Solution #3
Wiener Filters and the Steepest Descent Algorithm

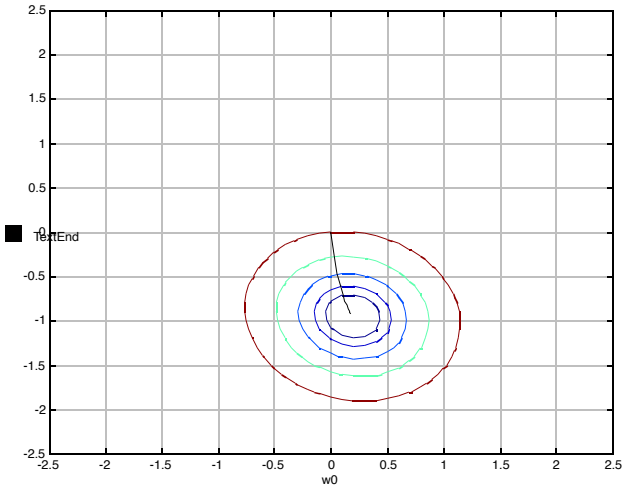
1.
(a) `J =`

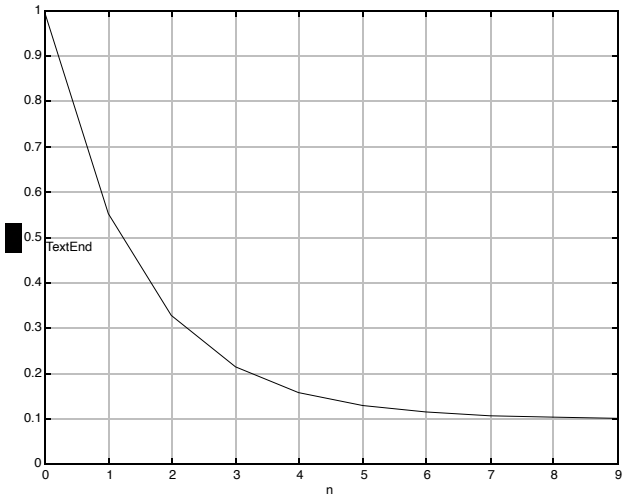
```
    0.9997
    0.5516
    0.3273
    0.2142
    0.1568
    0.1276
    0.1126
    0.1049
    0.1009
    0.0988
    0.0977
```

(b)
`w(:,N+1) =`

```
    0.1773
   -0.9185
```

(c)





2.
CASE I: $\mu = 0.3$

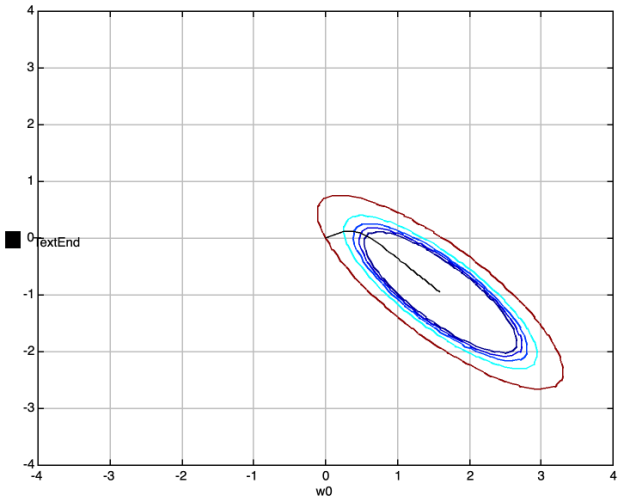
(a) `J(1:11) =`

```
    0.9991
    0.6366
    0.5187
    0.4560
    0.4088
    0.3684
    0.3326
    0.3008
    0.2723
    0.2468
    0.2241
```

(b) `w(:,11) =`

```
    0.8686
   -0.2234
```

(c)



CASE I: $\mu = 1.0$

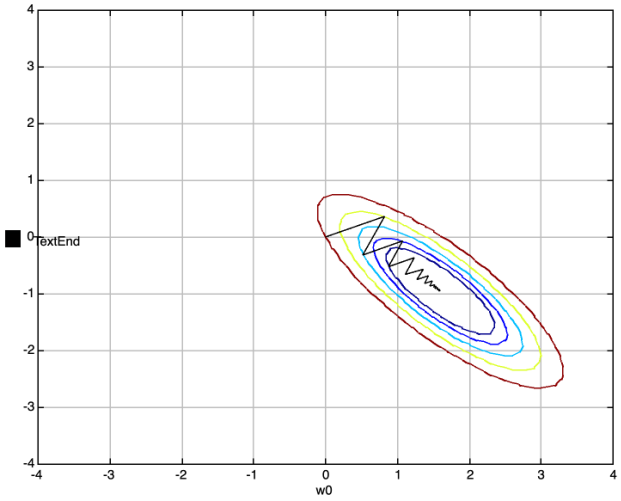
(a) `J(1:11) =`

```
    0.9991
    0.6787
    0.4645
    0.3212
    0.2254
    0.1614
    0.1186
    0.0900
    0.0708
    0.0580
    0.0495
```

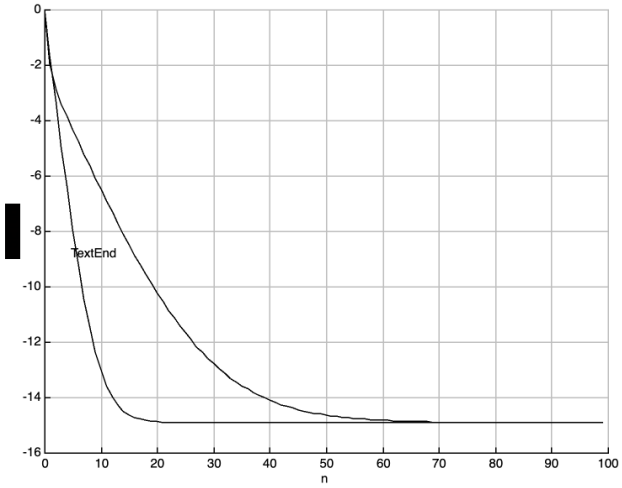
(b) `w(:,11) =`

```
    1.3814
   -0.8211
```

(c)



(d)



3.

(a)
```
J =
    0.9486
    0.4658
    0.2780
    0.2046
    0.1760
    0.1648
    0.1604
    0.1587
    0.1580
    0.1578
    0.1577
    0.1576
    0.1576
```

about 9 or 10 iterations.

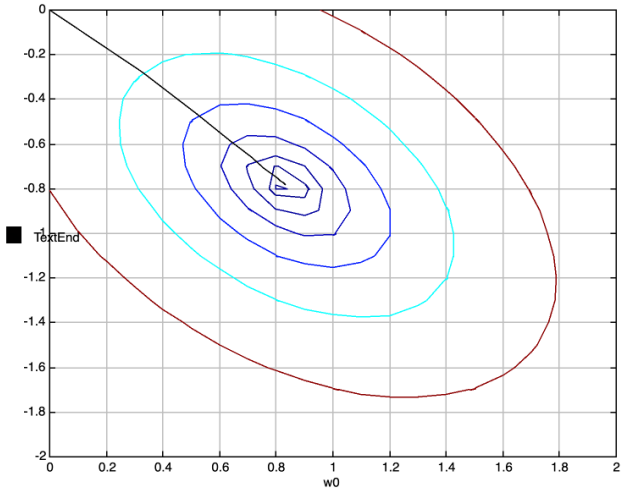
(b)
```
w(:,23) =
    0.8362
   -0.7854
```

Verified.

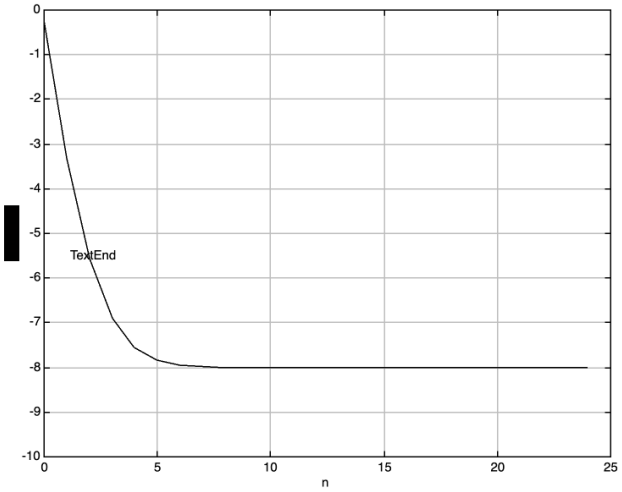
(c) `J(23) = 0.1576`

Verified.

(d)



(e)



```
% EE594 - Fall 2002 - Homework #3

%---
% 1
%---
a = [1 -0.1950 0.95]';  % X = 1.22
sigma_v = 0.0965;
%a = [1 -0.9750 0.95]';  % X = 3
%sigma_v = 0.0731;
%a = [1 -1.5955 0.95]';  % X = 10
%sigma_v = 0.0322;
%a = [1 -1.9114 0.95]';  % X = 100
%sigma_v = 0.00382179;

sigma_u = (1+a(3))/(1-a(3))*(sigma_v/((1+a(3))^2-a(2)^2));
r = [sigma_u;-a(2)/(1+a(3))*sigma_u;(-a(3) + (a(2)^2)/(1+a(3)))*sigma_u];

R = toeplitz(r(1:2));
p = [r(2) r(3)]';
mu = 0.3;
N = 10;
w_init = zeros(2,1);

[J,w] = steepest_descent(w_init,R,p,mu,sigma_u,N,1);
figure
MSE_plot(J,0,N-1,0,1)
figure
grid_data = [-2.5 2.5 0.1;-2.5 2.5 0.1];
trajectory(sigma_u,[r(1) r(2)]',p,w,J(1:5),grid_data)

%---
% 2
```

```
%---
mu = 0.3;  % mu = 0.3 or mu = 1.0
sigma_v = 0.0322;
a = [1 -1.5955 0.95]';
sigma_u = (1+a(3))/(1-a(3))*(sigma_v/((1+a(3))^2-a(2)^2));
r = [sigma_u;-a(2)/(1+a(3))*sigma_u;(-a(3) + (a(2)^2)/(1+a(3)))*sigma_u];

R = toeplitz(r(1:2));
p = [r(2) r(3)]';
N = 100;
w_init = zeros(2,1);

[J,w] = steepest_descent(w_init,R,p,mu,sigma_u,N,1);
hold on;
MSE_plot(J,0,N-1,1,1)
hold off;
figure;
grid_data = [-4 4 0.1;-4 4 0.1];
trajectory(sigma_u,[r(1) r(2)]',p,w,J(1:5),grid_data)

%---
% 3
%---
sigma_d = 0.9486;
r = [1.1 0.5]';
R = toeplitz(r(1:2));
p = [0.5272 -0.4458]';
lambda = eig(R);
mu = 1.0/max(lambda);
N = 25;
w_init = zeros(2,1);

[J,w] = steepest_descent(w_init,R,p,mu,sigma_d,N,1);
figure;
MSE_plot(J,0,N-1,1,1)
figure;
grid_data = [0 2 0.1;-2 0 0.1];
trajectory(sigma_d,r,p,w,J(1:9),grid_data)
```