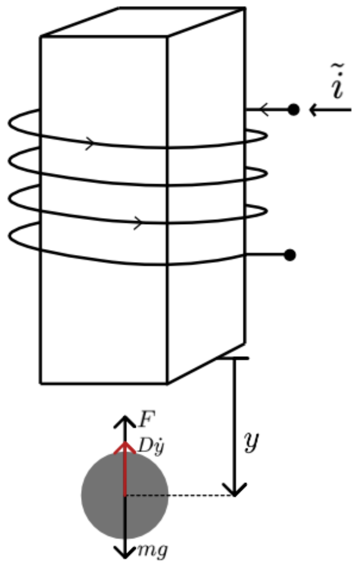
Laboratory 1 – Magnetic Levitation System



The simplified model of the system is

$$m\,\ddot{y} = mg - D\dot{y} - \frac{\tilde{\imath}^2}{2(1+y)^2}$$

Where $m = 1, D = 1$. Denoting by $i = \tilde{\imath}^{\,2}$

$$\begin{cases} \dot{y}_1 = y_2 \\ \dot{y}_2 = g - y_2 - \dfrac{i}{2(1+y_1)^2} \end{cases}$$

Tasks

1. Compute the constant input $\bar{\imath}$ such that $\bar{y}_1 = 1$ and $\bar{y}_2 = 0$ is an equilibrium.
2. Apply a change of coordinates which translates the equilibrium to the origin:

   $$x_1 = y_1 - \bar{y}_1$$
   $$x_2 = y_2 - \bar{y}_2$$
   $$u = i - \bar{\imath}$$

   Then, draw the phase plane to study the stability of the origin.
3. Compute the backstepping control law.

   Test the closed-loop in Simulink, considering different initial condition of the system.

   Then, inspect the closed-loop phase plane.
4. Assuming that only the position is measurable (y_1), design a Proportional controller. Test the closed-loop in Simulink, considering different initial condition of the system. Then, inspect the closed-loop phase plane.
5. Design a PI controller and test the closed-loop in Simulink.

Available files

- `levitation_openloop` (open-loop model of the system)
- `levitation_ol` (phase-plane equations)