ELEN E4810 Digital Signal Processing Midterm Test

Thursday 2011-10-27 11:00-12:15 (75 min) Dan Ellis <dpwe@ee.columbia.edu>

This test consists of 2 questions. Each question has equal weight.
You have one and one quarter hours (75 minutes) to complete the test.
This test is open-book: you are permitted to refer to your notes and textbooks during the test.
You may use a calculator for numerical work, but not for graphing. You cannot use Matlab or similar.
You must show all your workings to get credit for an answer.
You are on your honor to present work that is entirely your own.

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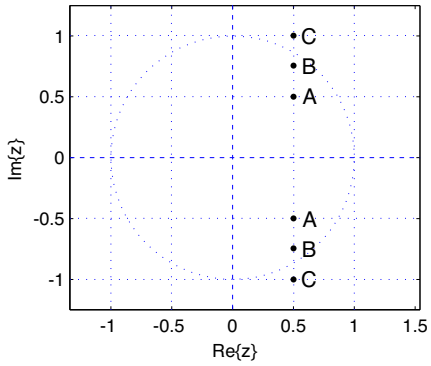
1. The diagram of the z-plane below shows a number of locations for conjugate-pairs of roots, labeled A, B, and C.

   (a) Where possible, sketch the magnitude response of the following systems over the range $\omega = 0 \ldots \pi$, taking care to indicate the approximate location and value of maxima and minima:

   i. zeros at A
   ii. zeros at B
   iii. zeros at C
   iv. poles at A
   v. poles at B
   vi. poles at C



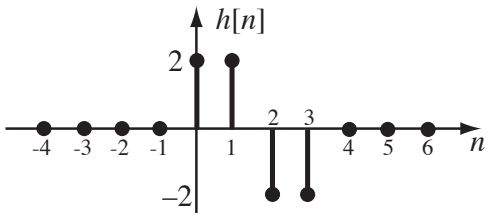
   All systems are scaled to have a d.c. gain of one (i.e., $H(e^{j\omega}) = 1$ when $\omega = 0$).

   (b) Which system has the impulse response with the lowest total energy? Find the values of that impulse response for $n = 0 \ldots 4$ (only two significant figures of accuracy are required).

2. For the sequence $h[n]$ shown below,

   (a) Find the closed-form expression for its DTFT, and the values for its 4-point DFT.

   (b) Sketch its magnitude and phase response over the range $\omega = 0 \ldots \pi$.



   (c) Consider the input sequence $x[n] = \cos(\omega_0 n) + h[n - n_0]$ where $\omega_0 = \pi$. Find $y[n] = h[n] \circledast x[n]$.

   (d) Find $|Y[k]|$, the magnitude of the 4-point DFT obtained by sampling the full DTFT of $y[n]$.