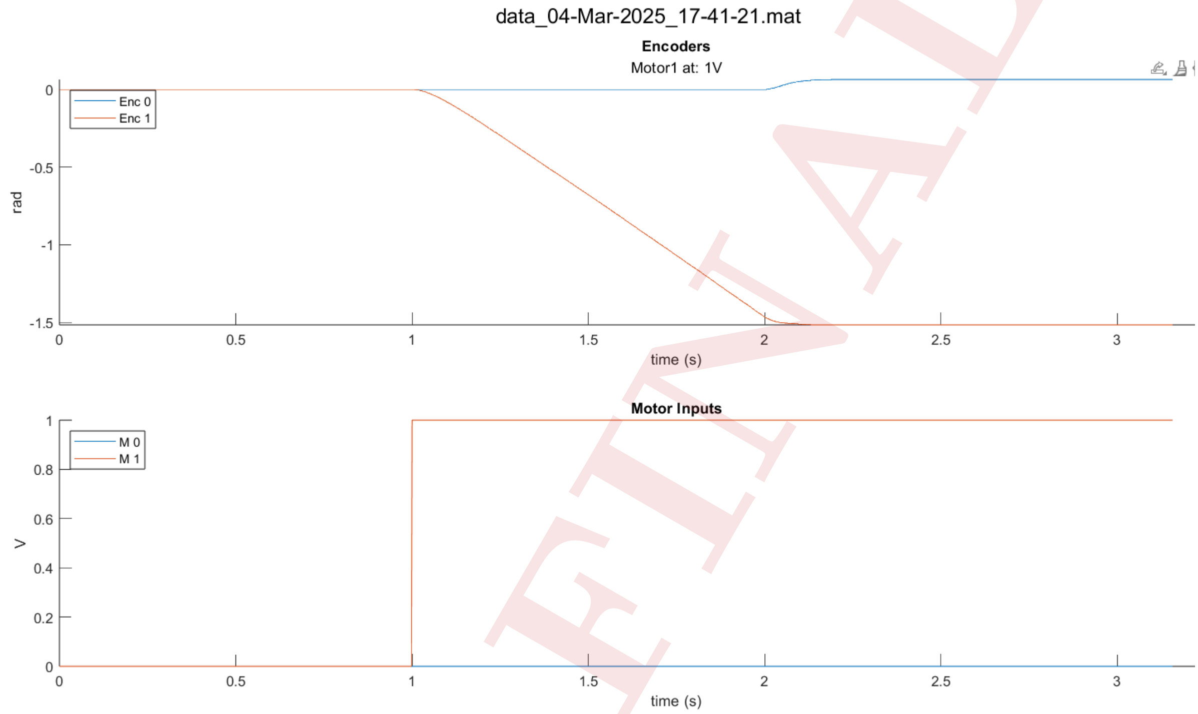
1. Derive the angle to find the speed
2. Filter out (relatively) high frequency "noise"

My proposal is to use a pure derivator (s) and two poles (τ_1, τ_2) at whatever rad/s to obtain a “band pass filter”.

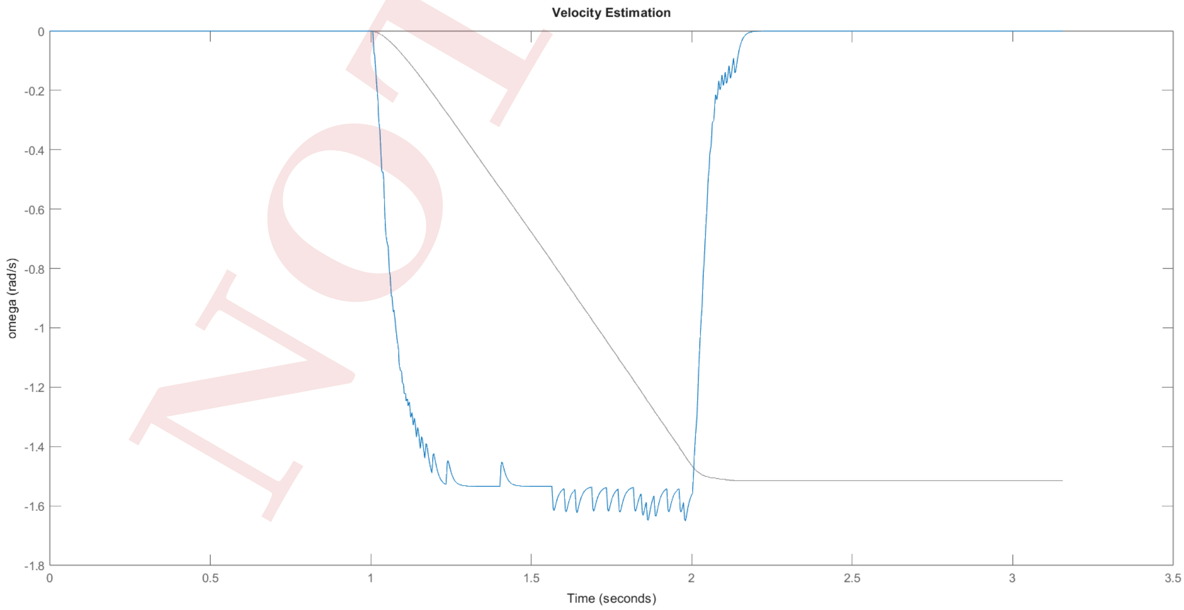
$$\text{Filter}(s) = \tau_1\tau_2 \frac{s}{(s+\tau_1)(s+\tau_2)} \tag{7.}$$

2.1) Numerical Examples

From `data_04-Mar-2025_17-41-21.mat`:



After derivation with poles at 80 & 400 rad/s:



We can see the encoder speed settling at 1.57 rad/s:

```
omega_l = 1.57;
V = 1;

omega_m = 70*omega_l;
R = 2.6;
k = 7.68e-3;
E = k * omega_m  = 0.8440
I = (V-E)/R = 0.0600
torque = I * k = 4.6071e-04
beta = torque/omega_m = 4.1920e-06
```

Repeat this for all the experiments :)

Then do an average or something.