9.39 Consider the problem of designing a signal predictor as shown in Figure 9.12.5. Suppose the signal whose value is to be predicted is as follows.

$$x(k) \;=\; \sin\left(\frac{\pi k}{5}\right)\cos\left(\frac{\pi k}{10}\right) + v(k) \qquad , \qquad 0 \le k < N$$

Here $N = 200$ and $v(k)$ is white noise uniformly distributed over $[-0.05, 0.05]$. Write a MATLAB script that used the FDSP toolbox function *f_rls* to predict the value of this signal $M = 20$ samples into the future. Use a filter of order $m = 40$ and a forgetting factor of $\gamma = 0.9$.

(a) Plot the learning curve.

(b) Using the final weights, compute the output $y(k)$ corresponding to input $x(k)$. Then plot $x(k)$ and $y(k)$ on separate graphs above one another using the *subplot* command. Use the *fill* function to shade a section of $x(k)$ of length M starting at $k = 160$. Then shade the corresponding predicted section of in $y(k)$ starting at $k = 140$.

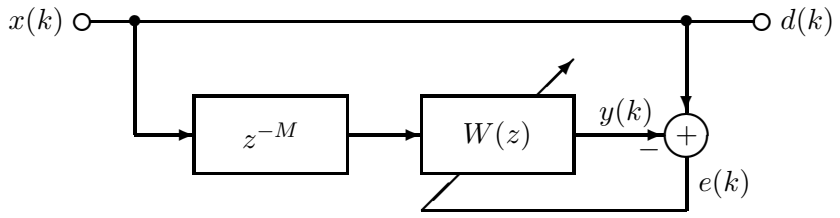
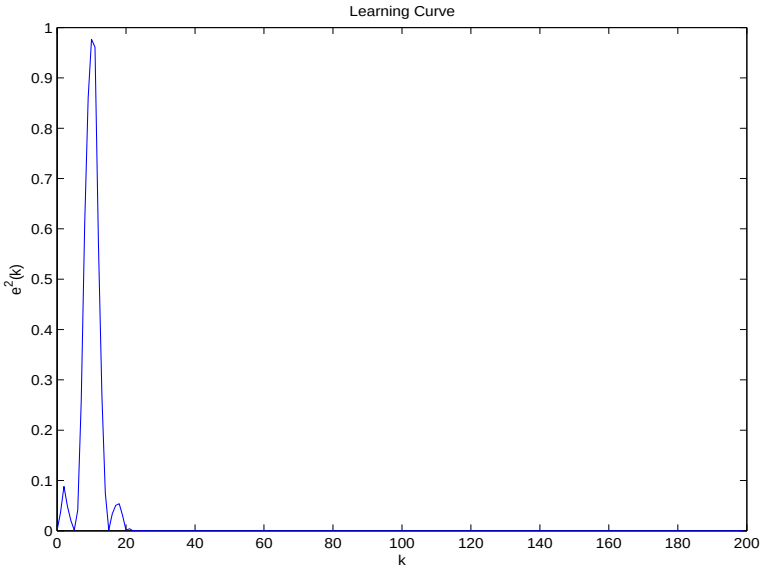


Figure 9.12.5: Signal Prediction

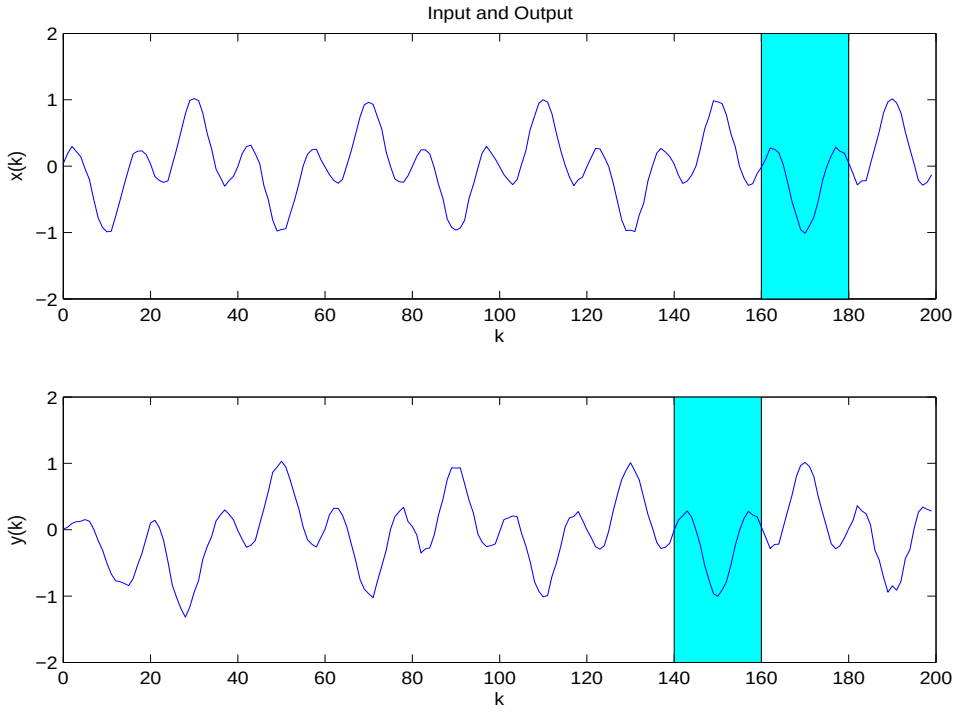
Solution

```
% Problem 9.39

% Initialize

clear
clc
m = f_prompt ('Enter filter order m',0,100,40);
gamma = f_prompt ('Enter forgetting factor gamma',0,1,0.9);
N = f_prompt ('Enter number of points N',1,2000,200);
M = f_prompt ('Enter number of samples to predict ahead M',0,40,20);
c = f_prompt ('Enter magnitude of white noise c',0,1,0.05);

% Construct input and desired output

k = [0 : N-1]';
```

```
v = f_randu(N,1,-c,c);
x = sin(pi*k/20).*cos(pi*k/10) + v;
d = x;
x_M = zeros(size(x));
x_M(M+1:N) = x(1:N-M);

% Compute the optimal weights

[w,e] = f_rls (x_M,d,m,gamma);

% Plot learning curve

figure
plot (k,e.^2)
f_labels ('Learning Curve','k','e^2(k)')
f_wait

% Plot input and output

y = filter (w,1,x);
figure
subplot (2,1,1)
fill ([160 180 180 160],[-2 -2 2 2],'c')
hold on
plot (k,x)
f_labels ('Input and Output','k','x(k)')
subplot (2,1,2)
fill ([140 160 160 140],[-2 -2 2 2],'c')
hold on
plot (k,y)
f_labels ('','k','y(k)')
f_wait
```



(a) RLS Learning Curve



(b) RLS Signal Prediction