EEE 391 Homework

(due: 15 March 2016, Tuesday by 17:00 in the homework box)

1) The sinusoid $x(t) = 3\sin(150\pi t - \frac{\pi}{6})$ is sampled with three different sampling periods:

a) 0.005 sec, b) 0.02 sec, c) 0.01 sec.

Analyze each case in detail by making a digital spectrum diagram with respect to $\hat{\omega}$. In each case, indicate whether the signal is undersampled, oversampled, or sampled at the Nyquist rate and whether folding occurs or not. For each part, find a closed-form expression for the reconstructed signal $y(t)$ and plot it on the same diagram as $x(t)$ using a different color or linestyle.

2) Suppose you are using a truncated optimal pulse for time-domain reconstruction such that the optimal pulse is truncated at the third zero crossing on each side of the origin.

a) Make an accurate sketch of this truncated pulse. All zero crossings and amplitude peaks should be labeled.

b) Suppose uniformly taken samples (with $T_s = 0.5$ s) of one complete period of $x(t) = 3\sin(0.5\pi t)$ are available and time-domain reconstruction needs to be done using the pulse shape described above. Make an accurate sketch by hand showing the sinusoidal signal $x(t)$ (in dashed lines), uniformly taken samples of $x(t)$ over one period ($x[n]$), individual pulses, and the reconstructed signal $y(t)$.

c) Repeat part b) for the following sequence: $y[-3] = -4,\ y[-2] = 2,\ y[-1] = 0,\ y[0] = 5,\ y[1] = -2, y[2] = 1,\ y[3] = 4$, and $y[n] = 0$ otherwise.

3) Given the following set of filter coefficients for a causal finite impulse response (FIR) filter described by the general difference equation $y[n] = \sum_{k=0}^{M} b_k x[n-k]$,

$$\{b_k\} = \{0, 0, 1, 0, 2, -3, 0, 2, 5\}$$

a) Write the difference equation of the filter using the given filter coefficients.

b) What is the length L and order M of this filter?

c) Make a signal flow diagram/chart for this filter.

d) Find the impulse response $h[n]$ of the filter $\forall n$ and sketch it accurately.

e) Find the output $y[n]$ of the filter $\forall n$ and sketch it accurately. Assume that the input to the filter is $x[-3] = -1,\ x[-2] = 1$, and $x[n] = 0$ otherwise.