University of Massachusetts Lowell
Department of Electrical and Computer Engineering
16.520 Computer Aided Engineering Analysis
Problem Set 4

1. Consider the convolution of the $N-pt$ impulse response $h(n)$ and the input signal x. The current and $N-1$ past inputs are stored in a FIFO buffer of dimension N. The current value of the output is computed as

$$y = \sum_{j=0}^{N-1} h(j) \times buffer(j)$$

The process is:

```
time_index=0
do time_index=0, inf
        x= getx(time_index)
        pushd (x,buffer,N)
        y= convolve(buffer,h,N)
        output(y)
enddo
```

a. For $N = 4$ and $h(j) = 0.5^j$ and $x(n) = \delta(n)$.

b. Using $h(j)$ determine and plot y versus the time_index given $x(j) = u(j) - u(j-10)$ where $u(j)$ is the unit step function. What is the maximum time-index that yields a non-zero result.

2. Using the LMS algorithm design a channel echo canceler.

a. Validated you work using zero mean unit variance Gaussian white noise for filter order $N = 5$. The channel model is given by the impulse response $h(n) = \delta(n) + 0.5\delta(n-1) + 0.5^2\delta(n-2)$.

b. Plot the ensemble averaged squared error as a function of the iteration count and convergence factor μ.