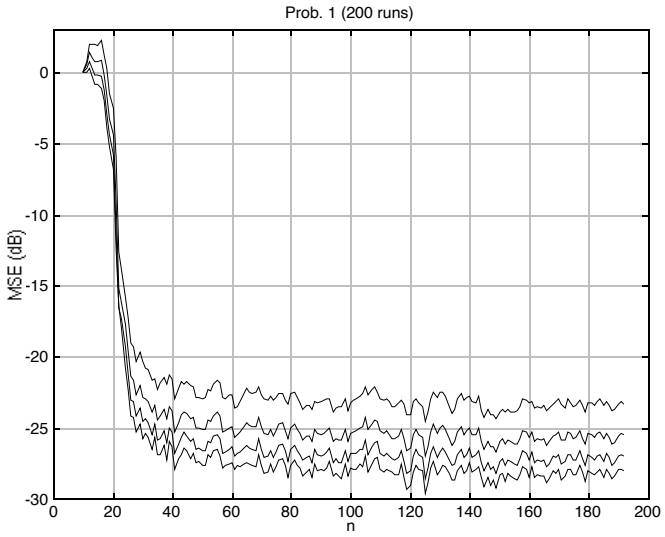
Solution #6: RLS Adaptive Filters

1)



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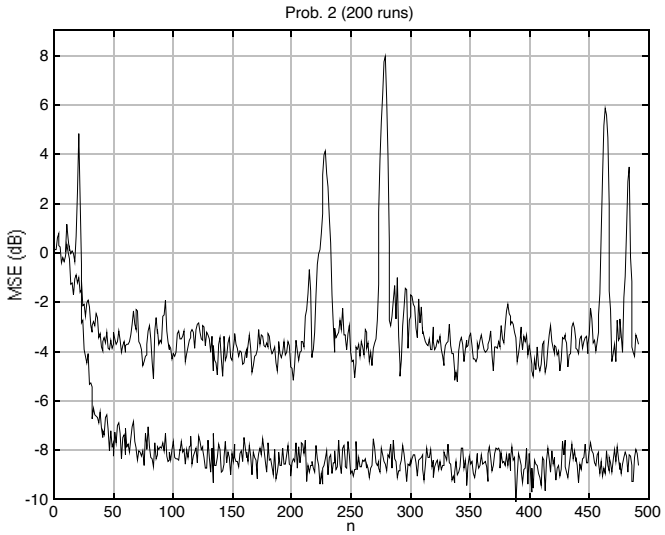
2)



```
% EE594 - Fall 2002 - Homework #6

%---
% Prob. 1
%---
% p. 415 Section 9.7 Adaptive Equalizer

% Channel Model
W = 3.5;  % 2.9 3.1 3.3 3.5
N = 3;  % length of channel impulse response
nn = [1:N]';
h = [0;(1+cos(2*pi/W*(nn-2)))/2];
```

```
% Signal information
L = 200;  % signal lengths
rand('seed',0);
randn('seed',0);
sigma_v2 = 0.001;  % variance of additive channel noise

% Adaptive filter information
M = 11;
w_init = zeros(M,1);
delay = 7;
num_runs = 200;

% RLS
lambda = 1;
sum_e2 = zeros(L-delay,1);
for run = 1:num_runs
   run
   x = sign(rand(L,1)-0.5*ones(L,1));  % +/- 1 data
   y = filter(h,1,x);  % output of channel
   v = sqrt(sigma_v2)*randn(L,1);  % channel noise
   u = y + v;  % input to adaptive filter
   u = u(delay+1:L);
   d = x(1:L-delay);  % d is x delayed by delta
% hack rls to return a prior error
% hack rls to start adaptation at n = M
   [e,w] = rls(w_init,u,d,lambda);
   sum_e2 = sum_e2 + e.^2;
end;
MSE = sum_e2 / num_runs;
%hold on
MSE_plot(MSE);
%hold off
axis([0 L -30 5])
title(['Prob. 1 (',sprintf('%d',num_runs),' runs)'])

%---
% 2
%---
% Channel Model
W = 3.1;  % 2.9 3.1 3.3 3.5
N = 3;  % length of channel impulse response
nn = [1:N]';
h = [0;(1+cos(2*pi/W*(nn-2)))/2];

% Signal information
L = 500;  % signal lengths
rand('seed',0);
randn('seed',0);
sigma_v2 = 0.1;  % variance of additive channel noise

% Adaptive filter information
M = 11;
w_init = zeros(M,1);
delay = 7;
num_runs = 200;
```

```
% RLS
lambda = 1;
sum_e2 = zeros(L-delay,1);
for run = 1:num_runs
   run
   x = sign(rand(L,1)-0.5*ones(L,1));  % +/- 1 data
   y = filter(h,1,x);  % output of channel
   v = sqrt(sigma_v2)*randn(L,1);  % channel noise
   u = y + v;  % input to adaptive filter
   u = u(delay+1:L);
   d = x(1:L-delay);  % d is x delayed by delta
   [e,w] = rls(w_init,u,d,lambda);
   % [e,w] = lms(w_init,u,d,0.075);
   sum_e2 = sum_e2 + e.^2;
end;
MSE = sum_e2 / num_runs;
%hold on
MSE_plot(MSE);
%hold off
axis([0 L -30 5])
title(['Prob. 2 (',sprintf('%d',num_runs),' runs)'])
```