Course: DSP Lab

Session 5: Differential Equation, Impulse response and Filter and Overlap-Save

Dept.: Electrical & Electronics Engineering V1.1

1 Objectives/Outcome:

a) Learn to use the MATLAB filter unction for discrete-time signal processing.
b) Solve a first-order linear differential equation using MATLAB's filter() function.

2 Tasks

2.1 Task1: Filtering a signal

Consider a moving average filter $y[n] = (1/5)(x[n] + x[n-1] + x[n-2] + x[n-3] + x[n-4])$. Perform following tasks for this system. As an input generate a sinusoidal of different frequencies with noise added to check on if noise is getting removed.

1) Plot the frequency response of the filter in dB (Consider Fourier transform with ω or z-transform) or you could use directly $\boldsymbol{freqz}()$
2) With the help of the $\boldsymbol{filter}()$ function, check the output of the system using filter by giving samples of different sinusoidal frequencies with noise. Select 5 different frequency inputs to validate the filter output in line with frequency response.

2.2 Task2: Impulse response and Overlap-response

Consider a difference equation $y(n) - y(n-1) + 0.9y(n-2) = x(n)$.

1) Plot the frequency response of the filter in dB (Consider Fourier transform with ω or z-transform) or you could use directly $\boldsymbol{freqz}()$
2) Plot the impulse response in time domain using $\boldsymbol{filter}()$ function
3) Develop the overlap-save function that can be written as (***Make the corrections needed):***

```
function [y] = overlapsave(x, h, N)
    % block length must be power of 2
    N=2^(ceil(log10(N)/log10(2)));
       lengthX=length(x);
    M=length(h);
       M1=M-1;
    L=N-M1;
       h=fft(h, N);
    x=[zeros(1, M), x, zeros(1, N-1)];
    K=floor((lengthX+M1-1)/L);
    Y=zeros(K+1, N);
    for k = 0:K
        xk = fft(x(k*L+1:k*L+N));
        Y(k+1,: ) = real(ifft(xk.*h));
    end
    Y=Y(:,M:N)';
    y=(Y(:))';
end
```

4) Generate a long sequence of input that can be used to convolve with h[n] using overlap-save function. Plot the output for different frequency inputs to validate the filter output in line with frequency response.