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EXERCISE 6.1

$$f_y(y) = \frac{1}{\sqrt{2\pi}\sigma_y} e^{-\frac{(y-m_y)^2}{2\sigma_y^2}}$$

$$S_{yy}(\tau) = \frac{S_1}{2T_1} e^{-\frac{1}{T_1}|\tau|}$$

$$\sigma_y^2 = m_y^2 - \{m_y^{(1)}\}^2$$

$$\{m_y^{(1)}\}^2 = \lim_{\tau \to \infty} S_{yy} = 0$$

$$\sigma_y^2 = \frac{S_1}{2T_1}$$

$$f_y(y) = \frac{1}{\sqrt{2\pi}\sqrt{S_1/2T_1}} e^{-\frac{y^2}{S_1/T_1}}$$

$$f_y(y) = \sqrt{\frac{T_1}{S_1 \pi}}\, e^{-\frac{y^2}{S_1/T_1}}$$

EXERCISE 6.2

(A) $x_1 = -1$, $x_2 = 0$ and $x_3 = 1$

$$P(\{x(\zeta, t+T) = x_i\} | \{x(\zeta, t) = x_j\}) = \begin{cases} \frac{1}{3}(1+2e^{-|T|}) & \text{for } i=j \\ \frac{1}{3}(1-e^{-|T|}) & \text{for } i \neq j \end{cases} \quad i,j = 1,2,3$$

Probabilities, $P(\{x(\zeta, t) = x_i\}) = ?$ for $i = 1, 2, 3$.

$$P = \begin{cases} \frac{1}{3}(1+2e^{-|T|}) & \text{for } i=j \\ \frac{1}{3}(1-e^{-|T|}) & \text{for } i \neq j \end{cases}$$

$\frac{1}{3}(1+2e^{-|T|}) = a$

$\frac{1}{3}(1-e^{-|T|}) = b$

$t_1 = t + \tau$, $t_2 = t$

Total probability,

$P(A) = \sum_n P(A \cap B_n)$

$P(A) = \sum_n P(A|B_n) P(B_n)$ .... (i)

$P(A|B) = \frac{P(B \cap A)}{P(B)}$

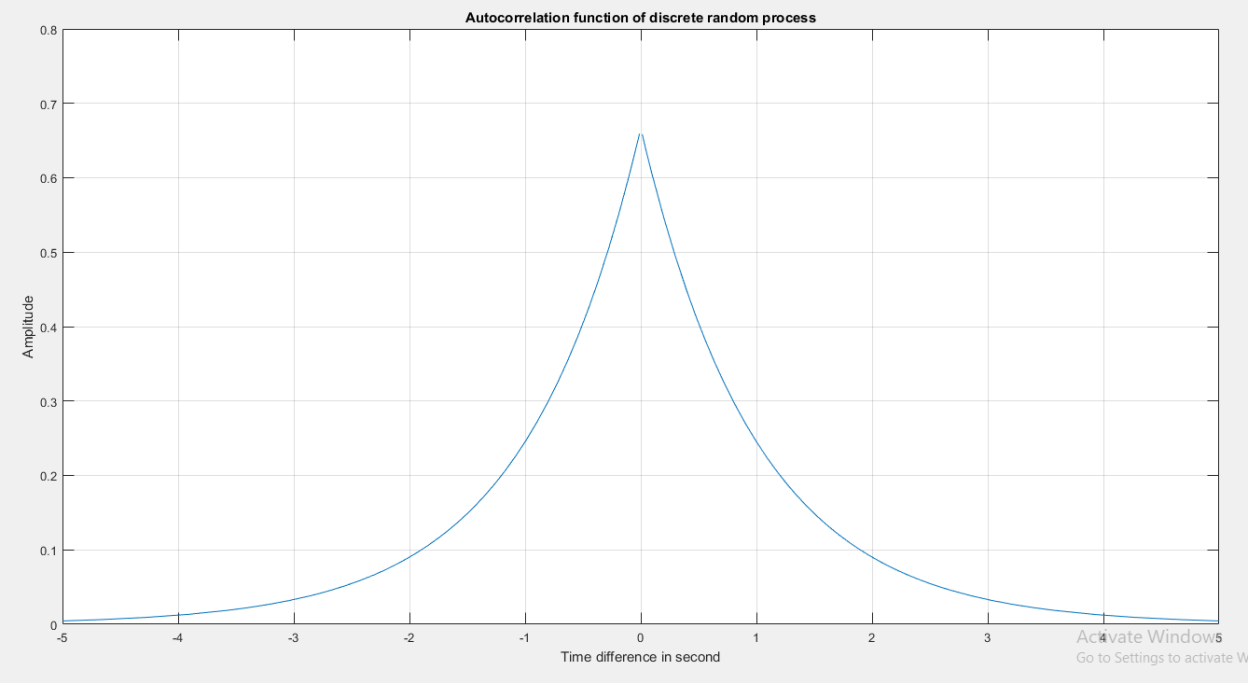
$$P_1 = P_1 a + P_2 b + P_3 b$$

$$P_2 = P_2 b + P_2 a + P_3 b$$

$$P_3 = P_1 b + P_2 b + P_3 a$$

$$\therefore \quad P_1 = P_2 = P_3 = \frac{1}{3}$$

B)

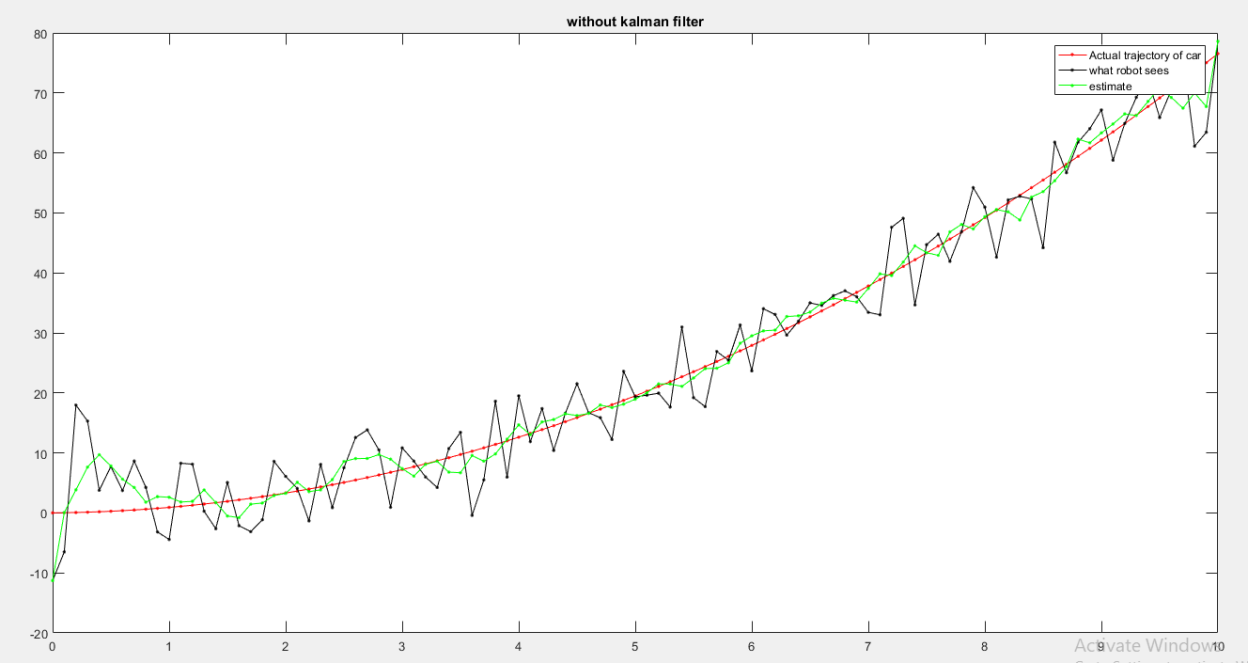


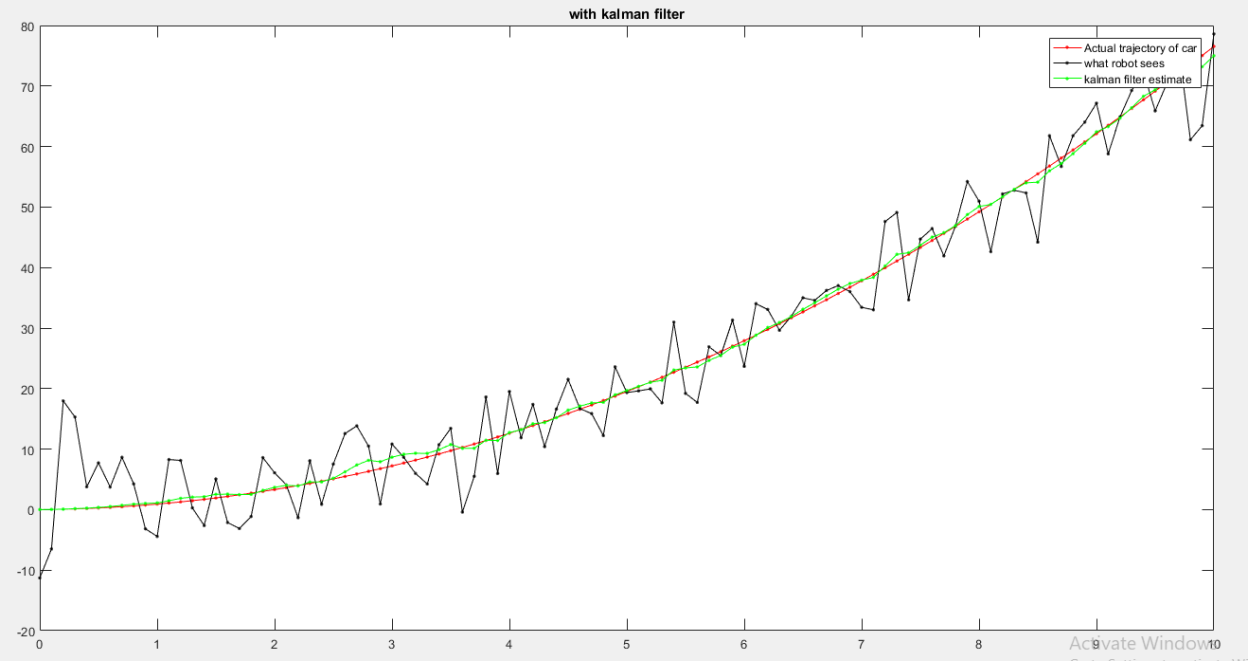

```
clc;
clear;
N = 3; %Total no of events of the discrete random process
syms tau; %Time difference
x1 = -1;
x2 = 0;
x3 = 1;
X = [x1 x2 x3];
%Conditional probabilities of event occurring
p_i_eq_j = (1+2*exp(-abs(tau)))/3;
p_i_not_eq_j = (1-exp(-abs(tau)))/3;
%Probabilities of each events
p1 = 1/3;
p2 = 1/3;
p3 = 1/3;
P = [p1 p2 p3];
%ACF of discrete random process
acf = 0;
for i = 1:N
    for j = 1:N
        if i==j
            acf = acf + X(i)*X(j)*p_i_eq_j*P(j);
        else
            acf = acf + X(i)*X(j)*p_i_not_eq_j*P(j);
        end
    end
end
acf;
figure('Name','Autocorrelation function of discrete random process');
fplot(tau,acf)
grid on
```

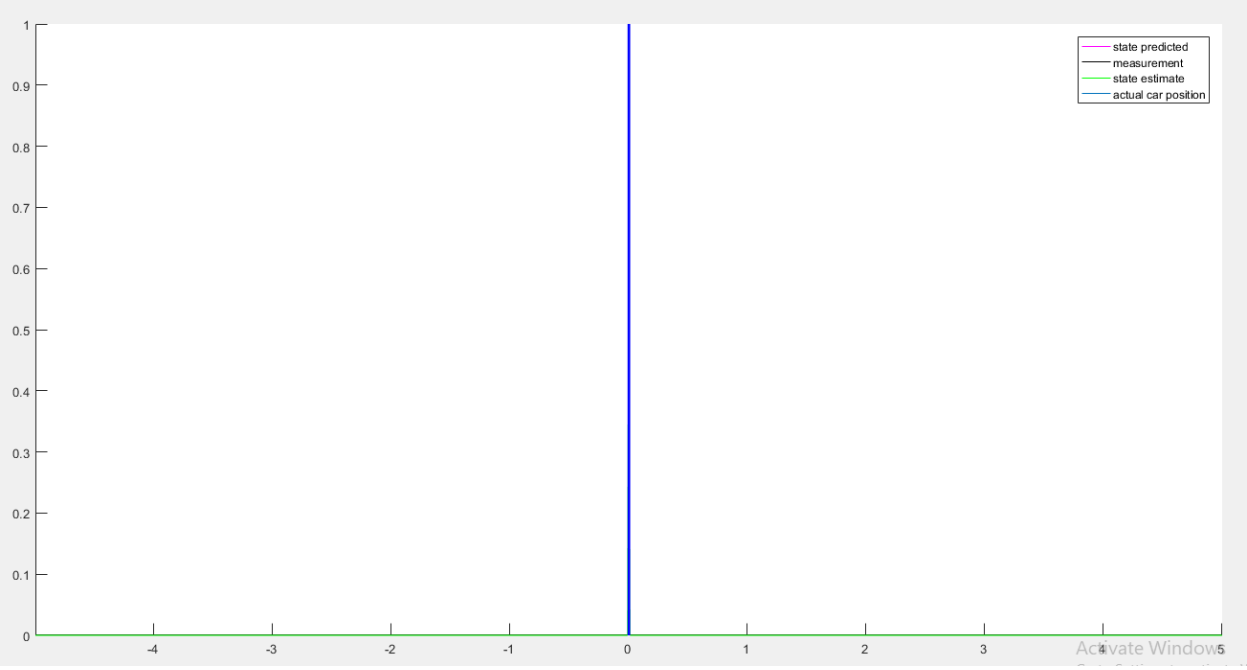
```
title('Autocorrelation function of discrete random process');
ylim([0 0.8])
xlabel('Time difference in second');
ylabel('Amplitude');
```

TASK 6.3

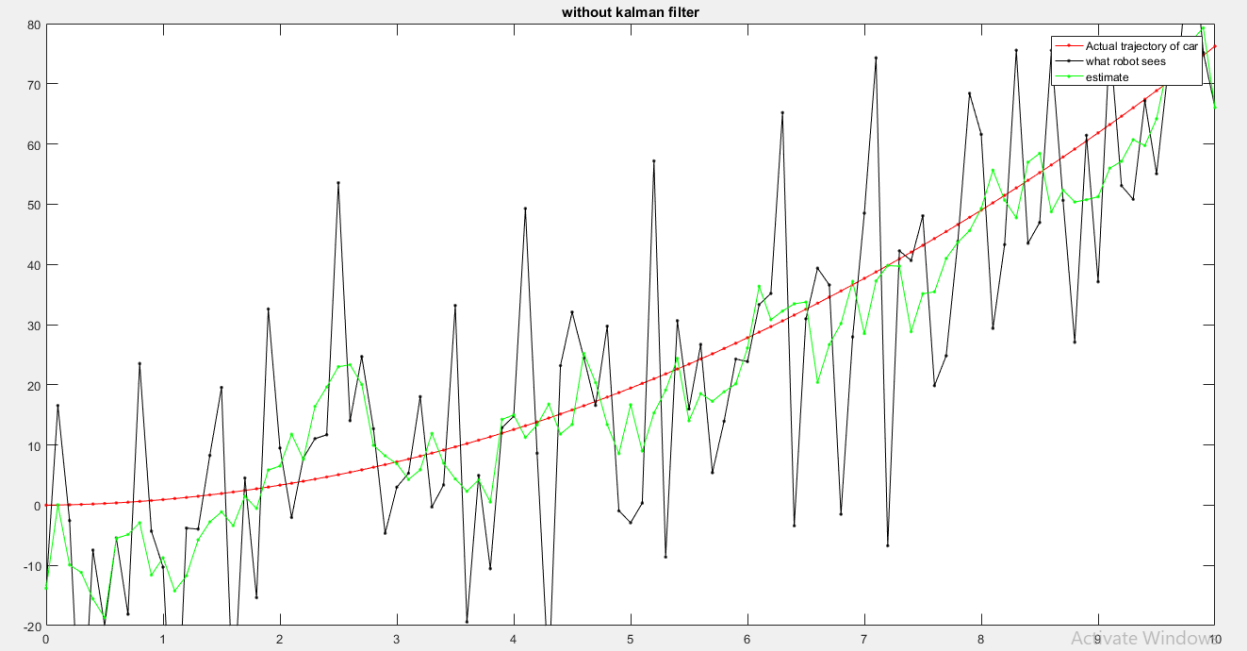
a) car_accel_noise_mag = 0.03; robot_noise_mag = 0.05;

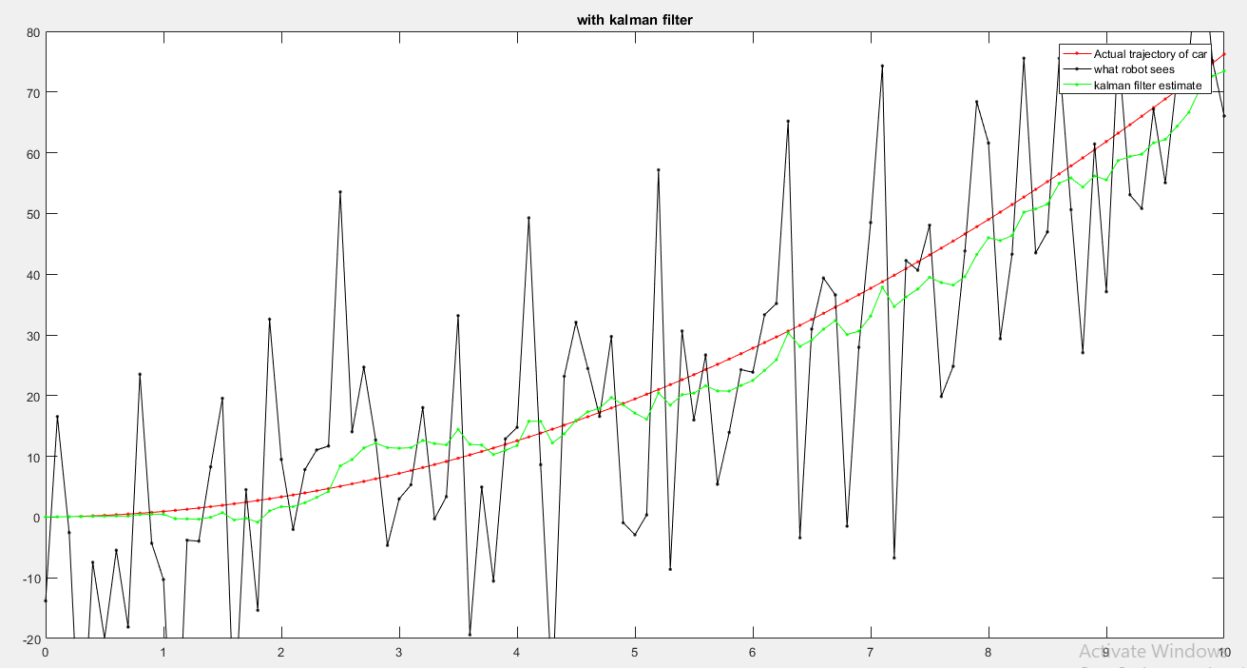


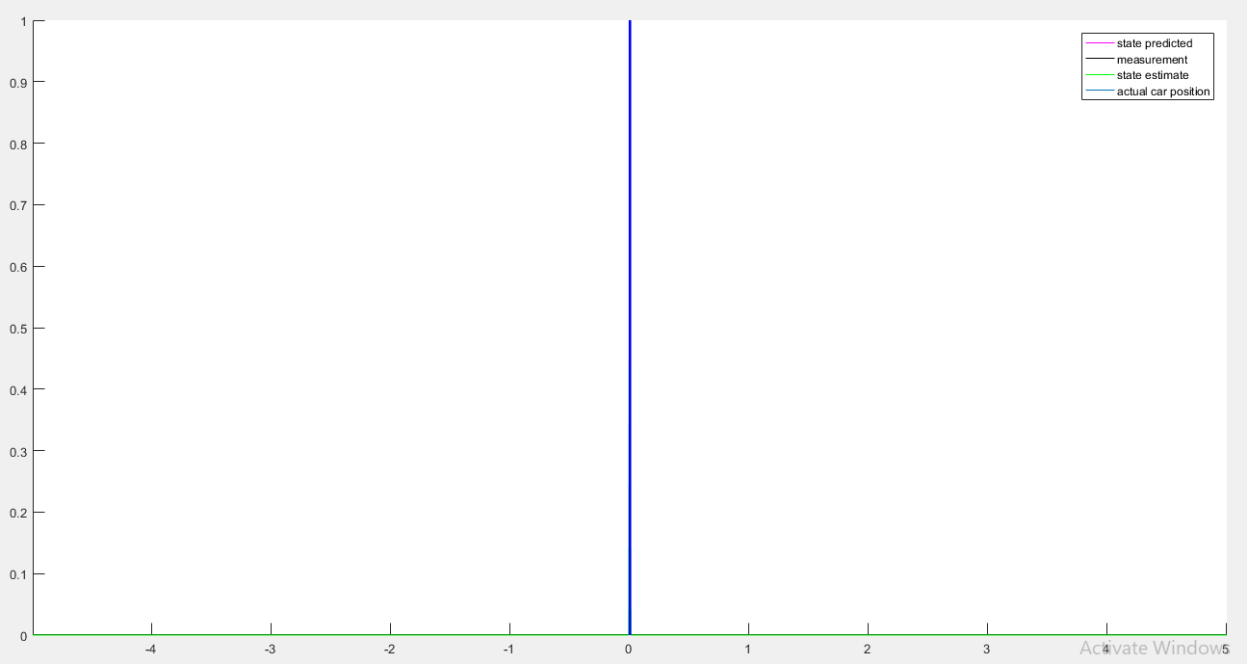




b) car_accel_noise_mag = 0.1; robot_noise_mag = 0.2;




with kalman filter
Actual trajectory of car
what robot sees
kalman filter estimate
80
70
60
50
40
30
20
10
0
-10
-20
0
1
2
3
4
5
6
7
8
9
10


state predicted
measurement
state estimate
actual car position
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-4
-3
-2
-1
0
1
2
3
4
5