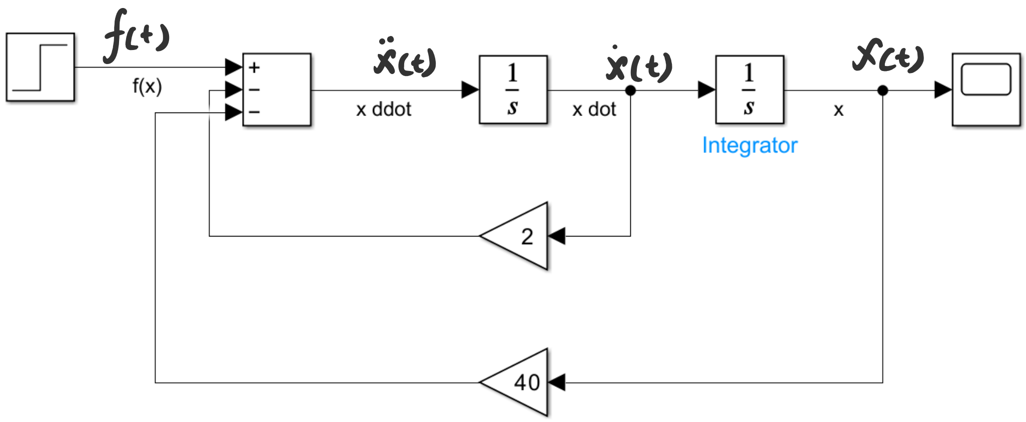
Lab 2 Prelab

1. Consider the differential equation

$$\ddot{x}(t) + 2\dot{x}(t) + 40x(t) = f(t).$$

   (a) Draw a time-domain block diagram representation of the original differential equation in terms of integrators, amplifiers, summing junctions, and splitting junctions. Don't forget the initial conditions. Label all connections between components to show the corresponding signals.

   (b) Draw a frequency-domain block diagram representation for the case of 0 initial conditions and use this to express $X(s) := \mathcal{L}[x(\#)](s)$ in terms of $F(s) := \mathcal{L}[f(\#)](s)$ and a transfer function $H(s)$.



$\ddot{x} + 2\dot{x} + 40x = f(t)$

$\because \mathcal{L}\{x(t)\} = X(s)$

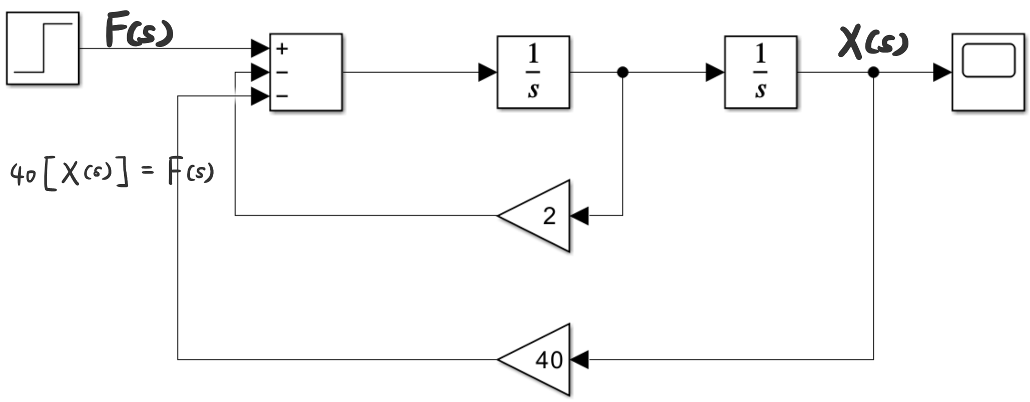
$\therefore \mathcal{L}\{\dot{x}(t)\} = sX(s) - x(0)$

$\mathcal{L}\{\ddot{x}(t)\} = s^2X(s) - s\,x(0) - \dot{x}(0)$

$\therefore s^2X(s) - s\,x(0) - \dot{x}(0) + 2[sX(s) - x(0)] + 40[X(s)] = F(s)$

$X(s) \cdot [s^2 + 2s + 40] = F(s)$

$X(s) = \frac{1}{s^2+2s+40} \cdot F(s)$



2. Consider the differential equation

$$\frac{1}{6}\ddot{\theta}(t) + 2\dot{\theta}(t) + 9.8\cos\theta(t) = 0$$

(a) Draw a time-domain block diagram representation of the original differential equation in terms of integrators, amplifiers, summing junctions, splitting junctions, and a component representing the nonlinear relationship $\theta \mapsto \cos\theta$. Don't forget the initial conditions. Label all connections between components to show the corresponding signals.