EE 530 – Homework 1

(due January 28, 1999)

1. A type-II FIR filter $h(n)$, $0 \leq n \leq N-1$ has even length ($N = 2M$) and satisfies the symmetry condition $h(N-1-n) = h(n)$, $0 \leq n \leq N-1$. Show that this filter has generalized linear phase. From the transfer function (or frequency response) can you infer anything about the zeros of a type-II FIR filter?

2. Let $H(z)$ be the transfer function of a linear phase FIR filter of length N. Show that if the system has a zero at $z = \alpha$ then it also has a zero at $z = 1/\alpha$. What does this imply about such a filter having the property of "minimum phase."

3. Derive the impulse response of the Hilbert transformer

$$H(e^{j\theta}) = \begin{cases} -j & 0 < \theta < \pi \\ 0 & \theta = 0 \\ j & -\pi \leq \theta < 0 \end{cases}$$

4. Design a $N = 64$ point FIR high-pass filter with cutoff frequency $3\pi/4$ using the frequency sampling method. Use one transition point and choose the magnitude of $H(k)$ at this point suitably to reduce the amount of pass band ripple. What is the minimum stop band attenuation of your filter.

5. Design a $N = 51$ point FIR filter with a Hamming window to approximate a Hilbert transformer.

6. Design a bandstop FIR filter using the windowing technique to satisfy the following specification: $\theta_{p,1} = 0.2\pi$, $\theta_{s,1} = 0.3\pi$, $\theta_{s,2} = 0.6\pi$, $\theta_{p,2} = 0.75\pi$, $\delta_{p,1} = \delta_{p,2} = 0.0025$, $\delta_{s,1} = \delta_{s,2} = 0.0021$. First choose one of Hanning, Hamming, or Blackmann window, as appropriate. Then repeat the design using a Kaiser window.