ESE 351 MATLAB Assignment 2 Draft

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Description automatically generated Please submit your MATLAB work as *both* a completed MATLAB script (including any additional functions you write) and a published .pdf of your output.

i: RC Circuit 1

1. **Impulse Response:** Last week, you explored the properties of a simple RC circuit (shown above), simulating its output to step and sinusoid signals using two methods – a discrete difference equation, and the lsim() linear simulation function. This week, you will simulate the same circuit using the relationship between the convolution integral and the impulse response.
   1. Use the impulse() function to form the impulse response of the RC circuit for constant e.g., . Note that as with lsim(), you can characterize your system using the format impulse(b, a, t) where *a* is a vector containing the left-hand coefficients of the canonical differential equation, *b* is the right hand coefficients, and *t* is a time vector that matches the time vector of your input *u.*
   2. Use the conv() function to convolve the impulse response with the two sinusoids from the previous assignment, and . Plot the results and compare them to your results using lsim() or the difference equation. Explain your observations in your own words.
2. **Linearity:** Using any of the previous methods (lsim, impulse response, difference equation), simulate the response of the circuit to the signal . Plot the output and compare it to the sum of the outputs from the previous section. Explain your observations in your own words.
   1. Optionally, use sound() or soundsc() to listen to the signal before and after passing through the circuit. (If you hear distortion, you may need to decrease the amplitude). What do you notice?
3. **Magnitude Plot**: By now you’ve no doubt noticed that passing different signals into the circuit results in different amounts of attenuation (a decrease in amplitude), and that this attenuation is linked to the frequency of the input.
   1. Using any of the previous simulation methods, simulate the output of the RC circuit for several different sine or cosine waves with frequencies between 10 Hz and 10 kHz. (To prevent aliasing, ensure your sample rate is sufficiently high!)
   2. Make a plot showing how the gain (ratio between output and input) of the signal varies as frequency varies.
      1. Express the gain in decibels. The gain in decibels is equal to and should be negative for all values of frequency
      2. Make sure to measure the amplitude of the circuit after the transient response has faded! When your signal begins, the circuit will take some time to reach a steady oscillation.
   3. Repeat this process using the second RC circuit.

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ii: RC Circuit 2

* 1. Compare the two magnitude plots. Which of these circuits is a “high-pass filter” (allows high frequencies through, attenuates low ones)? Which is a “low-pass filter?”
  2. Optionally, use the audioread() function to load the audio file chirp.wav off of canvas. This signal is a three second “chirp” sinewave that starts at 10 Hz and increases logarithmically to 10 kHz. Place this signal through both circuits and compare the results to the magnitude plots you created. Make sure to set the duration of the sim to three seconds and the sample rate to 44.1 kHz.