Tutorial 6
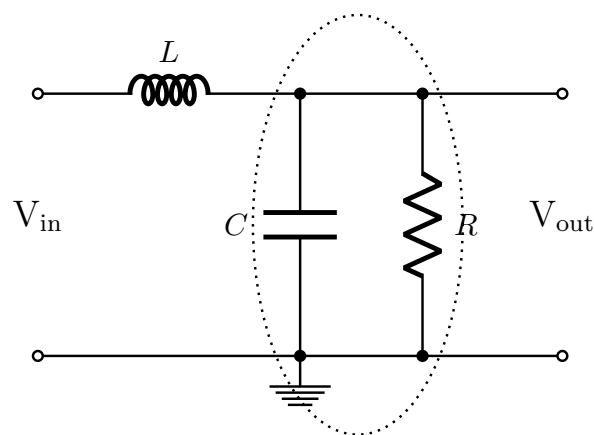
1. Given an LTI system with frequency response

$$H(\omega) = \frac{1}{1 + j\omega} \tag{1}$$

   Find the response to the input signal $x(t) = |\sin(t)|$.

2. Consider an LTI system having an impulse response $h(t) = u(t)$. Find the output signal of the system if the input signal is $x(t) = e^{-2t}u(t+2)$. Compare with the result of Q7 in Tutorial 5.

3. Consider the following analogue filter:

   (a) Intuitively explain that the above circuit implements a low-pass filter.

   (b) Find an equivalent circuit of the filter on the s-domain.

   (c) Find the equivalent impedance of the part denoted by the dotted ellipse.

   (d) From 3c, show that the magnitude frequency response of the filter is given by

   $$H(\omega) = \frac{1}{1 - \omega^2 LC + \frac{j\omega L}{R}}$$

   (e) Let $\omega_0 = \sqrt{\frac{1}{LC}}$ and $L = 2R^2C$. Determine the magnitude frequency response of the circuit $|H(\omega)|$ in terms of ω_0, and show that the circuit is a second order low-pass filter.

4. Consider a discrete-time LTI system with the impulse response $h[n]$ given by

$$h[n] = \begin{cases} 1 & n = -1 \\ -1 & n = 0 \\ 2 & n = 1 \end{cases}$$

Determine its response $y[n]$ to the input

$$x[n] = \cos\left(\frac{\pi}{2}n\right)$$