**ENEL102, fall term 2018**

**Assignment 2**

**Writing Matlab Functions Chapter 7**

**Due October 1**

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**Q1.** Write a single line command for an anonymous function that can calculate the following sum:



Test your function with .  
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**(Matlab input)**

f = @(x,y,z)sum(cos(x.^(1:9))+3\*y.^(1:9)+0.1\*(1:9)\*z)

s = f(1,2,1)

**(Matlab Response)**

s =

3.0754e+03

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**Q2.** Use the anonymous function of **Q1** to generate a plot of s=f(x,y,z) over the range of



Use 400 points for the x variable. Label the axis of your graph.

**(Matlab input)**

x = linspace(-1,1,400)

y = linspace(0.5, 0.5, 400)

z = linspace(0.1, 0.1, 400)

s = arrayfun(f,x,y,z)

plot(x,s)

xlabel("x")

ylabel("s")

**(Matlab Response)**



**Q3.** Consider the analog second order band pass filter consisting of a capacitor C, inductor L and a resistor R in series as shown in the figure.



The transfer function is given as



where



Write a function that determines the magnitude of the frequency response of the filter. That is we want a function that determines



The function must be written such that it accepts a vector of frequencies for .

Then use this function to compute the frequency response of the bandpass filter with L=1, C=1 and R=10 for a range of using a linear frequency scale. Generate the plot with 1000 points.

**(Matlab input)**

function [m] = H(w, R, L, C)

m = abs(R./(R+1j.\*w.\*L+1./(1j.\*w.\*C)));

end

w = linspace(0, 10, 1000)

m = H(w, 10, 1, 1)

plot(w,m)

xlabel("Frequency, \omega"), ylabel("Frequency response")

**(Matlab output)**



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**Q4.** Consider again the bandpass filter with a transfer function of



where



Write a function that determines the phase of the transfer function in degrees. Generate a plot of the phase shift of the bandpass filter for the frequency range of using a log frequency plot. Assume that L=1, C=1 and R=10.

**(Matlab input)**

function [x] = P5(w, R, L, C)

x= (180/pi).\*angle(R./(R+(1j\*w.\*L)+(1./(1j\*w.\*C))));

end

w = 10.^linspace(log10(0.01), log10(100))

m = P5(w, 10, 1, 1)

semilogx(w, m)

**(Matlab Response)**

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**Q5**. The signal delay through the filter is given by the rate of change of the phase shift of the filter with respect to excitation frequency. That is, the filter delay, denoted by D, is given as



Write a function that will determine D for a set of parameters L, C, R and. Use a numerical means of approximating the derivative. Hint – evaluate  for two closely spaced frequencies and then determine the change in angle from this. That is compute the slope from the ‘rise over run’.

Evaluate the delay for R=10, C=1, L=1 over the range of  based on around 1000 points with a linear scale. For the numerical derivative select a step size in of about .001. Also start the at around 0.01. Getting too close to will result in a limit complication.

**(Matlab input)**

function [x] = P5(w, R, L, C)

x= (180/pi).\*angle(R./(R+1j.\*w.\*L+1./(1j.\*w.\*C)));

end

function x = D(w, R, L, C)

x1 = P5(w, R, L, C);

x2 = P5(w+0.001, R, L, C);

x = -(x2-x1)/((w+0.001)-w);

end

w = linspace(0.01,2,1000);

delay = D(w, 10, 1, 1)

**(Matlab Response)**

delay =

46.7429

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**Q6**. The resonance frequency of the bandpass filter considered in the previous questions is given by



Write a program the calculates the delay of the filter as determined in **Q5**, at the resonance frequency of . Use L=1 and C=1 as before but now R is variable over the range of 0.1>R>10. Plot the delay as a function of R using a log plot (ie semilogx()).

**(Matlab input)**

function [x] = rfreq(R,L,C)

w\_r = 1/sqrt(L\*C);

w = w\_r + .001;

x1 = angle(R./(R+1j.\*w\_r.\*L+1./(1j.\*w\_r.\*C)));

x2 = angle(R./(R+1j.\*w.\*L+1./(1j.\*w.\*C)));

x = -(x2-x1)/.01;

end

R = linspace(.1,10);

delay = rfreq(R,1,1);

semilogx(R, delay);

xlabel('Resistance, \Omega'); ylabel('Delay');

**(Matlab Response)**

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