EE 530 – Homework 2

(due February 9, 1999)

1. In an experiment, the signal to be recorded contains interference from an electrical power-line. In order to get rid of this interfering signal, we wish to filter it by a digital band-stop filter with the following specifications: $\theta_{p,1} = 0.57\pi$, $\theta_{s,1} = 0.59\pi$, $\theta_{s,2} = 0.61\pi$, $\theta_{p,2} = 0.63\pi$, $A_{p,1} = A_{p,2} = 0.1$ dB, $A_s = 40$ dB. Design an FIR filter using the minimax principle. A 1000-point sample of the recorded signal $x(n)$ is given (see `http://www.eecs.wsu.edu/~ siva/ee530/ee530.html`). Obtain the filter output $y(n)$ for this signal (lookup the builtin function 'filter' in MATLAB). Obtain plots of the DFT of signals $x(n)$ and $y(n)$ and comment on the results.

2. Problem 6.12 from text.

3. Problem 6.13 from text.

4. Problem 6.14 from text (assume sampling time interval $T = 1$).

5. Problem 6.19 from text. (Addendum to the problem):
   Use this equation to derive the lowpass-highpass frequency transformation expression we obtained in class ($n = 1$ for this case). Assume that the lowpass cutoff frequency is $\theta_1 = \theta_l$ and the highpass cutoff frequency is $\phi_1 = \theta_h$.

6. Problem 6.20 from text.

7. Define the s-to-z transformation $s = \frac{z-1}{T}$. This is the *forward difference* approximation to the differentiation operator. Show that this transformation does not preserve stability; i.e., a stable analog filter $H_a(s)$ may be transformed to an unstable digital filter $H(z)$. (This is problem 10.31 in Porat's book.)

8. It is required to design a multiband digital IIR filter according to the following specifications:

   - Gain 1 with $\delta_p = 0.01$ in the frequency band $0 - 0.2\pi$.
   - Gain 0 with $\delta_s = 0.05$ in the frequency band $0.25\pi - 0.45\pi$.
   - Gain 1 with $\delta_p = 0.01$ in the frequency band $0.5\pi - 0.7\pi$.
   - Gain 0 with $\delta_s = 0.05$ in the frequency band $0.75\pi - \pi$.

   It is proposed to build the filter as a parallel connection of two filters $H_1(z)$ (low-pass) and $H_2(z)$ (bandpass). Design the system. (This is problem 10.28 in Porat's book.)