Experiment - 9 **Date - 12 / 4 / 24**

Aim - Realize Least Mean Squares (LMS) filter for denoising applications .

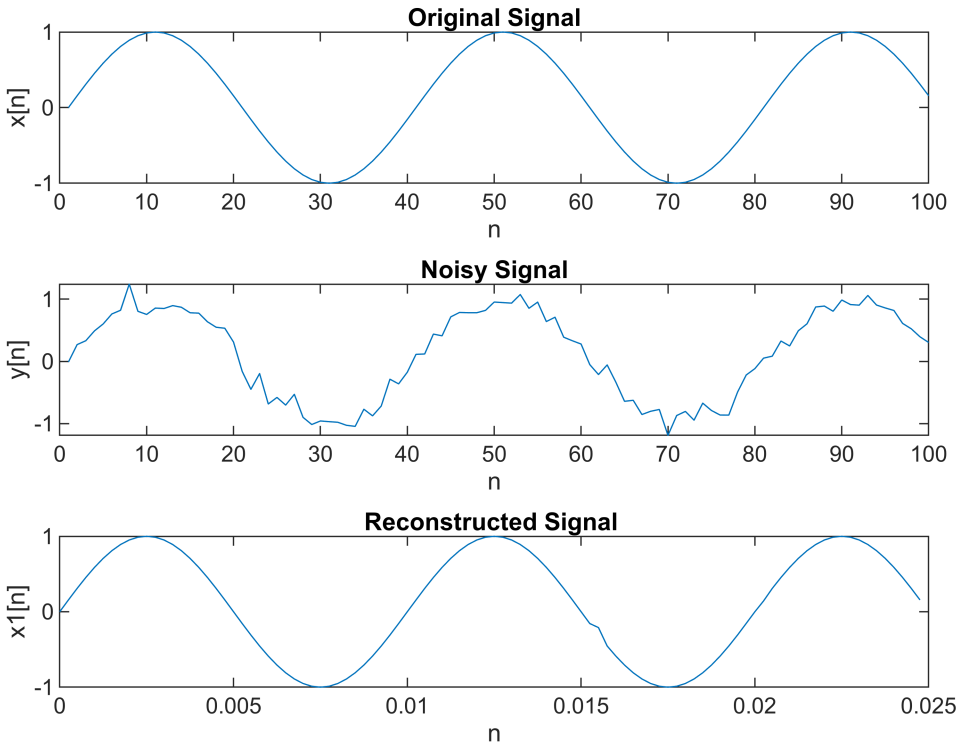
Laboratory Exercise

A) Generate and plot a discrete time sine wave and add gaussian random noise into it . Using the LMS filter model , remove the noise from the signal . Observe the frequency response of learned filter coefficients .

```
clc ; clear all ; close all ;

f = 100 ; fs = 4000 ; N = 100 ;
t = 0 : 1/fs : (N-1)/fs ;
% Defining Original Signal and Noisy Signal
x = sin(2 * pi * f * t) ; len = length(x) ;
y = awgn(x , 15 , 'measured') ;
subplot(3 , 1 , 1) ; plot (x) ; title("Original Signal") ; ylabel("x[n]") ;
xlabel("n") ;
subplot (3 , 1 , 2) ; plot(y) ; title("Noisy Signal") ; ylabel("y[n]") ;
xlabel("n") ;
fprintf("No. of samples :- %d ", len) ;
```

```
No. of samples :- 100
```

```
% Calculating Error
h(1 , :) = fir1(N-1 , 0.75) ; xs = y .* h ; e1 = x - xs ; iter = 1 ; delta = 0.1 ;
mu = 0.5 ;
err(1) = norm(e1) ;

while (err(iter) > delta)
        h(iter + 1 , :) = h(iter , :) + (2 * mu * y .* e1) ;
        xs = y .* h(iter + 1 , :) ;
        e1 = x - xs ;
        iter = iter + 1 ;
        err(iter) = norm(e1) ;
end

subplot(3 , 1 , 3) ; plot(t , xs) ; title ("Reconstructed Signal ") ;
ylabel("x1[n]") ; xlabel("n") ;
```




```
%subplot(2,2,4) ; plot(iter , e1) ;
```

Conclusion :- From this experiment we learnt , with increase in **Learning Rate** or increase in **Convergence Threshold** , the approximation becomes lesser accurate and thus , they both **should be small for better approximation** by the filter . This type of filtering is used very frequently in **noise cancellation** and **echo cancellation** algorithms .