ECE 2412: Simulation and Engineering Analysis
Laboratory 1 - Visualization and Plotting

Objective: To become familiar with some of the data presentation features of MATLAB including basic plotting and animation. This is to be achieved by investigating a passive circuit and wave interaction.

Prelab: Create a MATLAB diary file as you work through the textbook from Section 2.1 to Section 2.5 inclusive. Chapter 2 (short excerpts) is provided as a pdf file in the MATLAB folder. This folder can be found in the course homepage on D2L.

1 Basic Plotting

The RC circuit shown below forms a low pass filter. The transfer function of this filter is given as:

$$\frac{V_o}{V_i} = \frac{1}{1 + j\omega RC} \tag{1}$$

where $R = 50\Omega$ and $C = 1nF$.

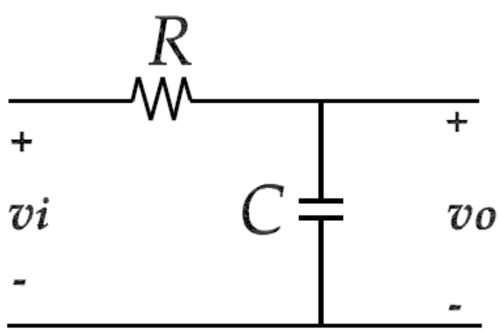

Figure 1: A passive low pass filter.

Plot the transfer function over a frequency range from $10kHz$ to $10MHz$ for the following cases:

Case A. Use a linearly spaced frequency vector.

1. Add labels to the x- and y-axis: include units here!
2. Add a title to the figure.
3. Add an arrow pointing to the intersection of the two lines, insert text near the arrow to explain. See the Insert tab on the plot window.
4. Turn the grid on.
5. Adjust all the line widths and text sizes to make them easily visible using the `Edit Plot` under the `Tools` tab on the plot window. The plot should look like Figure 2:

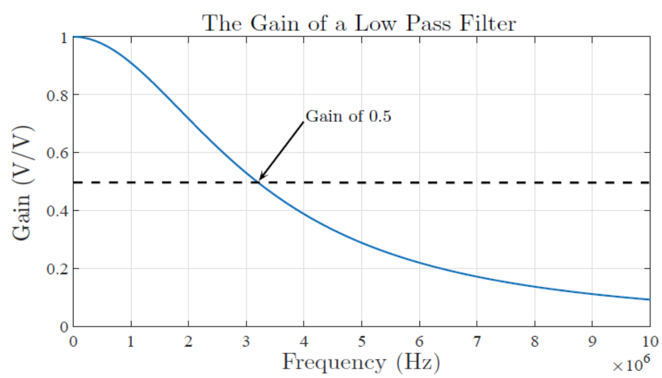

Figure 2: Example plot of for Case A.

6. Use the `Generate Code` command located under the `File` tab to produce a function with all the elements you have used to produce the plot.
7. Edit the generated code in order to be used to create the same plot.
8. Execute the file to produce the plot, submit the plot with your report.

Case B: Use a logarithmically spaced frequency vector.

1. Add labels to the x- and y-axis; include units here!
2. Add a title to the figure.
3. Add a horizontal line at the value $Vo/Vi = 0.5$.
4. Add an arrow pointing to the intersection of the two lines, insert text near the arrow to explain. See the `Insert` tab on the plot window.
5. Turn the grid on.
6. Adjust all line widths and text sizes to make them easily visible.
7. Use the `Generate Code` command located under the File tab to produce a function with all the elements you have used to produce the plot.

8. Edit the generated code in order to be used to create the same plot.
9. Execute the file to produce the plot, submit the plot with your report.

Case C: Family of Curves.

1. Modify the dot M file of Case A and run it for several values of capacitor to create a family of curves.
2. Include legend on the graph to indicate the value of C for each curve.
3. Select the values of C to produce an appealing presentation.

2 Modelling Wave Motion

The laser light used in optical fibres has a frequency of about $198THz$ while the speed of propagation within the fibre is near $2 \times 10^8 m/s$. If we let z be the position along the length of the fibre in meters, and t represent time in seconds, then the electric field intensity along the fiber is given as,

$$E(t, z) = E_o e^{j(\omega t - \beta z)} \tag{2}$$

which is both a function of time t and position z. Note that ω is the radian frequency ($2\pi f$) and β is the phase shift coefficient which equals (ω / speed of propagation). E_o is the initial condition and can be set to equal $1.0V/m$.

Case A. Plot the field at one instant in time.

1. Plot the real part of this field over the range of z from 0 to 10 m at t = 0.
2. Label the axis and submit this with your report.

Case B. Observe what happens as time advances:

The period of a 198 THz wave is about 5×10^{15} seconds. To see the movement, increment the time in steps of one tenth of a period. In a `for loop`, step time through two periods and watch what happens to the plot. Record your observations. Remember to plot the real part of E.

Case C. Propagation in the other direction:

A wave travelling in the opposite direction is given by:

$$E(t, z) = E_o e^{j(\omega t + \beta z)} \tag{3}$$

Note the change in sign. Change the sign in your Case B code above, run it and record the difference.

Case D. Interference pattern of two waves.
It is a common occurrence in transmission lines, including optical fibre, for there to exist waves propagating in both directions. The total field in the optical fibre is just the sum of the two waves. Generate both waves then add them together to produce the total field. Use the subplot feature to produce three plots in the same figure. Plot the forward wave, the reverse wave and the total wave. Remember to plot the real part of these complex numbers. This interference pattern is known as a standing wave pattern and normally only the amplitude of the pattern is observed. This can be achieved in your plot by taking the abs(real(total field)).