ECE486 Lab Report
Lab 1: Analog Simulation

Section *LA1*
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Prelab Exercises

Ex *a*.

From Newton's 3rd law, we derive the following equation:

$$ma_{tot} = f + b\dot{x} + kx$$
$$a_{tot} = \frac{\mathrm{d}^2}{\mathrm{d}t^2}x$$

thus we have the second-order ODE for the system,

$$m\ddot{x} = b\dot{x} + kx + f$$

and by simplifying the equation, we obtain

$$\ddot{x} = \frac{b}{m}\dot{x} + \frac{k}{m}x + \frac{f}{m}$$

Substituting the values for m, b, k, and f we obtain

$$\begin{cases} \ddot{x} &= \frac{0.7}{2}\dot{x} + \frac{1}{2}x + \frac{0.5}{2} \\ x_{t=0} &= 0 \\ \dot{x}_{t=0} &= 0. \end{cases} \tag{1}$$

Ex *b*.

Transform the second-order ODE into a linear equatoin using Laplace Transform:

$$\begin{aligned} \mathcal{L}\{\ddot{x}\} &= s^2X(s) \\ &= \frac{0.7}{2}sX(s) + \frac{1}{2}X(s) + \frac{0.5}{2s} \end{aligned}$$

Ex *c*.

For Figure 2(b) in the manual we can derive a group of equations based on KVL,

$$
\begin{aligned}
q_C &= Ce_o(t) \qquad (2) \\
e_i(t) - e_o(t) &= i(t)R \qquad (3) \\
\mathrm{d}q_C &= i(t)\,\mathrm{d}t \qquad (4)
\end{aligned}
$$

which gives

$$e_i(t) - \frac{q_C}{C} = i(t)R$$

i.e.

$$e_i(t) - \frac{1}{C}\int i(t)\,\mathrm{d}t - i(t)R = 0$$

Plots

Data Analysis