Question 4 - Take Home Final Exam - Alexander Christenson

```matlab
clear all; close all;

final19_q4_data

C = 3;
D = 3;
Q = 35;

cvx_begin quiet
    variables c(T) q(T)
    minimize(p'*(u+c))
    subject to
        c <= C
        -c <= D
        q <= Q
        -q <=0
        for k=1:T-1
            c(k) == q(k+1) - q(k)
        end
        c(T) == q(1) - q(T)
cvx_end

plot(t/4,c) % I tried to match the formatting from the data file with
 this, so the time is scaled by a factor of 4
legend('price','usage','charge rate')
title('Plot of usage, price, and charge over time')
xlabel('time')
hold off

% Part c - plot the minimum total cost vs Q
Q_max = Q;
p_star = [];
for(Q=1:Q_max)
    cvx_begin quiet
        variables c1(T) q1(T)
        minimize(p'*(u+c1))
        subject to
            c1 <= C
            -c1 <= D
            q1 <= Q
            -q1 <=0
            for k=1:T-1
                c1(k) == q1(k+1) - q1(k)
            end
            c1(T) == q1(1) - q1(T)
    cvx_end

    p_star = [p_star;cvx_optval];
```

```matlab
    end

figure()
plot(1:Q_max,p_star)
hold on

C = 1;
D = 1;
p_star1 = [];

for(Q=1:Q_max)
    cvx_begin quiet
        variables c1(T) q1(T)
        minimize(p'*(u+c1))
        subject to
            c1 <= C
            -c1 <= D
            q1 <= Q
            -q1 <=0
            for k=1:T-1
                c1(k) == q1(k+1) - q1(k)
            end
            c1(T) == q1(1) - q1(T)
    cvx_end

    p_star1 = [p_star1;cvx_optval];

end

plot(1:Q_max,p_star1)
legend('C=D=3','C=D=1')
title("Trade off between minimum total cost and capacity")
xlabel("Capacity")
ylabel("Minimum total cost")

%{
What the endpoints of the graph tell us is that the capacity and
 discharge
rates are very important in determining the value of the battery. The
general trend is that as the capacity increases the total cost is
 lowered,
however this is limited by how quickly the battery can charge/
discharge. It
also tells us that faster batteries lower the cost more.
%}
```
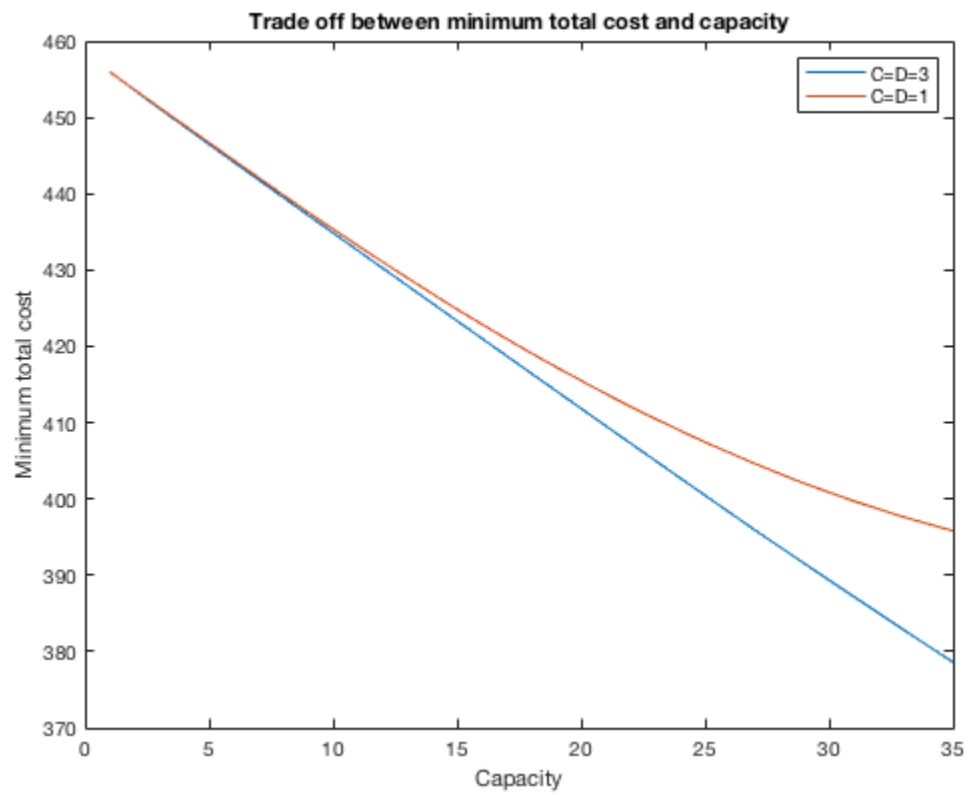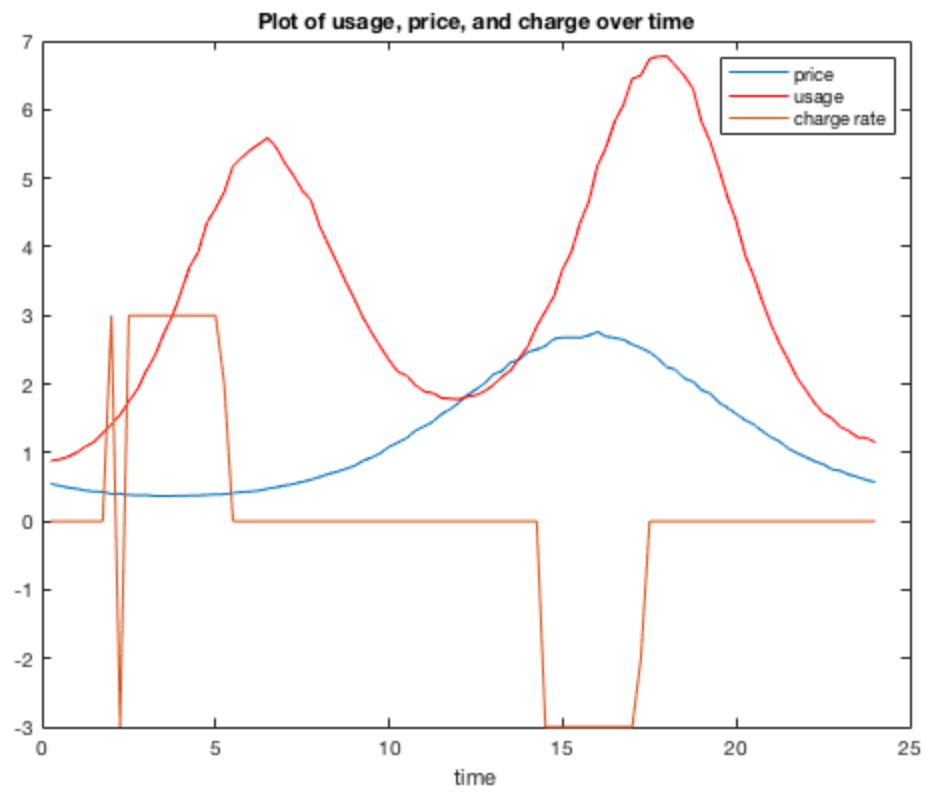
Plot of usage, price, and charge over time

Trade off between minimum total cost and capacity