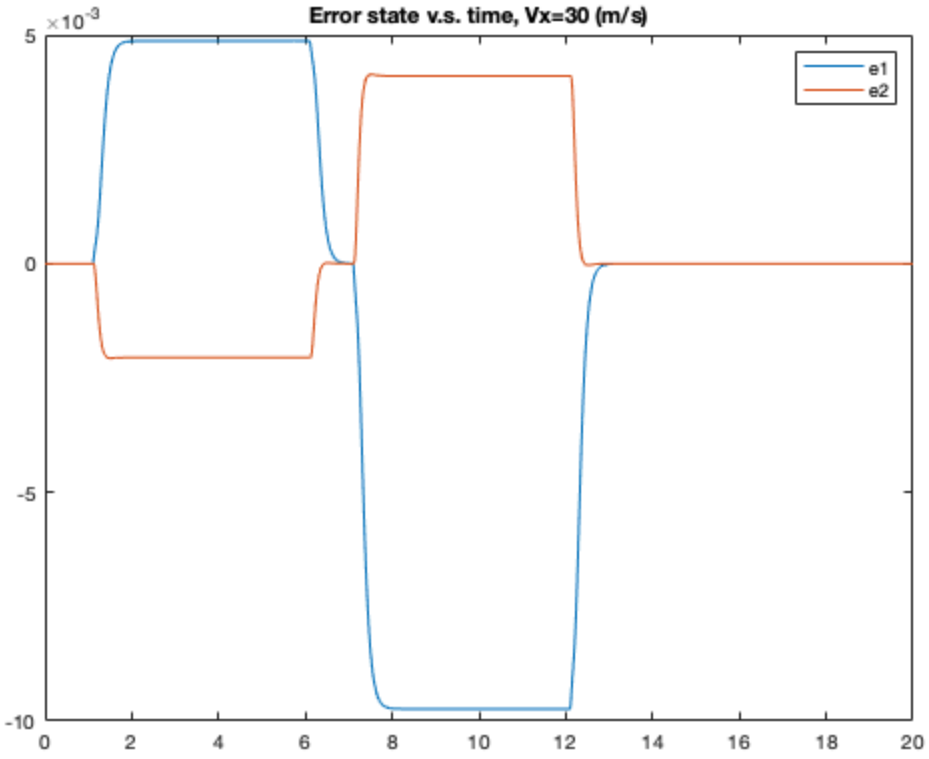
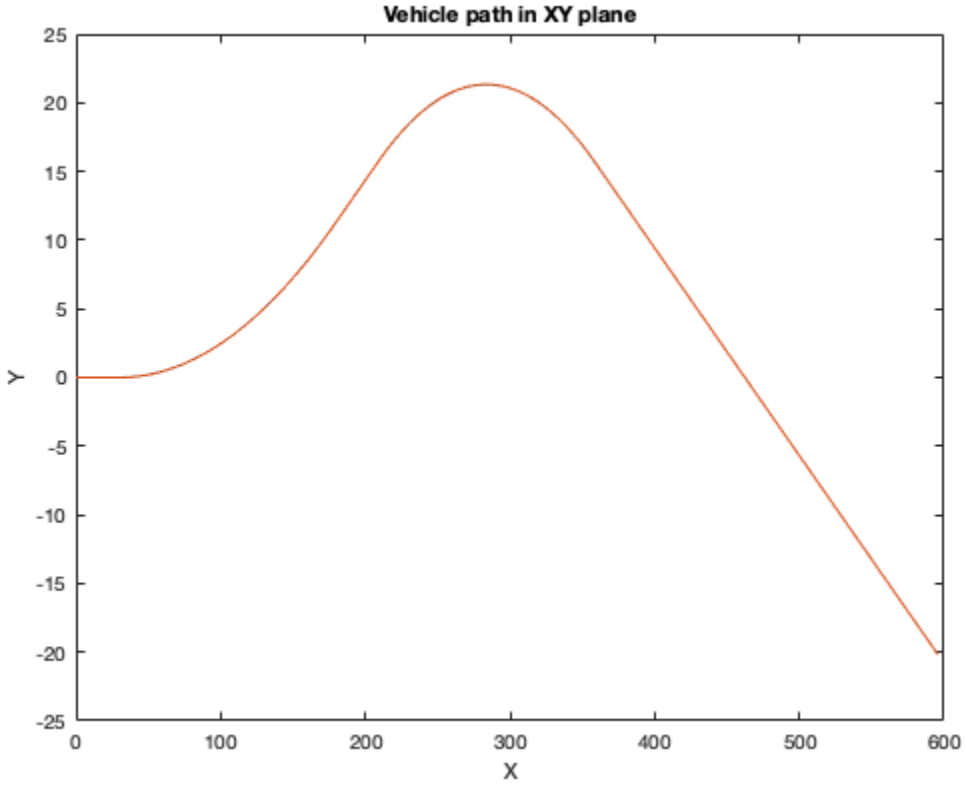
```
%Initial Condition:

xo=[0;0;0;0];

%timespan:
dt=0.01;
ts=0:dt:20;


Vx=30;
omega1=30/1000;
omega2=-30/500;
X=zeros();
Y=zeros();
X(1)=0;
Y(1)=0;


 for step=1:20/dt+1
    if  ts(step)>=0 && ts(step)<1
        theta(step)=0;
    elseif ts(step)>=1 && ts(step) <6
        theta(step)=omega1*(ts(step)-1);
    elseif ts(step)>=6 && ts(step)<7
        theta(step)=omega1*5;
    elseif ts(step)>=7 && ts(step)<12
        theta(step)=omega1*5+omega2*(ts(step)-7);
    else
        theta(step)=omega1*5+omega2*5;
    end
   if step>=2
        X(step)=X(step-1)+Vx.*cos(theta(step))*dt;
        Y(step)=Y(step-1)+Vx.*sin(theta(step))*dt;
    end

 end

[t,x]=ode45(@sys,ts,xo);



for step= 1: 20/dt+1

   xr_e(step)=x(step,1)*sin(theta(step));
   yr_e(step)=x(step,1)*cos(theta(step));

end
figure
plot (t, x(:,1))
hold on
plot (t,x(:,3))
title ('Error state v.s. time, Vx=30 (m/s)')
legend('e1','e2')
```

```
figure

 plot(X(1,:), Y(1,:))
 hold on
 plot (X(1,:)+xr_e(1,:), Y(1,:)-yr_e(1,:))
 xlabel('X')
 ylabel ('Y')
 title ('Vehicle path in XY plane')

function  dx = sys(t, x)

%Parameters:
Vx=30; %(m/s)
m=1573; %(kg)
Iz=2873; %(kg-m^2);
lf=1.1; %(m)
lr=1.58;  %(m)
Caf=80000; %(N/rad)
Car=80000;  %(N/rad)


A=[0 1 0 0; 0 -(2*Caf+2*Car)/(m*Vx) (2*Caf+2*Car)/m -
(2*Caf*lf-2*Car*lr)/(m*Vx); 0 0 0 1; 0 -(2*Caf*lf-2*Car*lr)/(Iz*Vx)
 (2*Caf*lf-2*Car*lr)/Iz -(2*Caf*lf*lf+2*Car*lr*lr)/(Iz*Vx)];
B1=[0; 2*Caf/m; 0; 2*Caf*lf/Iz];
B2=[0;-((2*Caf*lf-2*Car*lr)/(m*Vx))-Vx; 0; -(2*Caf*lf*lf+2*Car*lr*lr)/
(Iz*Vx)];


p=[-25, -10, -20+i, -20-i];
K=place(A,B1,p);

Ap=A-B1*K;     %Ap matrix after u=-Kx(t)

dt=0.1; %time for the turnning

dphi_des1=30/1000;
dphi_des2=30/500;

dphi_des =  -dphi_des1*heaviside(t-1-dt)+dphi_des1*heaviside(t-6-
dt)+dphi_des2*heaviside(t-7-dt)-dphi_des2*heaviside(t-12-dt);


dx = Ap*x+ B2*dphi_des;



end
```


Error state v.s. time, Vx=30 (m/s)
×10^-3
5
0
-5
-10
0
2
4
6
8
10
12
14
16
18
20
e1
e2


Vehicle path in XY plane
25
20
15
10
5
0
-5
-10
-15
-20
-25
Y
0
100
200
300
400
500
600
X

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