EEL 6586: HW#4

Assignment is due Wednesday, Feb 26, 2003 in class. Since we will go over the assignment in class on Feb 28, late homework will not be accepted past that day. There is no matlab component of this homework.

PART A: Cepstrum Problems

A1 Compute the complex cepstrum of $H(z) = (1 - 2z^{-1})/(1 + .25z^{-2})$

A2 Compute the real cepstrum of $H(z) = (1 - 2z^{-1})/(1 + .25z^{-2})$

A3 Let $x_1(n)$ and $x_2(n)$ denote two sequences and $\hat{x}_1(n)$ and $\hat{x}_2(n)$ their corresponding complex cepstra. If $x_1(n) * x_2(n) = \delta(n)$ determine the relationship between $\hat{x}_1(n)$ and $\hat{x}_2(n)$.

A4 Suppose the complex cepstrum of of $y(n)$ is $\hat{y}(n) = \hat{s}(n) + 2\delta(n)$. Determine $y(n)$ in terms of $s(n)$.

A5 Euclidean distance in complex cepstral space can be related to a RMS log spectral distance measure. Assuming that

$$\log S(\omega) = \sum_{n=-\infty}^{n=+\infty} c_n e^{-jn\omega}$$

where $S(\omega)$ is the power spectrum (magnitude-squared Fourier transform), prove the following:

$$\sum_{n=-\infty}^{n=+\infty} (c_n - c'_n)^2 = \frac{1}{2\pi} \int |\log(S(\omega)) - \log(S'(\omega))|^2 d\omega$$

where $S(\omega)$ and $S'(\omega)$ are the power spectra for two different signals.

PART B: Textbook Problems

2.18

6.20

PART C: Extra Credit

Assuming that

$$H(z) = \sum_{n=0}^{\infty} h(n) z^{-n} = \frac{G}{1 - \sum_{k=1}^{p} a(k) z^{-k}}$$

Prove that the complex cepstrum $\hat{h}(n)$ can be derived from the linear prediction coefficients a(k) using the following relation:

$$\hat{h}(n) = a(n) + \sum_{k=1}^{n-1} (k/n) \hat{h}(k) a(n-k)$$

for $n \geq 1$.