EE2160 CAD Laboratory - Python Exercise 1

1 RC Integrator Circuit

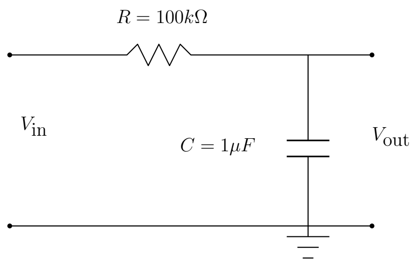
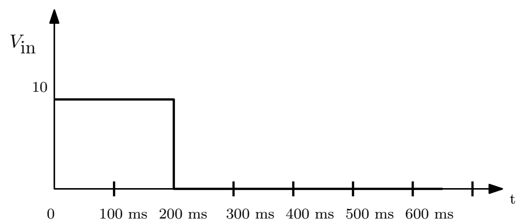


Figure 1: RC integrator circuit

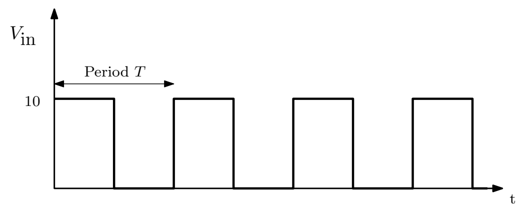
Figure 1 shows an RC integrator circuit. Plot the magnitude and phase response of the transfer function $V_{\text{out}}(\omega)/V_{\text{in}}(\omega)$. Generate Bode magnitude and phase plots. [Hint: Use *scipy.signal.bode*]

Plot the output voltage for the following input signals. Use the subplot command to show input and output voltages on the same figure.

1. Input pulse



2. Input square wave: Try $T = 0.1RC$, $T = RC$, and $T = 10RC$



2 RC Differentiator Circuit

Repeat the above exercise for the RC differentiator circuit shown in Figure 2.

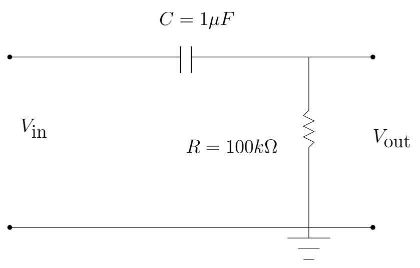


Figure 2: RC differentiator circuit

3 RLC Circuit

In Figure 3, $L = 1mH$, $C = 1\mu F$ and R is a variable. Then, the transfer function $V_c(\omega)/V_s(\omega)$ is

$$\frac{V_c(\omega)}{V_s(\omega)} = \frac{1}{1 - \omega^2 LC + j\omega CR}. \tag{1}$$

Define $\omega_0 = 1/\sqrt{LC}$ and $Q = \omega_0 L/R$. We have three regions of operation : (i) $Q < 1/2$ overdamped (ii) $Q = 1/2$ critically damped (iii) $Q > 1/2$ underdamped.

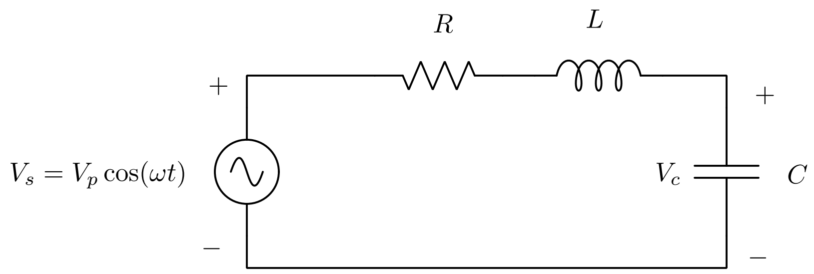


Figure 3: Second Order RLC circuit

3.1 Exercise

1. Choose two different values of R for each of the overdamped and underdamped regions. Also choose R for the critically damped situation. Plot the magnitude and phase response of $V_c(\omega)/V_s(\omega)$. Overlay the Bode magnitude plot over the exact magnitude response.

2. Now look at the step response of the above circuit for the cases you studied earlier. You can use *scipy.signal.lti*. Also see the following link `http://ofan666.blogspot.in/2011/04/lti-transient-response-analysis-using.html`. Overlay all plots on the same axes. Use different colours for the different parameters. Also plot a legend.

3. Finally, consider the case when $Q = 1/\sqrt{2}$. Repeat the frequency and transient response for this case. Is there anything special about this situation?