Assignment 5 - Correlation and Convolution

Due February 13, 1996

Please show your work. For those questions that ask you to use Matlab show the exact commands you used to compute the results.

Question 1

(a) Compute by hand the linear and circular correlation and convolution (4 results) of the two sequences: $a = \{1, 2, 3\}$ and $b = \{2, 1\}$.

(b) Use Matlab's `conv()` function to compute the linear convolution and correlation of the two sequences given above.

(c) Use Matlab's `fft()` and `ifft()` functions to compute the circular convolution of the two sequences above.

(d) Use the `fft()` and `ifft()` functions to compute the linear convolution and correlation of the two sequences above. Use the shortest length FFTs (not necessarily a power of 2) that will correctly compute the linear convolution.

Hints:

- *the Matlab expression* `x(length(x):-1:1)` *produces the vector* `x` *in reverse order*
- *the* `conj()` *function computes the complex conjugate*
- `x=[x zeros(1,10)]` *will append 10 zeros to the vector* `x`

Question 2

Set up the `MATLABPATH` environment variable as described in Assignment 4 before running Matlab. Use the command `asg5sigs` to load the variables `s`, `x` and `y` into your Matlab workspace. Use these variables to answer Questions 2 and 3.

The variable `s` contains a 1024-point sequence of filtered noise. Use the DFT method as in Question 1(d) to compute it's (non-circular) autocorrelation function. Plot the autocorrelation function for lags between 0 and 63.

Compute and plot the estimated power spectrum of `s` from the first 64 points of the ACF.

Hint: The process of computing the inverse and forward FFTs may introduce small imaginary components into the ACF. You can remove these with the `real()` *or* `abs()` *functions.*

Question 3

The vector `y` contains noise plus the signal `x` delayed by an unknown amount. Correlate `y` with `x` to estimate the delay. *Hint: the optional second output array of the* `sort()` *function can be used to find the index of the largest element in an array.*