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ECE Deptartment **Summer 2001**

ECE521 Experiment # 1: Fourier Series and Periodic Signal Reconstruction
(Issued Tuesday 5/22, Due Tuesday 6/5)

The purpose of this experiment is the following:

1. Demonstrate the representation of a periodic signal by Fourier Series. Fourier series coefficients are calculated by the discrete Fourier transform (DFT) which can be computed using the all-familiar FFT algorithm.

2. Reconstruct an approximation to the original periodic signal using only a portion of the Fourier series coefficients.

3. Get experience with available software tools (e.g., Matlab) for signal/speech processing.

You may read the Matlab program "example1.m" to help you do this exeriment in Matlab.

Part 1: Fourier series representation

1. (a) Generate N samples from the following periodic signals with period T Seconds: An even square wave (sometimes called cosine square wave) $x_1(t)$; A 60% pulse signal $x_2(t)$; A 20% pulse signal $x_3(t)$; A 10% pulse signal $x_4(t)$; A one-cycle cosine wave $x_5(t)$; A two-cycle cosine wave $x_6(t)$; and A one-cycle triangular wave $x_7(t)$.

2. (b) Use the FFT to generate the Fourier coefficients of the signals above and plot the *line spectrum.* Compare with the theoretical results. Explain the spectrum behavior of the pulse signals as the pulse width varies.

Part 2: Signal Reconstruction

1. (a) For the signals $x_1(t)$ and $x_3(t)$ in part 1, use the 10 largest and the 3 largest *magnitude* Fourier coefficients to reconstruct the approximate signals. For all other signals use only the 3 largest magnitude Fourier coefficients to reconstruct the approximate signals. Plot the original and the reconstructed signals on the same graph. Comment on your results.

2. (b) Calculate by hand the Fourier series expansion for $x_1(t)$ and $x_3(t)$ (i.e., obtain the coefficients X_n).

3. (c) Using the 3 largest coefficients in (b), calculate by hand the reconstructed signal (using Fourier series representation) for $\hat{x}_1(t)$ and $\hat{x}_3(t)$ for times $t = 0, T/4, T/2, 3T/4, T, ..., 2T$, where T is the period in Seconds. Compare your results with part (a).

Note: *Write a neat report. All figures should have meaningful captions, properly labeled, and referred to in the text. Refrain from using any handwritten symbols, equations, etc. in your report, use a word-processor*