Practical 6

CSE Spring 2023

1. **Epidemic disease ((over)simplified)**

   Let us consider a virus ravaging through a town of 10000 people. It initially has 10 infected people in it. None of the people in the initial population are immune to the virus.

   Every day, 1% of healthy people die of natural causes (i.e. not because of the virus). Also, every day 10% of healthy people are infected with the virus. Lastly, every day, 1% of healthy people are given a vaccine that makes them immune to the virus.

   However, every day also 50% of those that have been infected with the virus die. Another 25% of those that have been infected are cured from the virus every day (and become immune). Lastly, the people who are immune to the virus die from natural causes at the same rate as people who are healthy, that is, every day 1% of them dies.

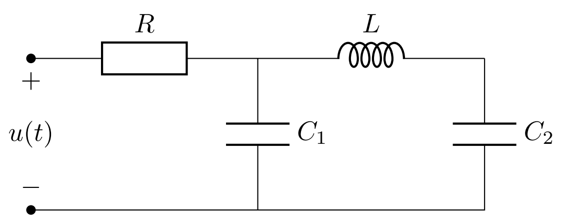
   The town also has an influx of people. Every day, 10 new healthy (but not immune) and 10 new infected people come to the town.

   Plot the number of healthy (but not immune), infected and immune people in the town over time. For this, write down the difference equations governing the system, convert it to a state-space model and use the Python Control Systems Library to plot the outcome (see documentation).

   After you have done that, you can also try to modify the parameters given above to see how they affect the situation.

2. **Electrical circuit**

   Look at the following circuit.

   Using KVL and KCL, derive differential equations governing the system.

   We are interested in how the voltages across L, C_1 and C_2 perform over time if $u(t)$ is a unit step input (goes from $0V$ to $1V$ at time $t = 0$). For this, convert the system to a state-space representation and use the Python Control Systems Library to simulate its behaviour (assuming initial voltages and currents are all 0).

   Use the following values:
   $R = 1k\Omega$
   $C_1 = 10nF$
   $C_2 = 100nF$
   $L = 100mH$

   You can also vary the values to see how the performance changes. Also try different inputs as $u(t)$.