

```
clear all
%% Q4 Part D
A=[-1, 1, 0;0,-1,0;0,0,1];
B=[0;1;1];
C=[1,1,0];
D=0;
xInit=[4;6;3];

sys0 = ss(A,B,C,D);

Q=eye(3);
R=1;

[K,S,P] = lqr(A,B,Q,R);

sys1 = ss(A-B*K,B,C,D);
[y0,tOut,x0] = initial(sys0,xInit);
[y1,tOut,x1] = initial(sys1,xInit,tOut);

figure(1),clf
subplot(4,1,1),hold on
plot(tOut,y0)
plot(tOut,y1)
ylabel("Output y"),xlim([0,8]),legend("Open loop","Full State Feedback")
title("LQR Solution for Q=I, R=1")
subplot(4,1,2),hold on
plot(tOut,x0(:,1))
plot(tOut,x1(:,1))
ylabel("State x[1]"),xlim([0,8]),legend("Open loop","Full State Feedback")
subplot(4,1,3),hold on
plot(tOut,x0(:,2))
plot(tOut,x1(:,2))
ylabel("State x[2]"),xlim([0,8]),legend("Open loop","Full State Feedback")
subplot(4,1,4),hold on
plot(tOut,x0(:,3))
plot(tOut,x1(:,3))
ylabel("State x[3]"),xlim([0,8]),legend("Open loop","Full State Feedback")
ylim([0,10])
xlabel("Time (s)")
%% Q4 Part E
Qs=[0.001, 1, 1000];
Rs=[0.001, 1, 1000];
figure(2),clf
figure(3),clf
figure(4),clf
figure(5),clf
for i=1:3
    for j=1:3
        Q=eye(3);
        R=1;
```

```
[K,S,P] = lqr(A,B,Q*Qs(i),R*Rs(j));

sysn = ss(A-B*K,B,C,D);
[yn,tOut,xn] = initial(sysn,xInit,tOut);

figure(2)
subplot(3,3,i*3-3+j)
plot(tOut,yn)
xlim([0,8])
%
% figure(3)
% subplot(3,3,i*3-3+j)
% plot(tOut,xn(:,1))
% xlim([0,8])
%
% figure(4)
% subplot(3,3,i*3-3+j)
% plot(tOut,xn(:,2))
% xlim([0,8])

figure(5)
subplot(3,3,i*3-3+j)
plot(tOut,xn(:,3))
xlim([0,8])
% title(sprintf("Q=%f, R=%f",Qs(i),Rs(j)))
end

end

for i=2:5
figure(i)
subplot(3,3,1), ylabel("Q=0.001")
subplot(3,3,4), ylabel("Q=1")
subplot(3,3,7), ylabel("Q=1000")

subplot(3,3,7), xlabel("R=0.001")
subplot(3,3,8), xlabel("R=1")
subplot(3,3,9), xlabel("R=1000")
end

figure(2)
subplot(3,3,2), title("Output y")

figure(5)
subplot(3,3,2), title("State X[3]")
```