FALL 24 EC516 Problem Set 03

Due: Sunday September 29 (Before 11:59pm)

You must submit your homework attempt on Blackboard Learn. For this purpose, you must convert your homework attempt to a pdf file and upload it at the corresponding homework assignment on Blackboard Learn.

Problem 3.1 (ZT Algebraic Properties)

Let $x[n]$ be a discrete time signal with z-transform $X(z)$.

(a) Show that $x[n-n_0]$ has z-transform $z^{-n_0}X(z)$
(b) Show that $x[-n]$ has z transform $X(z^{-1})$
(c) Show that $x^*[n]$ has z-transform $X^*(z^*)$
(d) Show that $x[n] * h[n]$ has z-transform $X(z)H(z)$

Problem 3.2 (ZT Calculation and ROC)

Determine the z-transform of each of the following signals and the corresponding region of convergence in each case. You may use $X(z) = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$, the Finite Sum Formula and/or the Infinite Sum Formula.

(a) $x[n] = \delta[n-3]$
(b) $x[n] = u[n] - u[n-5]$
(c) $x[n] = (0.25)^n u[n]$
(d) $x[n] = (0.25)^{n-1} u[n-1]$
(e) $x[n] = (0.25)^n u[n-1]$
(f) $x[n] = (0.25)^n u[n] + (0.5)^n u[n]$
(g) $x[n] = (0.25)^n \cos(0.25\pi n) u[n]$

Problem 3.3 (Convolution Sum Basics)

Calculate the convolution $y[n] = x[n] * h[n]$ in each of the following cases and *show your work*:

a) $x[n] = u[n] - u[n-5]$ and $h[n] = 0.5\delta[n-3]$
b) $x[n] = n\{u[n-1] - u[n-5]\}$ and $h[n] = 2\delta[n+3]$
c) $x[n] = u[n] - u[n-5]$ and $h[n] = u[n] - u[n-5]$
d) $x[n] = u[n] - u[n-5]$ and $h[n] = u[n] - u[n-3]$
e) $x[n] = u[n] - u[n-5]$ and $h[n] = u[n]$

HINT: Use the interpretation of the convolution operation as producing a sum of echoes (amplitude scaled and delayed versions) of the input signal.

Problem 3.4 (Approaches & Topics Review)

Part (A):

(a) What should be produced after a DSP Engineer performs *discovery*? Give an example of the result of discovery.
(b) What should be produced after a DSP Engineer performs *design*? Give an example of the result of design.
(c) What should be produced after a DSP Engineer performs *implementation*? Give an example of the result of implementation.
(d) What should a DSP engineer do if after performing *evaluation* the engineer finds that the implementation does not satisfy what is needed from the designed DSP solution? G

Part (B): As described in one of the EC516 lectures, the six *Major Topics* to be studied in EC516 are:

(a) D igital F ilter
(b) S pectral A nalyzer
(c) S pectrogram A nalyzer
(d) F ilterback
(e) P arametric S ignal M odeling
(f) C apstral A nalyzer

Part (C):

(a) A DSP Engineer typically measures *computational cost* of a DSP *implementation* in terms of what?
(b) Give an example of a type of application in which a DSP engineer would choose an IIR filter over a FIR filter. Explain the reason behind that choice.
(c) Give an example of a type of application in which a DSP engineer would choose an FIR filter over a IIR filter. Explain the reason behind that choice.