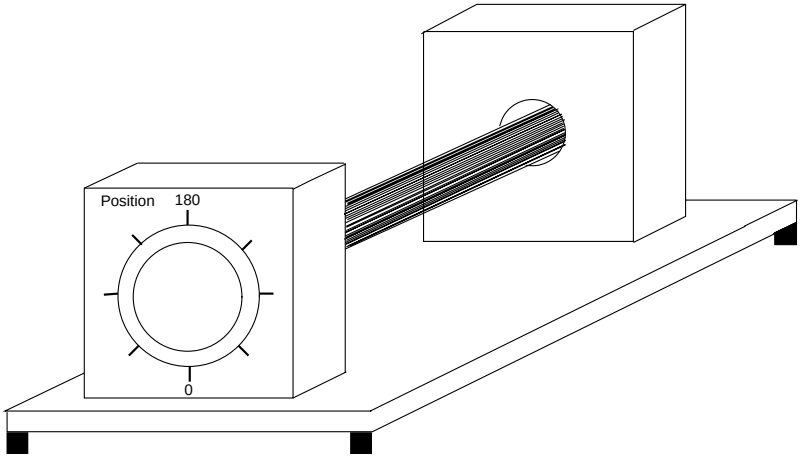
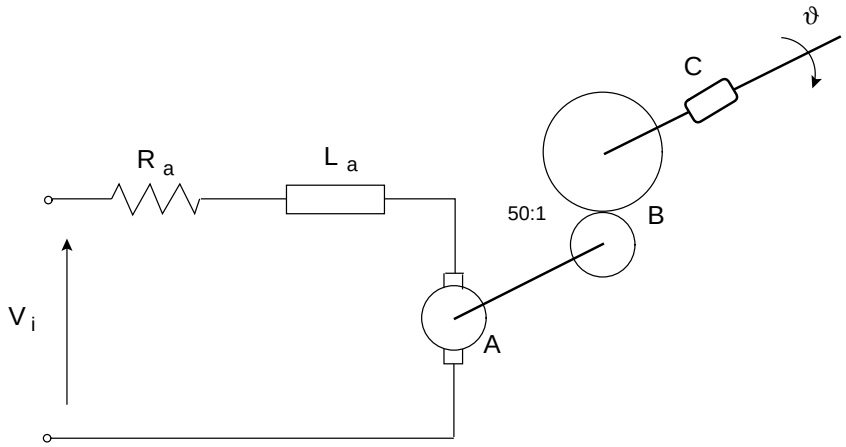
Angular Speed Control

General Description

The process consists of a DC motor, a reduction unit, a tachometer and a visualization system. The DC motor (A) generates the actuating signal for the speed control system and the reducer (B) reduces the angular velocity. Reducer consists in two cogwheel performing a reduction of 50:1.





Motor Parameters

Nominal voltage	$24\,V$
Armature inductance (L_a)	$2.8\,mH$
Armature resistance (R_a)	$5.5\,\Omega$
Motor torque constant	$0.046\,Nm/A$
Nominal velocity	$4000\,RPM$
Max motor voltage no motion	$\pm\,2.3\,V$
Max applicable voltage	$\pm\,5\,V$

Mathematical Model

The open-loop transfer function of the process can be approximated as follows:

$$G(s) = \frac{K}{(1 + T_f\,s)(1 + T_m\,s)}$$

with:

$$K = \frac{k_g\,k_M}{R_f}$$

k_M	overall motor constant ($rad/V \cdot s$)
k_g	generator constant (V/A)
R_f	resistance of the field circuit (Ω)
T_f	generator field constant (s)
T_m	motor mechanical constant (s)

Due to a threshold present in the process, the full dynamics can be written as:

$$\omega(s) = \begin{cases} 0 & \text{if } \ |V_i| \in [0\,,2.3] \\ \dfrac{4}{(1 + \frac{1}{10}\,s)\,(1 + \frac{1}{2000}\,s)}\,V_i(s) & \text{if } \ |V_i| \in [2.3\,,5] \end{cases}$$

where V_i is the voltage applied to the motor and ω is the angular speed measured by a tachometric dynamo.