MEMO Number CMPE323-Lab04 rev1

DATE: October 7, 2016
TO: CMPE323
FROM: EFC LaBerge
SUBJECT: Convolution

1 INTRODUCTION

This lab provides the opportunity to manipulate Laplace Transforms using both functions embedded in MATLAB and new functions that you will create in MATLAB.

2 EQUIPMENT

For this lab, you need a laptop with MATLAB installed.

For the purpose of CMPE323, please use the following naming conventions for all output files:

CMPE323F16_Lab<Lab#>_<Your Campus ID>

For the purpose of CMPE323, please use the following naming conventions for MATLAB scripts or functions that you are required to submit.

<function name>_<Your Campus ID>

Examples will be given in the lab description. Follow the instructions exactly, or you may not get graded!

3 LAB TASKS

You might find it useful to use the MATLAB function `diary` to capture your inputs and outputs.

3.1 Determining Poles and Zeros

MATLAB has embedded functions to determine poles and zeros, but before using them, we will first do it "by hand".

Consider the causal, stable, LTI system with a Laplace Transform described by the coefficients

bs = [1 2 5]

as = [1.0000 7.0000 14.8125 12.8750 6.5000],

where the coefficients are in descending orders of the Laplace variable, s, with $s^0 = \text{constant term}$ on the right.

Write the transfer function $H(s)$ as the ratio of polynomials in s.

Use the MATLAB function roots to determine the zeros and the poles of $H(s)$.

3.2 Creating a Pole Zero Plot

Create the following MATLAB function, and use it to plot the poles, zeros, and Region of Convergence (ROC) for the system described by the arrays given in 3.1. Include a summary discussion of your strategy for implementing the function

```
function [  ] = polezero_plot( b,a,s_or_z,ROC)
% function [  ] = polezero_plot( b,a,s_or_z,ROC)
% Creates a pole-zero plot in either the s-domain or z-domain based on
% the M-th order numerator polynomial with coefficients in b and the N-th
% order denominator polynomial with coefficients in a
% EFCL 11/5/2014
%
% Calling Parameters
%   b:  1 x (M+1) array of numerator coefficients, with b(1) being the
%   coefficient of s^(M) and b(M+1) being the coefficient of s^(0)
%   a:  1 x (N+1) array of denominator coefficients, with a(1) being the
%   coefficient of s^(N) and a(N+1) being the coefficient of s^(0).
%   s_or_z:  single character with 's' indicating that the plot is in the
%   s-plane and 'z' indicating the plot is in the z-plane (used for
%   discrete-time systems).  Any other input is invalid.
%   ROC:  1 x 2 array [ROCmin ROCmax] indicating the Region of Convergence.
%   values of +/-Inf are accceptable
%
% This first version should display an error message with no other output
% if s_or_z = 'z', that is, the z-plane implementation will be provided at
% a later time.
%
%
```

3.3 Partial Fraction Expansion

MATLAB knows how to do Partial Fraction Expansion (PFE). Research the MATLAB function ***residue***, and consider how you might use it to obtain the PFE coefficients. Then use ***residue*** to perform the PFE and using those results, compute and plot each of the components of the impulse response, and then the total impulse response, $h(t)$ of the system from 3.1 as a function of time. Use professional practices in the plot

3.4 Additional practice

Consider the causal LT system described by the differential equation

$$\frac{d^2 y}{dt^2}+4\frac{dy}{dt}+5y=2x, \qquad 22\backslash* \text{ MERGEFORMAT ()}$$

where x is the input and y is the output. Create the pole zero plot. Compute and plot each of the components of the impulse response, and then the total impulse response of this system. Describe why your RoC looks the way it does.

4 LAB SUBMISSIONS

Submit the following via the Blackboard assignment Lab 5.

Using this lab description document as a template, create a single PDF file named in accordance with the output naming conventions given above. The content must include

a. The outputs and discussions generated in 3.1.

b. Describe your approach to the coding exercise

c. The outputs and discussions generated in 3.3.

d. The outputs and discussions generated in 3.4.

Professional, high quality writing, math, and graphic (that is plots) presentation is expected, and must be provided for you to earn full credit.

In a separate file, but as part of your submission, include you MATLAB script for 3.3. Use good programming practices in your function. I strongly suggest that your function include my function definition section from 3.3.